University of Thessaly

Department of Physical Education and Sport Science

PhD Program in Exercise & Health

"The effect of lifestyle modifications on aspects related to fatigue, quality of life, health and sleepiness"

by

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Ηλίας

“Never say never,

because limits,

like fears, are often just an illusion.”

Michael Jordan

Abstract

Introduction: Unhealthy lifestyle behaviors such as physical inactivity, chronic stress, irregular sleep patterns, and poor recovery practices have emerged as key contributors to fatigue, reduced quality of life and the growing prevalence of sleep-related disturbances. These factors, often coexisting in modern urban lifestyles, are strongly associated with metabolic, psychological, and neurological dysfunctions. Within this scientific and public health context, lifestyle medicine promotes a holistic, behavior-focused approach to restoring and maintaining health through non-pharmacological interventions. Among these, massage therapy whether manual or mechanical has gained attention as a potentially effective method for improving sleep, enhancing recovery and promoting both mental and physical well-being.

The current PhD thesis explores the efficacy of lifestyle-based, non-invasive therapeutic modalities, with an emphasis on massage interventions, in improving sleep parameters, managing fatigue and enhancing quality of life. Utilizing objective tools (e.g., PSG-EEG) and subjective assessments (e.g., validated questionnaires), this thesis consists of five distinct but thematically interlinked experimental studies conducted in real-life and clinical settings.

Aims: The primary purpose of this doctoral thesis was to investigate the acute and chronic effects of various types of massage therapy on vigilance and alertness levels in healthy people and those suffering from insomnia symptoms. Specifically, the objectives were to Study 1: to evaluate the timing effect of pre-competition sports massage, using two different massage oils, on sprint performance, Study 2: to investigate the effect of two different types of manual massage sessions on day-time napping in poor sleepers, Study 3: to assess the effectiveness of a single session of relaxation massage prior to bedtime on sleep quality and quantity indices in individuals with symptoms of chronic insomnia, Study 4: to examine the effectiveness of various massage protocols available on automatic electric massage chair (AEMC) prior to daytime nap on relaxation and indices of sleep quality and Study 5: to assess the long-term impact of the new generation massage chairs in aspects relate to sleep and quality of life in individuals with severe symptoms of insomnia.

Methodology: The present PhD thesis divided into 5 studies. The total sample (N=99) consisted of healthy adults, athletes and individuals with severe insomnia symptoms. Inclusion criteria such as PSQI >5 or AIS ≥16 was used to identify poor sleepers and individuals with insomnia. Participants took part in a range of interventions involving either manual massage (e.g., sports massage and/or relaxation massage) or mechanical massage via automatic electric massage chairs, with each protocol designed to examine short-term or long-term effects on sleep behavior, indices and psychological status.

Across all studies, participants were exposed to multiple conditions, including control (no massage), "sham" and active interventions. Interventions ranged from 5 to 45 minutes in duration (i.e., 5, 30, or 45 minutes) and were delivered either by trained massage professionals or through standardized automatic massage chair programs targeting sleep and fatigue recovery or relaxation.

Sleep was monitored using polysomnographic EEG systems, while additional physiological parameters (e.g., muscle tone, heart rate) and psychological states (e.g., relaxation, level of fatigue, alertness) were assessed via validated questionnaires and functional tests (e.g. handgrip).

Results: The overall findings of this doctoral thesis demonstrate that massage-based interventions both manual and automated produced significant improvements in a wide range of physiological and psychological outcomes across various populations. Massage protocols led to measurable enhancements in physical performance, muscle tone, sleep parameters and subjective states of relaxation. Specifically, (Study 1) sports massage was found to significantly enhance athletic performance, particularly when applied after warm-up and combined with essential oils, leading to a meaningful reduction in sprint times. (Study 2,3) Relaxation massage consistently increased subjective relaxation scores, reduced muscle tone and improved sleep parameters such as sleep efficiency, sleep latency and sustained sleep duration, as recorded by polysomnography-EEG device and sleep diaries. Furthermore, (Study 4) the use of an automatic electric massage chair (AEMC), yielded both immediate and long-term benefits. Short-term sessions improved sleep efficiency and physiological relaxation markers (e.g., heart rate and muscle tone), while long-term use (Study 5) led to clinically relevant improvements in sleep quality and total sleep time, as well as significant reductions in insomnia symptoms.

Discussion: In the current PhD research thesis, we have found that massage-based interventions both manual and mechanical can exert significant beneficial effects on multiple dimensions of performance and health, particularly in relation to sleep quality, fatigue, and subjective well-being. Across five thematically linked experimental studies, our findings consistently demonstrated that targeted massage protocols led to improvements in both objective (e.g., EEG-derived sleep quality, efficiency, sprint performance) and subjective (e.g., sleepiness scales, quality-of-life indices) outcomes.

Conclusion: This doctoral thesis confirms the application of massage, manual or mechanical can be a scientifically validated, non-pharmacological tool for improving physiological performance, sleep quality, reducing fatigue, and enhancing overall quality of life. The integration of electrophysiological, psychological, and physical performance indicators strengthens the case for embedding massage interventions within broader lifestyle medicine frameworks.

Moreover, the use of advanced technologies such as AEMCs opens new possibilities for self-directed, accessible treatment at home. Future research should prioritize large-scale clinical trials, long-term follow-up, and cost-effectiveness studies to evaluate broader implementation in pre-clinical, clinical and community settings. Ultimately, the findings of the present work support the integration of massage-based interventions into comprehensive health promotion and chronic disease prevention strategies.

“Η Επίδραση της Αλλαγής του Τρόπου Ζωής στις Πτυχές που Σχετίζονται με την Κόπωση, την Ποιότητα Ζωής, την Υγεία και την Υπνηλία”

Περίληψη

Εισαγωγή: Ανθυγιεινές συμπεριφορές τρόπου ζωής, όπως η σωματική αδράνεια, το χρόνιο άγχος, οι ακανόνιστοι ρυθμοί ύπνου και οι ελλιπείς πρακτικές αποκατάστασης, από επίπονη εργασία ή έντονη άσκηση, έχουν αναδειχθεί ως βασικοί παράγοντες που συμβάλλουν στην συνολική κόπωση, τη μείωση της ποιότητας ζωής και την αυξανόμενη επικράτηση διαταραχών σχετικών με τον ύπνο. Οι παράγοντες αυτοί, που συχνά συνυπάρχουν στο σύγχρονο αστικό περιβάλλον, συνδέονται στενά με μεταβολικές, ψυχολογικές και νευρολογικές δυσλειτουργίες. Στο πλαίσιο αυτό, η Ιατρική του Τρόπου Ζωής προάγει μια ολιστική προσέγγιση με επίκεντρο τη συμπεριφορά, στοχεύοντας στην αποκατάσταση και διατήρηση της υγείας μέσω μη φαρμακευτικών παρεμβάσεων. Μεταξύ αυτών, παρεμβάσεις μάλαξης είτε που εφαρμόζεται χειρωνακτικά είτε μηχανικά αυτοματοποιημένη (π.χ. αυτόματη ηλεκτρική καρέκλα μάλαξης) έχει συγκεντρώσει το επιστημονικό ενδιαφέρον ως ενδεχομένως αποτελεσματική μέθοδος βελτίωσης του ύπνου, ενίσχυσης της αποκατάστασης και προαγωγής της ψυχικής και σωματικής ευεξίας.

Η παρούσα διδακτορική διατριβή διερευνά την αποτελεσματικότητα των μη φαρμακευτικών, βασισμένων στον τρόπο ζωής θεραπευτικών παρεμβάσεων, με έμφαση στις εφαρμογές της μάλαξης, στην ενίσχυση των παραμέτρων του ύπνου, στη διαχείριση της κόπωσης και στη βελτίωση της ποιότητας ζωής. Μέσω της χρήσης αντικειμενικών εργαλείων (όπως PSG-EEG) και υποκειμενικών αξιολογήσεων (όπως επικυρωμένα ερωτηματολόγια), η διατριβή αυτή αποτελείται από πέντε διακριτές αλλά θεματικά διασυνδεδεμένες πειραματικές μελέτες που διεξήχθησαν σε συνθήκες πεδίου και κλινικές συνθήκες.

Σκοποί: Ο κύριος σκοπός της παρούσας διδακτορικής διατριβής είναι η διερεύνηση των οξέων και χρόνιων επιδράσεων διαφόρων τύπων θεραπείας μέσω του μασάζ στα επίπεδα εγρήγορσης και επαγρύπνησης τόσο σε υγιή άτομα όσο και σε άτομα με συμπτώματα αϋπνίας. Συγκεκριμένα εξετάστηκε, Μελέτη 1: κατά πόσο η εφαρμογή αθλητικής μάλαξης πριν από δρόμο ταχύτητας (σπριντ), με χρήση δύο διαφορετικών

ελαίων, επηρεάζει την απόδοση στο σπριντ, Μελέτη 2: κατά πόσο δύο διαφορετικοί τύποι χειρομαλάξεων επηρεάζουν τη διάρκεια και την ποιότητα του μεσημεριανού ύπνου σε άτομα με ελλιπή ύπνο, Μελέτη 3: μια και μόνο συνεδρία χαλαρωτικής μάλαξης πριν την ώρα κατάκλισης βελτιώνει τους δείκτες ποιότητας και ποσότητας ύπνου σε άτομα με συμπτώματα χρόνιας σοβαρής αϋπνίας, Μελέτη 4: να εξεταστούν διάφορα πρωτόκολλα μάλαξης μέσω αυτόματης ηλεκτρικής καρέκλας μασάζ (AEMC) πριν τον μεσημεριανό ύπνο, αν επηρεάζουν τη χαλάρωση και παραμέτρους ποιότητας ύπνου και Μελέτη 5: κατά πόσο οι καρέκλες μάλαξης νέας γενιάς επιδρούν μακροπρόθεσμα στον ύπνο και στην ποιότητα ζωής σε άτομα με σοβαρά συμπτώματα αϋπνίας.

Μεθοδολογία: Η παρούσα διδακτορική διατριβή χωρίζεται σε πέντε επιμέρους μελέτες. Το συνολικό δείγμα (N=99) περιλάμβανε υγιείς ενήλικες, αθλητές και άτομα με κλινικά σημαντικά συμπτώματα αϋπνίας. Ως κριτήρια ένταξης για τον εντοπισμό κακής ποιότητας ύπνου ή αϋπνίας χρησιμοποιήθηκαν τιμές ερωτηματολογίων όπως PSQI >5 ή AIS ≥16. Οι συμμετέχοντες έλαβαν μέρος σε ποικίλες παρεμβάσεις που περιλάμβαναν είτε χειρωνακτική μάλαξη(π.χ. αθλητική ή χαλαρωτική μάλαξη) είτε μηχανική μάλαξη μέσω αυτόματων ηλεκτρικών καρεκλών μάλαξης, με κάθε πρωτόκολλο να έχει σχεδιαστεί για να εξετάζει τις βραχυπρόθεσμες ή μακροπρόθεσμες επιδράσεις της παρέμβασης στη συμπεριφορά ύπνου και στην ψυχο-φυσιολογική κατάσταση των ατόμων.

Σε όλες τις μελέτες, οι συμμετέχοντες συμμετείχαν σε πολλαπλές συνθήκες, συμπεριλαμβανομένων της ομάδας ελέγχου (χωρίς παρέμβαση μάλαξης), «εικονικών» και ενεργών παρεμβάσεων μάλαξης. Οι παρεμβάσεις διήρκησαν από 5 έως 45 λεπτά (δηλαδή 5, 30 ή 45 λεπτά) και εφαρμόστηκαν είτε από εκπαιδευμένους επαγγελματίες μασάζ είτε μέσω τυποποιημένων προγραμμάτων αυτόματων καρεκλών μασάζ, με στόχο τη βελτίωση του ύπνου, τη χαλάρωση και την ανάνηψη από την κόπωση .

Ο ύπνος παρακολουθήθηκε μέσω πολυυπνογραφικών συστημάτων EEG, ενώ επιπλέον φυσιολογικές παράμετροι (π.χ. μυϊκός τόνος, καρδιακός ρυθμός) και ψυχολογικές καταστάσεις (π.χ. χαλάρωση, κόπωση, εγρήγορση) αξιολογήθηκαν μέσω έγκυρων ερωτηματολογίων και λειτουργικών δοκιμασιών. Ως κριτήρια ένταξης για τον εντοπισμό κακής ποιότητας ύπνου ή αϋπνίας χρησιμοποιήθηκαν τιμές ερωτηματολογίων όπως PSQI >5 ή AIS ≥16.

Αποτελέσματα: Τα συνολικά ευρήματα της παρούσας διδακτορικής διατριβής καταδεικνύουν ότι οι παρεμβάσεις με βάση τη μάλαξη, είτε μάλαξη που εφαρμόζεται με το χέρι είτε αυτοματοποιημένη μάλαξη με αυτόματη ηλεκτρική καρέκλα μασάζ νέας γενιάς, παρήγαγαν σημαντικές βελτιώσεις σε ένα ευρύ φάσμα φυσιολογικών και ψυχολογικών παραμέτρων σε διάφορους πληθυσμούς. Συνολικά, τα πρωτόκολλα μάλαξης οδήγησαν σε μετρήσιμες ενισχύσεις της αθλητικής απόδοσης, του μυϊκού τόνου, βελτίωση των παραμέτρων του ύπνου και των υποκειμενικών καταστάσεων χαλάρωσης. Συγκεκριμένα, (Μελέτη 1) η αθλητική μάλαξη φάνηκε να ενισχύει σημαντικά την αθλητική απόδοση, ιδίως όταν εφαρμοζόταν μετά την προθέρμανση και σε συνδυασμό με τη χρήση αιθέριων ελαίων, οδηγώντας σε σημαντική μείωση του χρόνου ολοκλήρωσης σε δοκιμασίες ταχύτητας (σπριντ).

Η χαλαρωτική μάλαξη αύξησε σταθερά τα υποκειμενικά σκορ χαλάρωσης, μείωσε τον μυϊκό τόνο και βελτίωσε τις παραμέτρους του ύπνου, όπως η αποδοτικότητα ύπνου (Sleep Efficiency), ο λανθάνων χρόνος έναρξης ύπνου (Sleep Latency) και η διατηρούμενη διάρκεια ύπνου (Sustained Sleep duration), όπως καταγράφηκαν μέσω πολυυπνογραφικής συσκευής EEG και ημερολογίων ύπνου (Μελέτη 2,3).

Επιπλέον, η χρήση αυτόματης ηλεκτρικής καρέκλας μάλαξης (AEMC) απέφερε τόσο άμεσα (Μελέτη 4) όσο και μακροπρόθεσμα οφέλη (Μελέτη 5). Βραχυπρόθεσμες συνεδρίες βελτίωσαν την αποδοτικότητα ύπνου και δείκτες φυσιολογικής χαλάρωσης (π.χ. καρδιακός ρυθμός και μυϊκός τόνος), ενώ η μακροχρόνια χρήση οδήγησε σε κλινικά σημαντικές βελτιώσεις στην ποιότητα ύπνου και στη συνολική διάρκεια ύπνου, καθώς και σε σημαντικές μειώσεις των συμπτωμάτων αϋπνίας.

Συζήτηση: Στην παρούσα διδακτορική διατριβή διαπιστώθηκε ότι οι παρεμβάσεις με βάση τη μάλαξη, τόσο η χειρωνακτική μάλαξη όσο και η μηχανική (μέσω καρεκλών μάλαξης), μπορούν να επιφέρουν σημαντικά ευεργετικά αποτελέσματα σε πολλαπλές διαστάσεις της απόδοσης και της υγείας, ιδίως σε σχέση με την ποιότητα ύπνου, την κόπωση και την υποκειμενική ευεξία. Σε πέντε θεματικά συνδεδεμένες πειραματικές μελέτες, τα ευρήματά μας κατέδειξαν με συνέπεια ότι στοχευμένα πρωτόκολλα μάλαξης οδήγησαν σε βελτιώσεις τόσο σε αντικειμενικούς δείκτες (π.χ. ποιότητα ύπνου μέσω EEG, αποδοτικότητα ύπνου, επίδοση σε σπριντ) όσο και σε υποκειμενικούς δείκτες (π.χ. κλίμακες υπνηλίας, δείκτες ποιότητας ζωής).

Συμπεράσματα: Η παρούσα διδακτορική διατριβή επιβεβαιώνει ότι η εφαρμογή μάλαξης, χειρωνακτική ή μηχανική, μπορεί να αποτελέσει ένα επιστημονικά τεκμηριωμένο, μη φαρμακευτικό εργαλείο για τη βελτίωση της σωματικής απόδοσης, ποιότητας ύπνου, τη μείωση της κόπωσης και την ενίσχυση της συνολικής ποιότητας ζωής. Η βελτίωση ηλεκτροφυσιολογικών, ψυχολογικών και δεικτών φυσικής απόδοσης ενισχύει την επιχειρηματολογία για την ενσωμάτωση των παρεμβάσεων μάλαξης σε ευρύτερο πλαίσιο εφαρμογών της Ιατρικής του Τρόπου Ζωής.

Επιπλέον, η χρήση προηγμένων τεχνολογιών όπως οι Αυτόματες Ηλεκτρικές Καρέκλες Μάλαξης (AEMC) ανοίγει νέες δυνατότητες για εξατομικευμένη, εύκολα προσβάσιμη θεραπεία στο σπίτι. Μελλοντικές έρευνες θα πρέπει να επικεντρωθούν σε ευρείας κλίμακας κλινικές δοκιμές, μακροχρόνια παρακολούθηση και μελέτες κόστους-αποτελεσματικότητας για την αξιολόγηση της εφαρμογής σε κλινικά και κοινοτικά περιβάλλοντα. Συνολικά, τα ευρήματα υποστηρίζουν την ενσωμάτωση των παρεμβάσεων μάλαξης σε ολοκληρωμένες στρατηγικές προαγωγής υγείας και πρόληψης χρόνιων νοσημάτων.

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List of abbreviations

AEO= Sports massage using activation essential oil

BO= Sports massage using baby oil

REL= Relaxation massage

ACT= Activation massage/sports massage

PSG= Polysomnography system

EEG= Electroencephalography

PSQI= Pittsburgh Sleep Quality Index Score

RSQ= Relaxation State Questionnaire

SF-36= 36-Item Short Form Survey Instrument

BDI= Beck's Depression Inventory

PSS= Perceived Stress Scale

HST= The Home Sleep Test/a portable sleep monitoring system

BMI= Body Mass Index.

PLA= Placebo/Sham massage

AIS-8= Athens Insomnia Scale

STAI= State-Trait Anxiety Inventory

DSQ-5= Daily Questionnaire-5 Days

AEMC= Automatic Electric Massage Chair

VASS= Visual Analog Sleepiness Scale

ES= Easy Sleep Automatic Massage Program

FR= Fatigue Recovery Automatic Massage Program

WM= Worker-Mode Automatic Massage Program

TST= Total Sleep Time

Introduction

Modern societies are increasingly confronted with the consequences of unhealthy lifestyle habits, such as physical inactivity, poor dietary patterns, excessive stress and insufficient sleep.[1,2] These lifestyle-related factors are now recognized as major contributors to the global burden of chronic cardiometabolic diseases and diminished quality of life, acting through complex biological pathways including inflammation, endocrine signaling and metabolic regulation.[3] The World Health Organization emphasizes the need for holistic, multidimensional strategies that address physical, mental and social well-being simultaneously. In this context, Lifestyle Medicine has emerged as a scientifically grounded approach that aims to prevent and manage chronic diseases through the promotion of healthy behaviors and behavioral change interventions.[4]

Among the core pillars of Lifestyle Medicine, particular emphasis is placed on physical activity, balanced nutrition, stress management, abstaining from toxic substances, caring for sexual health, developing and maintaining positive social relationships, reducing exposure to environmental risks and high-quality sleep all of which directly influence psychological resilience, cognitive performance and physical functioning.[5] Of growing interest in recent years is the role of sleep in maintaining overall health. Sleep is a highly regulated biological process essential not only for physical recovery and immune function but also for metabolic health. Insufficient or poor-quality sleep has been identified as a key risk factor for metabolic dysfunction, including obesity and type 2 diabetes, as well as for various mental health conditions such as depression and anxiety.[6]

The modern epidemic of insomnia and sleep disorders has prompted the scientific community to seek safe, effective, and sustainable non-pharmacological solutions. Within this scope, relaxation techniques such as massage therapy[7], mindfulness[8] and structured physical exercise[9] have gained popularity as adjunctive interventions that can enhance sleep quality and overall well-being. Massage therapy, particularly relaxation massage based on Swedish techniques, has demonstrated significant benefits for reducing cortisol levels, enhancing parasympathetic activity, increasing melatonin secretion, and promoting a sense of calm and physical relief.[10]

Despite these promising findings, the literature still suffers from methodological limitations, such as small sample sizes and limited use of objective sleep assessment methods (e.g., electroencephalography).

Similarly, the prevalence of both mental and physical fatigue has emerged as a significant barrier to daily functioning productivity and psychosocial well-being.[11] Chronic fatigue frequently coexists with sleep disturbances, creating a vicious cycle that compromises an individual's ability to maintain homeostasis and cope with daily demands.[12] Accordingly, improving fatigue and sleep-related symptoms through lifestyle-based strategies (i.e., massage therapies) constitutes an urgent public health objective.

This doctoral dissertation is situated within this broader scientific and societal context. It explores the effects of lifestyle interventions particularly those involving massage therapy and sleep hygiene on key dimensions of health, including sleep quality, fatigue, stress, and quality of life. By employing a multidisciplinary framework that incorporates elements of sleep physiology, exercise science and lifestyle medicine the research aims to provide evidence-based insights into how non-pharmacological interventions can restore balance and improve psychosomatic functioning.

Furthermore, through a series of five independent but thematically connected studies, the dissertation evaluates the acute and chronic effects of targeted interventions ranging from relaxation massage to the use of automatic electric massage chairs on both healthy and clinical populations. Objective sleep assessments, subjective well-being indices, and psychophysiological measures are utilized to capture the multidimensional impact of these interventions. The overarching goal is to advance scientific knowledge on effective lifestyle-based strategies that promote recovery and sustainable health outcomes.

Aims – Significance

The aim of the current PhD research thesis was to assess the effectiveness of lifestyle-based, non-pharmacological interventions specifically relaxation massage, sports massage, and sleep hygiene practices on key health parameters such as sleep quality, daytime sleepiness, sprint performance, stress levels, and overall quality of life. More specifically, the primary objective of the study was to evaluate the acute and long-term effects of these interventions on critical indicators of physical and psychological well-being, using both objective and subjective assessment methods. More specific:

1. To evaluate the overall and timing effect of a commonly used pre-competition sports massage, using two different massage oils, on sprint performance (chapter 1).
2. To investigate the effect of two different types of manual massage sessions on day-time napping in poor sleepers (chapter 2).
3. To assess the effectiveness of a single session of relaxation massage prior to bedtime on sleep quality and quantity indices in individuals with symptoms of chronic insomnia, defined by an Athens Insomnia Scale score of 16 or higher, indicating severe insomnia. (chapter 3).
4. To examine the effectiveness of various massage protocols available in automatic electric massage chairs (AEMCs) applied prior to daytime nap on relaxation and indices of sleep quality (chapter 4).
5. To assess the long-term impact of the new generation of massage chairs in aspects related to sleep and quality of life in individuals with severe insomnia, defined as those scoring 16 or higher on the Athens Insomnia Scale (chapter 5).

Evidence-based practice is an approach to professional decision-making which is based on the quality, relevance and consistency of scientific evidence that improves outcomes following a specific intervention. In the case of massage applications, the evidence-base is still lacking, whether at the efficacy level (i.e. under ideal/controlled conditions) or, more so, at the effectiveness level (i.e. under field/real-life conditions). The gaps in the evidence-base exist despite the immense popularity of various massage protocols, which are implemented in various professional service contexts, including sport, health and the well-being industry targeting healthy and non-healthy populations. Moreover, given the labor intensive nature of manual massage, technological advancements have been invested in the

creation and promotion of whole body massage machines, in the form of chairs, to promote efficiency (i.e. without waste or use of human effort and time) and accessibility. Still, there is no sufficient evidence of their effectiveness. Thus, the significance of the present work is very high. By systematically researching various effects of popular massage applications the present work can contribute to the evidence-base of massage applications and help sport, health and well-being professionals take research-informed decisions on the relevance of massage applications for their clients.

Literature Review

1. Definition of Health

The World Health Organization (WHO, 1948) defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity".[13] This holistic view underscores the interplay between biological, psychological and social determinants of health.[14] This definition, although formulated many decades agoand despite the criticism that it can be considered "utopian", remains relevant today as it acknowledges the holistic nature of human health, highlighting the importance of quality of life. According to this definition, health is a dynamic state that is not confined to a specific moment in time or a particular condition of the organism, but encompasses the ongoing interaction with the environment, social conditions, and personal behaviors.[15] Thus, health is viewed not only as a biological parameter, but also as reflecting an individual's overall perceived quality of life, which is influenced by personal, social and environmental factors.[16] Since quality of life is a key aspect in health assessment, it is essential to examine the tools used for its evaluation as well. To better understand this multifaceted nature of health, the biopsychosocial model offers a comprehensive framework.

1.1 Biopsychosocial Model of Health

Within the field of health, Quality of Life (QoL) has significantly evolved in recent years and has become a central indicator in the evaluation of an individual's health.[17] This concept recognizes that health is not limited to the absence of disease or disability, but encompasses a multidimensional approach that evaluates an individual's overall well-being and life satisfaction.[18] According to the WHO, quality of life (QoL) refers to an individual's subjective perception of their position in life, in the context of their culture, value systems, goals and expectations. Therefore, quality of life is subjective and depends on each person's perception of whether their life conditions meet their expectations and needs.[19]

Physical well-being refers to the bodily conditions associated with an individual's overall health, such as physical fatigue, mobility, and pain.[20] These factors directly impact daily life, functionality, and an individual's ability to perform daily activities. The psychological dimension encompasses emotional status, mental health, cognitive functioning, and perceived well-being.[21] Emotional well-being encompasses psychological balance, a sense of happiness, and the ability to manage stress and life pressures.[22] The quality of social relationships refers to interpersonal connections, such as support from friends and family, as well as experiences of loneliness, as positive social relationships enhance emotional well-being and contribute to overall quality of life.[23] Lastly, the dimension of environmental parameters concerns external factors that influence daily life, such as safety, accessibility, social infrastructure, and an individual's economic status.[24] Given the multidimensional nature of quality of life which encompasses physical, psychological, social, and environmental domains appropriate tools are essential for its comprehensive assessment. The integration of the biopsychosocial model provides a solid theoretical foundation for addressing the doctoral research question, as it allows for the simultaneous examination of the physical, psychological, and social dimensions of fatigue and daytime sleepiness as indicators of overall quality of life.

1.2 Tools for Quality of Life Assessment

The assessment of quality of life (QoL) has become a central focus in medical and therapeutic research, leading to the development of validated tools designed to capture individuals' perceptions of their health status and overall well-being.[25] These tools allow the objective recording of individuals' subjective impressions regarding their health and life conditions, incorporating various dimensions of their daily existence. The use of these tools contributes to a better understanding of how people perceive their health and how it affects their lives on multiple levels.

One of the most widely used instruments is the Short Form-36 Health Survey (SF-36)[26], a comprehensive and generic questionnaire that evaluates health-related quality of life across diverse populations and clinical conditions. It consists of 36 items grouped into eight dimensions: physical functioning, role limitations due to physical health, bodily

pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems and mental health. These dimensions are further synthesized into two composite scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS), which reflect an individual's overall physical and mental health status respectively. Its widespread application in studies evaluating interventions such as massage therapy, physical activity, and psychological stress reduction reflects its ability to detect meaningful changes in both physical and psychological aspects of health. [27] Alongside the SF-36, other established instruments such as the WHOQOL-BREF[28], EuroQol-5D (EQ-5D)[29] and Nottingham Health Profile (NHP)[30] are also employed, with the choice of tool depending on the specific research aims, population, and context. The use of such standardized instruments ensures comparability between studies and enhances the accuracy and depth of quality-of-life assessment in both clinical and community settings. Considering the wide-reaching implications of quality of life, it is essential to explore factors that can significantly impair it, such as anxiety, insomnia, and fatigue. As quality of life is directly influenced by psychosomatic factors, it is essential to examine conditions such as stress, insomnia, and fatigue, which play a decisive role in an individual's well-being.

2. Anxiety, Insomnia and Fatigue

Anxiety is defined as a state of excessive worry and apprehension, often accompanied by physical symptoms such as increased heart rate or restlessness. It is one of the most widespread psychological conditions in modern society and has been recognized as a major risk factor for the development of both insomnia and fatigue.[31] Insomnia refers to difficulty falling asleep, staying asleep, or achieving restful sleep, and when anxiety remains at high levels for a prolonged period, it can trigger a range of psychosomatic disorders.[32,33] Increased activity of the sympathetic nervous system and elevated cortisol levels under conditions of sleep deprivation may exacerbate insomnia and reduced sleep quality.[34] Insomnia, in turn, has serious consequences for mental and physical health, such as decreased performance, increased anxiety, irritability, and an increased risk of developing chronic conditions like cardiovascular disease and type 2 diabetes.[35] Moreover, the lack of good-quality sleep affects the body’s ability to recover

both physically and mentally, burdening the individual with increased fatigue and reduced tolerance to stress.[36]

Fatigue is a subjective feeling of tiredness and lack of energy, which may be physical, mental, or both. It is commonly associated with sleep disturbances[37] but can also result from other factors such as excessive stress, poor nutrition, and lack of physical activity.[38] Fatigue reduces motivation, affects concentration and emotional regulation and limits the ability to perform daily tasks efficiently. Premature or persistent fatigue is a common complaint in a range of conditions, including various chronic health conditions, and has tightly intertwined physical and mental.[39]

A pre-requisite from one's recovery from work[40] or sport[41] exertions causing intense fatigue, is to enjoy a restorative sleep. Notably, chronic sleep deprivation can have long-term effects, impairing the body's ability to recover and negatively impacting the individual's ability to cope with everyday demands.[42]As fatigue often coexists with other lifestyle factors, such as physical inactivity and poor diet, addressing these underlying causes is crucial to improving overall health. Indeed, a sedentary lifestyle and poor diet, both of which are prevalent in modern society, contribute significantly to fatigue and the deterioration of both physical and mental well-being. The triad of anxiety, insomnia and fatigue represents a complex interplay of mutually reinforcing factors that undermine daily functioning and psychosomatic health. Within the context of this dissertation, understanding these relationships is crucial for evaluating the effects of a multifactorial lifestyle intervention.

2.1. Tools for Fatigue, Daytime Sleepiness, Anxiety and Insomnia Assessment

The objective and subjective measurement of fatigue and daytime sleepiness constitutes an important aspect in evaluating the overall health and well-being of individuals, at any age and condition Especially in research examining the effects of lifestyle interventions, the use of valid and reliable tools is essential for documenting changes.

Fatigue is often assessed using the following scales:

- **Fatigue Severity Scale (FSS)[43]:** A self-reported scale measuring the severity of fatigue and its impact on daily activities. It consists of 9 statements scored on

a 7-point Likert scale, where higher scores indicate greater fatigue severity. The average score across items is calculated, with a typical cutoff of 4 or higher suggesting significant fatigue. The FSS is widely used in both clinical and research settings to assess fatigue levels across various populations and conditions. Daytime sleepiness is mainly evaluated with:

- **Epworth Sleepiness Scale (ESS)[44]:** A brief self-assessment scale measuring the likelihood of dozing off in eight different daily situations. Scores above 10 indicate increased daytime sleepiness.
- **Karolinska Sleepiness Scale (KSS):** A scale that assesses the immediate subjective feeling of sleepiness on a scale from 1 (very alert) to 9 (very sleepy). It is used to measure subjective sleepiness at specific time points.

Additionally, anxiety is often assessed using the following scales:

- **Perceived Stress Scale (PSS-10)[45]**: A 10-item self-report questionnaire designed to measure the degree to which individuals perceive their life situations as stressful over the past month. Items assess feelings of unpredictability, lack of control, and overload. Each item is rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often), resulting in a total score between 0 and 40. Items 4, 5, 7, and 8 are positively stated and are reverse scored. Higher total scores reflect greater levels of perceived stress. The PSS-10 is widely used in both clinical and research settings due to its reliability and ease of administration, offering valuable insight into the subjective experience of stress.

Moreover, insomnia problems are mainly evaluated with:

- **Pittsburgh Sleep Quality Index (PSQI)[46,47]**: A self-rated questionnaire that assesses sleep quality and disturbances over a one-month interval. It evaluates components such as sleep duration, sleep latency, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each

component is scored from 0 to 3, and the total global score ranges from 0 to 21, with higher scores indicating poorer sleep quality. A global score greater than 5 is commonly used to distinguish poor sleepers from good sleepers. The PSQI is widely used in both clinical and research settings to provide a comprehensive assessment of sleep quality.

- **Athens Insomnia Scale (AIS-8)[48]:** An 8-item self-report questionnaire evaluating insomnia symptoms including sleep induction, awakenings during the night, final awakening, total sleep duration, sleep quality, well-being, functioning capacity, and daytime sleepiness. Each item is scored from 0 (no problem) to 3 (severe problem), resulting in a total score ranging from 0 to 24. The severity of insomnia is commonly classified as follows: scores from 0 to 7 indicate no insomnia, scores from 8 to 15 indicate mild to moderate insomnia, and scores of 16 or higher indicate severe insomnia. This scale allows both the detection and quantification of insomnia severity, providing a useful tool for clinical assessment and research purposes.

The use of these tools allows for the quantification of changes resulting from lifestyle interventions and contributes to the evaluation of their effectiveness in improving fatigue, daytime sleepiness and insomnia problems. The systematic assessment of these symptoms using validated tools constitutes the first step toward implementing targeted interventions in the context of modern lifestyle.

3. Addressing Modern Lifestyle Challenges

Adopting a healthy lifestyle, which includes incorporating positive habits into daily life, has been shown to bring significant benefits to the restoration of mental and physical health. In our era, where work overload, stress, technological dependencies, and poor eating habits dominate, the need for a strong response to these issues is urgent. For example, reducing stress through relaxation techniques, such as mindfulness, has been shown to contribute to improved concentration and overall well-being. Meditative

practices, which encourage awareness of the present moment, reduce stress levels and enhance individuals' mental resilience.[49]

Massage, for example, is an effective method for reducing muscular tension and psychological stress, providing immediate relief and improving blood circulation.[50]

The combination of cognitive behavioral therapy for insomnia (CBT-I) with other non-pharmacological treatments may offer a powerful mechanism for improving sleep quality and overall well-being, especially in individuals with insomnia comorbid with psychiatric or medical conditions.[51] Specifically, patients who undergo CBT for insomnia experience a significant reduction in symptoms, such as difficulty falling asleep and nighttime awakenings, while an increase in total sleep duration is also observed.[52]

Additionally, regular physical exercise, such as aerobic activities (e.g., walking, running) or gentle forms of exercise like yoga, contributes to stress relief and enhances mental health.[53] Research shows that regular exercise not only improves physical fitness but also acts as a natural antidepressant, increasing the production of endorphins and other hormones associated with positive mood.[54]

Finally, a balanced diet plays a crucial role in health restoration, as proper nutrition can enhance immune system function, improve sleep quality, and boost overall mood. For example, consuming foods rich in omega-3 fatty acids, antioxidants and vitamins enhances cognitive function and the body's ability to cope with daily stress.[55] In this context, the application of lifestyle medicine, which emphasizes the importance of nutrition, physical activity, and stress management, offers a comprehensive approach to supporting health and preventing chronic diseases.

3.1. Lifestyle Medicine - ELMO

The European Lifestyle Medicine Organization (ELMO) is an organization that promotes the application of lifestyle medicine as a strategy for the prevention, management, and support of the treatment of many chronic diseases. The organization recognizes that lifestyle changes are central to promoting health and well-being, and the pillars of ELMO provide a comprehensive framework for enhancing quality of life

through the improvement of daily habits. These core principles directly align with the 8 key pillars of Lifestyle Medicine, which emphasize the importance of daily health practices.

3.2. Lifestyle Medicine main Pillars

Lifestyle Medicine is based on 8 key pillars, which include: adopting a healthy diet, engaging in regular physical activity, ensuring adequate and quality sleep, managing stress, abstaining from toxic substances, caring for sexual health and fertility, developing and maintaining positive social relationships, and reducing exposure to environmental risks. These pillars work together, promoting the prevention of chronic diseases and enhancing overall health and well-being.[56]

Specifically, the modern approach to lifestyle medicine recognizes the importance of multifactorial intervention in maintaining health and preventing chronic diseases. A central role in this perspective is played by adopting a diet rich in plant-based foods, with an emphasis on fruits, vegetables, whole grains, and legumes, as well as limiting the consumption of processed foods and saturated fats.[57]

Recent literature data clearly demonstrate that such a dietary approach can reduce the risk of developing cardiovascular diseases, metabolic syndrome, type 2 diabetes, and certain types of cancer.[58,59]

Regular physical activity is also an integral part of this approach. Aerobic exercises, such as walking, running, or cycling, combined with muscle-strengthening activities, contribute to the enhancement of the cardiorespiratory and musculoskeletal systems, the regulation of body weight, and psychological well-being by increasing endorphin levels.[60] The World Health Organization guidelines recommend at least 150-300 minutes of moderate-intensity exercise per week for adults.[61] Particular emphasis is also placed on sleep, given its critical role in regulating homeostasis and neuroendocrine function. The optimal sleep duration for adult's ranges between 7 and 9 hours per day, with an emphasis on sleep quality, not just its duration.[62] Sleep deficiencies have been associated with an increased risk of cardiometabolic disorders, obesity, cognitive dysfunction, and mental health conditions.[63] Moreover, managing psychological stress

is a critical factor for maintaining health, especially in a modern environment with high demands. Techniques such as mindfulness meditation, yoga, and deep breathing have proven effective in reducing cortisol levels, improving emotional well-being, and alleviating symptoms of anxiety and depression.[64]

Abstaining from harmful substances, such as tobacco and excessive alcohol consumption, remains one of the key strategies for health prevention and promotion. Numerous studies have confirmed the positive effects of smoking cessation and reducing alcohol intake on reducing cardiovascular morbidity, liver damage, and the risk of various types of cancer.[65]

Sexual and reproductive health is often overlooked in the literature on preventive medicine, despite being a fundamental component of overall well-being. Promoting safe sexual practices, preventing sexually transmitted infections, and supporting fertility, especially through healthy nutrition, physical activity, and psychosocial balance, are essential interventions.[66–68] Moreover, social cohesion and the presence of supportive social bonds have emerged as protective factors against mental and physical disorders. Participation in social networks and community activities fosters a sense of belonging, reduces isolation, and enhances mental resilience.[69]

Finally, environmental exposure constitutes a critical and often underestimated risk factor. Contact with pollutants, such as heavy metals, endocrine disruptors, and particulate matter, has been associated with an increased incidence of respiratory, cardiometabolic, and neurological disorders. Protecting individuals by minimizing exposure to these substances and promoting healthy environmental practices is a crucial area of intervention for public health.[70]

By addressing multiple aspects of an individual's lifestyle such as diet, physical activity, stress management, and sleep lifestyle medicine provides a comprehensive framework for achieving and maintaining optimal health. One of the most crucial elements of this framework is sleep, which plays a central role in regulating the body’s homeostasis and overall function. The pillars of Lifestyle Medicine form the core framework of the intervention in this doctoral dissertation. The targeted modification of key daily habits such as diet, exercise, sleep, and stress management is aimed at improving fatigue, sleepiness and overall quality of life. Among all pillars, sleep plays a central role,

making it essential to thoroughly investigate its physiology and the consequences of its disruption.

4. Sleep and Health

Sleep is one of the most fundamental yet complex biological processes of the human body. Rather than being a passive state, it is now recognized as a dynamic process that performs vital functions for the regulation of homeostasis, the restoration of bodily tissues, cognitive processing, and emotional balance.[71] For this reason, the study of sleep and its contribution to overall health has garnered significant scientific interest, particularly in light of contemporary epidemiological data showing an increased prevalence of sleep disorders in both healthy and clinical populations. A clear example of this is seen in medical students, where poor sleep quality and daytime sleepiness are prevalent and significantly impact their academic performance, mental health, and overall quality of life. Studies have shown that medical students, especially those with sleep deprivation, exhibit higher levels of anxiety and depression and lower perceptions of their educational environment and quality of life.[72]

Furthermore, recent research suggests that a short nap can effectively reverse the negative effects of sleep deprivation on attention, primarily through the restoration of brain networks responsible for attention regulation.[73] Given the increasing prevalence of sleep disorders and their significant impact on both physical and mental health, the search for effective, non-pharmacological treatments, such as relaxation techniques and lifestyle interventions, has also gained considerable attention in recent years. A deeper understanding of sleep physiology, particularly the alternating cycles of NREM and REM sleep, is essential for developing such interventions.

4.1. Sleep Physiology

Sleep is divided into two main phases: Non-Rapid Eye Movement (NREM) sleep and Rapid Eye Movement (REM) sleep, which alternate cyclically throughout the night, with an average cycle lasting 90 minutes.[74] The NREM phase consists of three stages

(N1, N2, and N3), with stage N3 characterized by the dominance of delta waves on the electroencephalogram (EEG) and considered the most "restorative" form of sleep. During this phase, a reduction in metabolism is observed, along with decreased brain activity, a slowing of heart rate and respiratory rate, and increased secretion of growth hormone.[75] In contrast, REM sleep is marked by high brain activity, muscle atonia, and frequent dreaming. It is also associated with emotional regulation, memory consolidation, and neural plasticity.[76,77]

The quality of sleep depends on various factors, including its duration, continuity, and the proportion of time spent in different sleep stages. External factors such as the environment, diet, mental state, and physical activity can also influence sleep quality.[78] A key regulatory factor of the circadian rhythm is the hormonal secretion of melatonin from the pineal gland, which facilitates the onset of sleep and is influenced by light exposure.[79] This hormonal regulation is essential for the body's ability to carry out critical functions during sleep, which include the regulation of the endocrine and metabolic systems, as well as the immune, cardiovascular, respiratory and neuromuscular systems.

4.2. The Role of Sleep in Physical and Mental Functioning

Sleep is involved in critical functions of the human body. On a physical level, it serves as a key regulator of the endocrine and metabolic systems, while also having a direct impact on the immune, cardiovascular, respiratory, and neuromuscular systems.[80] Adequate sleep duration and quality are associated with the regulation of appetite through the hormone’s leptin and ghrelin, with metabolic balance (insulin and glucose regulation), and with the reduction of systemic inflammation. Furthermore, sleep deprivation has been linked to an increased risk of developing chronic diseases such as type 2 diabetes, hypertension, and cardiovascular diseases, thus highlighting the wide-ranging impact of insufficient sleep on health.[81]

At the psychological level, sleep affects the organization and consolidation of memories, the processing of emotional experiences, and mood stability. Scientific evidence has highlighted the association between good sleep quality and enhanced

cognitive function, learning, and creative thinking.[82] Furthermore, the REM phase is pivotal for the discharge of the amygdala and the adaptation to stressful events, thus contributing to psychological resilience.[83] Additionally, sleep is associated with muscle mass repair, recovery from physical fatigue, and healing after injuries, elements that are particularly crucial for populations such as athletes and the elderly.[84] Given its critical role in physical restoration, inadequate sleep can lead to significant consequences, particularly in the case of insomnia, which not only disrupts recovery but also contributes to cognitive, emotional and immune dysfunction.

4.3. Consequences of Insomnia: Cognitive, Emotional and Immune Dysfunction

Insomnia, whether as a primary disorder or a symptom of other conditions, is one of the most prevalent sleep disorders in the modern world. It is characterized by difficulty falling asleep or staying asleep, or by non-restorative sleep, and is accompanied by functional impairment during the day.[85] The cognitive consequences of chronic insomnia are significant and include reduced attention, working memory, information processing speed, and executive function.[86] At the same time, neurophysiological alterations have been recorded in the prefrontal cortex, an area crucial for problem-solving and emotional regulation. Emotionally, insomnia increases the risk of developing anxiety and depressive disorders. Chronic sleep deprivation has been shown to enhance stress hyperreactivity and dysregulate emotional regulation mechanisms.[87]

Finally, the immune dysfunction associated with insomnia is a critical risk factor for increased morbidity. Reduced sleep is linked to lower cytokine production, enhanced inflammatory response, and greater vulnerability to infections and chronic diseases.[88] Given these serious consequences, addressing insomnia through therapeutic interventions, both pharmacological and non-pharmacological, is essential for improving overall health and reducing the risk of further complications. The study of the effects of insomnia provides valuable insights into the mechanisms through which sleep disturbances impact psychological and physical well-being. This data forms a foundation for evaluating the impact of non-pharmacological interventions within the scope of the doctoral research.

4.4. Therapeutic Interventions for Insomnia

The therapeutic approach to insomnia includes a broad range of interventions, classified into pharmacological and non-pharmacological categories. While hypnotic medications are a common choice, especially for short-term cases, their long-term use is associated with adverse effects, addiction risks, and decreased effectiveness over time. As a result, there is increasing emphasis on non-pharmacological, behavioral, and complementary therapies, which are incorporated into the framework of Functional and Personalized Medicine. Cognitive Behavioral Therapy for Insomnia (CBT-I) is considered the first-line treatment. It includes techniques such as stimulus control, sleep restriction, cognitive restructuring, and improvement of sleep hygiene. CBT-I has been shown to provide long-term results, even after the therapy is discontinued.[89]

At the same time, the role of interventions aimed at reducing stress and enhancing relaxation is crucial. Techniques such as guided imagery, progressive muscle relaxation, yoga, and mindfulness meditation have shown positive results in improving sleep quality and the overall psychosomatic well-being of individuals with insomnia.[90]

Massage, particularly relaxation massage based on the principles of Swedish massage, emerges as a promising complementary intervention. Through the application of gentle and rhythmic techniques (such as effleurage, tapotement and friction), blood circulation is enhanced, muscle tension is reduced, and both physical and mental relaxation are promoted. The benefits of massage include the increase of serotonin and melatonin levels, as well as the reduction of cortisol, thus supporting the reinforcement of the natural sleep-wake cycle.[91,92]

Moreover, improving sleep hygiene is a fundamental factor in the management of insomnia. This includes maintaining a consistent sleep schedule, avoiding electronic devices and caffeine before bedtime, creating a quiet and dark environment, and limiting activities in bed that are not related to sleep.[93]

Overall, the choice of therapeutic strategy should be individualized, taking into account the person’s specific characteristics, the severity of insomnia and the coexistence of

other psychological or physical disorders. Non-pharmacological approaches, whether used alone or in combination with other interventions, can provide an effective and safe solution for managing chronic insomnia. One such approach is massage therapy, an ancient practice with a long history of promoting relaxation and alleviating tension. One of the most promising non-pharmacological approaches is massage, which has been the subject of extensive historical and scientific investigation.

5. Massage

5.1. History of Massage

Massage is an ancient practice used for pain relief, tension reduction, and bodily relaxation, in a preventative, invigorating or therapeutic The earliest civilizations to use massage included the Egyptians (The Tomb of Akmanthor – BC 2330, depicts men applying massage), Chinese (the Huangdi Neijing text - BC 722-481, mentions massage in 30 of its chapters), Greeks (from pre-classical to Roman years) and Persians (Al-Qānūn fī aṭ-Ṭibb or The Canon of Medicine- Avicenna – AD 980 to AD 1037), who incorporated massage into their sport training, medical and healing practices. For example, in Ancient Greece, Homer, both in Iliad and Odyssey, describes the application of massage. For example, in various Iliad rhapsodies massage, combined with oils applications, is purported to afford pain relief and sleep. Hippocrates recognized the value of massage for alleviating various physical conditions stating (BC 460) that ““The physician must have experience in many things, and assuredly in rubbing.””, while Ancient Olympians received massages with oils and herbs to help relax muscles and prepare their bodies for competition (following on the teachings of Herodicus, the father of sports medicine). There is a actually a plethora of depictions of athletes receiving massage (rubbing/ανάτριψις) before and after competition with massage specialists at work (foot rubbers/ποδοτρίφτες και αλλείπτες). Later on, Galen further developed its techniques and integrated them into his medical work, also as a part of the preparation of gladiators.[94] Romans combined massage with steam baths and alternations between cold and hot water. [94] In China, massage was linked to traditional Chinese medicine and the theory of energy flow through the meridians, with the technique of Tui Na becoming an integral part of therapeutic practice. Similarly, in

India, the use of aromatic oils and herbs in massage has its roots in traditional Indian medicine.[95]

Today, massage remains a recognized method of performance promotion, relaxation, pain relief and wellness, incorporating modern techniques that combine traditional practices with scientific approaches. Massage is widely used in the fields of wellness, sports training, sports medicine, physiotherapy, mental health, with, partially at least, proven benefits for reducing anxiety, relieving muscle tension and enhancing overall well-being.[96–98] This scientific understanding of its physiological effects has deepened, demonstrating how massage positively impacts the circulatory, lymphatic, musculoskeletal and nervous systems. The choice of massage as the primary lifestyle intervention tool in this study is based on its longstanding popular use in addressing anxiety, fatigue, and insomnia. Its historical background and purported effects support its application within the framework of lifestyle modification and the proposed studies aim to solidify the necessary evidence base .

5.2. Types and Techniques of Massage

There are various types of massage and techniques, which differ in their movements, intensity, and applications. Each technique has different application indications and is used to achieve specific outcomes in an individual's well-being and functionality. The most commonly used massage application paradigms include Swedish Massage, Sports Massage, Deep Tissue Massage, Reflexology, Aromatherapy, and Relaxation Massage.

Swedish Massage

Swedish Massage is the most widely used massage paradigm and is considered the foundation for many other techniques. It was developed by Per Henrik Ling in the 19th century and is one of the gentlest forms of massage, primarily focusing on improving circulation and relieving tension. The main techniques used in Swedish Massage[99]

- **Effleurage**: Slow, long, and steady strokes used to warm up the muscles and prepare the body for more intense movements.
- **Petrissage**: Kneading and pressure applied to the muscles to help relieve muscle tension.

- **Friction**: Circular movements used to break down knots or muscle spasms and promote circulation.
- **Tapotement**: Light tapping with the palms or fingers to stimulate blood flow and invigorate the muscles.

Swedish Massage is considered effective for relieving stress, improving circulation and restoring balance to the body.[100,101]

Sports Massage

Sports Massage is a specialized form of massage primarily used for the prevention and recovery from sports-related injuries, as well as to enhance athletic performance. The approach combines elements of Swedish Massage with specific movements and methods designed to address the needs of athletes. It incorporates techniques such as Effleurage, which, as mentioned above, involves, slow and long strokes, here with an emphasis on sliding the hands along the muscles following the natural direction of the muscle body. Percussive techniques like Hacking, involving rapid, chopping movements with the hands, and Tapotement, consisting of light fingertip tapping, are also applied. To activate muscle energy and improve circulation, dynamic techniques such as Pounding, which involve strikes with the fists, are used. These techniques can be applied before, after, or during rehabilitation from injuries, with the goal of alleviating pain, enhancing muscle endurance, and promoting faster recovery for athletes.[102]

- **Pre-event massage**: Used to prepare the body for exercise and increase blood flow to the muscles.
- **Post-event massage**: Applied after intense physical activity to aid muscle recovery and relieve tension.
- **Rehabilitation massage**: Used during training or recovery to assist in healing from injuries, reducing pain, and easing tension in injured muscles.

The main goals of this technique are injury prevention, improved mobility and enhanced muscle endurance.

Deep Tissue Massage

Deep Tissue Massage uses intense pressure to reach the deeper layers of muscles and connective tissue. This technique is especially useful for treating chronic muscle tension, injuries, or areas with accumulated tightness, such as the back, shoulders, and neck. Deep Tissue Massage involves movements that focus on reducing muscle spasms and restoring flexibility. It is often applied to areas with long-standing muscle tightness and is particularly effective for treating Myofascial Pain Syndrome and muscle stiffness.[103]

Reflexology

Reflexology is an alternative therapy based on applying pressure and stimulating specific points on the body, usually on the feet, hands, and ears. According to reflexology theory, these points are connected to various organs of the body, and activating them can positively influence their function. Reflexologists mainly use their thumbs and fingers to apply pressure to these points and achieve therapeutic effects. Reflexology is particularly effective in relieving anxiety, enhancing circulation, and promoting the body's overall well-being. [104] Reflexologists use special techniques with their thumbs and fingers to apply pressure and make small circular movements on the reflex points, thereby improving blood and lymphatic circulation, reducing muscle tension, promoting relaxation, and helping the body restore its natural balance. The therapeutic benefits of reflexology are diverse and include reducing anxiety and stress by activating the parasympathetic nervous system, relieving chronic pain such as headaches, migraines, lower back pain, neck syndrome, and arthritis, improving circulation by increasing blood flow and better oxygenating tissues, regulating hormones in cases of hormonal imbalance such as premenstrual syndrome (PMS) or menopausal symptoms, supporting digestion by relieving bloating, indigestion, or constipation, and strengthening the immune system, as relaxation and balance restoration help the body better resist diseases.

Aromatherapy Massage

Aromatherapy massage is a specialized form of therapeutic massage that combines classic techniques (such as effleurage, petrissage, and tapotement) with the use of essential oils, which are derived from the distillation or extraction of plants, flowers, fruits, leaves, or resins and carry powerful natural compounds with therapeutic and aromatic properties.[105]

Essential oils are not applied directly to the skin but are diluted in carrier oils, such as jojoba oil or sweet almond oil, to ensure safe absorption through the skin. Aromatherapy massage aims both at muscle relaxation and sensory stimulation through the sense of smell, as the aromatic compounds affect the brain's limbic system, which is linked to emotions, memory, and behavior, providing relief from anxiety, reducing tension, and improving emotional well-being. Common essential oils used include lavender oil (for relaxation and sleep improvement), peppermint oil (for revitalization and muscle pain relief), orange oil (for mood enhancement and stress reduction), and rosemary oil (for stimulation and improved concentration). Therapists carefully select the appropriate blend based on each individual's needs, applying it with gentle, rhythmic movements to enhance absorption and promote the calmness of both body and mind, making aromatherapy massage effective not only for physical relief but also for psychological wellness in cases of insomnia, anxiety, mild depression, and general body revitalization.[106]

Relaxation Massage

Relaxation massage is widely described in the literature as a gentle form of massage designed to promote deep relaxation, alleviate psychological stress, and enhance overall well-being. It typically emphasizes slow, flowing, and light-pressure movements that aim to activate the parasympathetic nervous system, which is responsible for the body's rest-and-digest response. Key techniques often include effleurage (long, gliding strokes), petrissage (kneading and squeezing), tapotement (rhythmic tapping), friction

(deep, circular rubbing), and vibration or shaking movements. Importantly, in the context of relaxation massage, these methods are applied with soft intensity, differing from therapeutic or deep-tissue massages, in order to maximize calming and stress-relieving effects. Studies have shown that relaxation massage can increase blood circulation, reduce muscle tension, improve flexibility, and help reduce mild pain, contributing to both physical and emotional recovery.[107,108]

It is especially recommended for individuals experiencing stress from daily life, as it helps restore emotional balance and supports psychological well-being. In many clinical and experimental studies, including the current one, the total duration of a relaxation massage session typically lasts around 45 minutes, covering the full body, including the palms and feet, using rhythmic and soothing movements to optimize the relaxation outcome.[7]

Similarly, with the rise of modern technology, Automatic Electronic Massage Chairs (AEMCs) have emerged in recent years as non-pharmacological interventions, providing a convenient and effective way to promote relaxation and enhance sleep quality.

Massage Chairs and Applications in Promoting Relaxation and Sleep

Automatic Electronic Massage Chairs (AEMCs) have emerged in recent years as non-pharmacological interventions aimed at improving relaxation and sleep quality in individuals experiencing elevated levels of work-related stress.[109] Studies have shown that the use of massage chairs is associated with reductions in stress, mental fatigue, and musculoskeletal pain, as well as improvements in muscle flexibility and overall quality of life.[110] Additionally, AEMCs offer a range of automatic massage protocols targeting the reduction of muscle tension and fatigue, enhancing functionality and well-being[111] and they appear to contribute to improved sleep quality.[112]

However, a large portion of the available data comes from unpublished internal manufacturer sources rather than independent, randomized controlled trials, thus limiting the strong scientific validation of these claims.

Beyond their use for relaxation and sleep improvement, AEMCs have also been studied in other populations. In clinical settings, the application of mechanical massage through AEMCs has been shown to significantly reduce pain levels in women during labor, suggesting a non-invasive alternative method of analgesia.[113] Similarly, in patients undergoing chemotherapy, the use of AEMCs helped alleviate treatment side effects[114], while among professional groups at high risk for musculoskeletal disorders, such as musicians, regular use appeared to have preventive value by reducing muscle tension and enhancing physical resilience.[115]

Particularly interesting is the use of AEMCs in sports. According to Xie et al., the application of automatic massage reduced vagal nerve tone and accelerated the clearance of metabolites such as lactic acid, leading to faster recovery after intense exercise.[116] These findings support the view that AEMCs may serve as an efficient recovery tool for athletes compared to other passive methods.

In summary, the existing findings highlight that AEMCs can be a valuable tool for managing stress and musculoskeletal dysfunctions, as well as promoting relaxation and sleep quality in both healthy and clinical populations. Nevertheless, the limited availability of high-quality research data, particularly concerning the direct effects of AEMCs on sleep and relaxation indicators, underscores the need for further randomized controlled trials. Similarly, the growing body of research into traditional forms of massage therapy, especially relaxation massage based on Swedish techniques, also points to its potential benefits for sleep quality, duration and overall well-being.

5.3. Effects of Massage on the Circulatory, Lymphatic and Musculoskeletal Systems

Massage is well known for its positive effects on various systems of the human body, including the circulatory, lymphatic, musculoskeletal, and nervous systems.[117] Understanding these effects has been enhanced by modern studies, which demonstrate the benefits of massage at both physiological and biological levels.

Massage enhances blood circulation and the delivery of oxygen and nutrients to the tissues, improving blood flow and supporting tissue recovery after strain or injuries.[118] Increased circulation helps reduce muscle pain and promotes faster recovery after intense physical exercise or injuries.[119] Additionally, lymphatic drainage is enhanced, facilitating the removal of toxins and preventing the buildup of fluids, which provides significant benefits in reducing swelling and inflammation.

Regarding the musculoskeletal system, massage relieves muscle tension, reduces muscle spasms, and promotes tissue relaxation, contributing to the relief of chronic muscle discomfort and increased flexibility.[120] These benefits not only enhance physical comfort but also have a regulatory effect on the nervous system. Specifically, massage stimulates the parasympathetic system, which is responsible for restoring the body's balance after stress.

5.4. Regulatory Effects of Massage on the Nervous System

Massage has a positive effect on the nervous system, particularly the parasympathetic system, which is responsible for restoring the body's balance after stress. Among the key outcomes of massage are the reduction of heart rate and blood pressure, as well as the enhancement of feelings of calmness and well-being.[121] Activation of the parasympathetic system reduces the body's response to stress or tension, promoting relaxation and mental well-being.[122]

In addition, studies have shown that massage can lead to an increase in parasympathetic activity and a decrease in sympathetic activity, which is associated with the "fight-or-flight" response. This shift in autonomic nervous system activity helps reduce anxiety, promote deeper sleep, and improve overall mood regulation.[123] Furthermore, research suggests that regular massage therapy may contribute to long-term improvements in the autonomic regulation of the nervous system, making it a useful tool for managing chronic stress and preventing burnout.[124] This regulation also extends to the endocrine system, where massage has been shown to significantly affect hormone levels, increasing oxytocin and reducing stress hormones, thereby contributing to hormonal balance and enhancing both mental and physical well-being.

5.5. Effects of Massage on Hormones

Massage has been shown to significantly affect the endocrine system by increasing oxytocin levels and reducing stress hormones, thereby contributing to hormonal balance and enhancing both mental and physical well-being.[125] Numerous studies have shown that the application of therapeutic massage leads to a reduction in cortisol levels, the primary stress hormone, which is associated with the activation of the parasympathetic nervous system and a decrease in physiological arousal.[126,127] At the same time, an increase in the production of serotonin and dopamine is observed, two neurotransmitters associated with good mood, pleasure, and psychological stability.

Furthermore, massage appears to enhance the secretion of oxytocin, a neurohormone that promotes feelings of trust, connection, and relaxation, while also exhibiting analgesic and anti-stress properties. The positive effect on these hormones has been linked not only to the reduction of anxiety and depressive symptoms but also to the improvement of sleep quality and overall psychosomatic health. These changes seem to be immediate and persist for a considerable period after the massage session, making this method a valuable tool in the context of non-pharmacological interventions for improving well-being.[128] As such, massage has become one of the oldest therapeutic methods used for relieving stress, pain, and muscle tension, and its diverse techniques continue to be an integral part of modern health practices. These techniques vary in terms of movements, intensity, and applications each offering unique benefits depending on the specific therapeutic needs of the individual.

5.6. Effects of Massage on Sleep

Relaxation massage, primarily based on Swedish massage techniques (such as superficial and deep effleurage), has garnered increasing scientific attention as a complementary, non-pharmacological intervention for improving sleep quality, duration and well-being.[129–131] The literature indicates that massage exerts multiple physiological effects, such as reducing cortisol levels and other stress markers,

increasing the neurotransmitters serotonin and melatonin, and activating the parasympathetic nervous system, all of which contribute to muscle relaxation, stress reduction, and easier transition into deeper NREM sleep stages.[132] Specifically, in vulnerable populations such as the elderly, cancer patients, children with developmental disorders, and individuals with chronic stress or depression, massage interventions have been associated with improvements not only in sleep but also in overall quality of life.[106] Despite these promising findings, the current research base exhibits significant limitations: most studies involve small sample sizes, often lack a placebo group or blind design, and the massage techniques and protocols vary across studies, with many relying on subjective questionnaires rather than objective measurements such as EEG. Therefore, there is a pressing need for large, randomized, controlled clinical trials that combine psychophysiological, biochemical, and electrophysiological assessment parameters to determine the true efficacy and mechanisms of relaxation massage as a therapeutic strategy for managing insomnia. The documentation of massage as a means to improve sleep and well-being strengthens the scientific foundation of this doctoral study, which focuses on the application of relaxation techniques within the framework of lifestyle modification. The limited use of objective assessment methods (such as EEG) in previous studies highlights the need for the present research effort.

Study 1

The Effect of Timing of Sports Massage on 60-m Sprint Performance in Competitive Athletes

Status: Accepted

Journal: International Journal of Therapeutic Massage & Bodywork

Impact Factor: 1.0

This study is accepted for publication and scheduled to be officially published in December 2025: *The Effect of Timing of Sports Massage on 60-m Sprint Performance in Competitive Athletes*. *Ilias Ntoumas, Christina Karatzaferi, Christoforos D. Giannaki, Vasileios Nousios, Konstantina Siarava, Aliki Mpakatselou, Fotini Papanikolaou, Aggelos Pappas, Charalampos Krommidas, Efthimios Dardiotis, Eleftherios Lavdas, Giorgos K. Sakkas. International Journal of Therapeutic Massage & Bodywork (IJTMB).*

Abstract

Background*:* Sports massage is considered to improve muscle tone, flexibility and thus, overall, contribute to the improvement of athletes' performance. It is not yet clear whether pre or post warm-up sports massage can enhance athletes' performance. Additionally, while essential oils are believed to enhance the effects of massage, empirical evidence remains limited.

Purpose*:* The present study aimed to evaluate the timing effect of pre-competition sports massage, using two different massage oils, on sprint performance.

Methods: A total of 40 competitive male young sprint & multiple-sprint sport athletes were randomly divided into two groups, Group 1: sports massage applied after the warm-up followed by a max 60-m sprint trial; Group 2: sports massage before the warm-up followed by a max 60-m sprint trial. All participants were assessed in 3 different massage conditions: a. Control: usual warm-up, no massage; b. AEO: sports massage using activation essential oil; c. BO: sports massage using baby oil.

Results: The results demonstrated a statistically significant main effect of massage on sprint performance, by reducing 60-m sprint time [$F(2,78) = 5.304$, $p \leq 0.005$]. Specifically, sprint performance improved (3.91%, $p=0.008$) when the sport massage session took place after the athletes' warm-up (Group 1) and when the AEO was applied ($p=0.004$).

Conclusion*:* A brief pre-competition sports massage, especially when after the warm-up session and when AEO is applied, could be used as a complementary approach to help improve sprint performance.

Keywords: sprint; sports massage; essential oil; performance

Introduction

The application of massage has adapted over time into various techniques with diverse uses, making it a prevalent practice of alternative or complementary medicine across various cultures and work or sport disciplines. Massage techniques can target the entire body or specific muscle groups to achieve different outcomes for a variety of targeted populations. Most members of the general public may have the experience of a "relaxation massage". Such a massage protocol, usually of long durations (20 to 60 min) incorporates longer and slower strokes, like effleurage and petrissage[133], with gentle pressure across the body. It is employed by the general population to reduce stress,[134] alleviate overall muscle tension and promote a sense of mental and physical well-being.[135]

The application of "sports massage" to athletes, aims primarily to address either the preparation or the recovery of muscles engaged in athletic activities, and is of shorter durations (anything from 5 to 30 min). (4) Pre-event sports massage, which prepares athletes before competition or training, includes techniques such as light effleurage, faster strokes, and tapotement to reduce stress and blood pressure[136], enhance blood flow, promote vasodilation, warm up muscles, and increase flexibility.[137] In contrast, post-event sports massage involves firmer pressure to address muscle soreness and tension built up during physical activity.[138]

High-performance athletes incorporate massage as a regular component of their daily recovery routine, especially after intensive training or competition.[139] Massage following intensive training or competitions has been shown to reduce the severity of muscle soreness and help maintain muscle function and repair.[140,141] According to a systematic review and meta-analysis by Davis et al., the effect of sports massage can positively improve flexibility and Delayed Onset Muscle Soreness (DOMS), establishing it as a valuable tool for athletes.[142] Regarding the application of pre-competition massage, there is limited evidence of its benefit on actual performance and debate in the literature regarding the optimal timing of the massage session, i.e. whether it should be applied before or after the athlete's warm-up, for performance enhancement and/or injury prevention.(11)

Regarding other approaches, recent studies have proposed potential benefits for various modalities such as foam rolling, percussion guns, dynamic stretching and vibration

therapy in improving physical function. Foam rolling, for example, has been shown to enhance flexibility by relaxing tension in skeletal muscles and fascia.[143] Similarly, vibration therapy has been found to elicit physiological and psychological benefits.[144] However, the benefits of pre-competition vibration therapy on power performance remain inconclusive, nor is there evidence showing superiority of such modalities over pre-competition sports massage (which will be the focus of this article).[145,146]

In recent years, the integration of essential oils in massage applications has received significant attention, with the aim of harnessing possible synergistic benefits.[147] Essential oils, derived from various plant sources, are purported to offer a broad range of therapeutic actions that could plausibly enhance the effects of massage.[148,149] Oils such as lavender, chamomile, propolis, and bergamot exert their calming and anxiety-reducing effects primarily through modulation of the gamma-aminobutyric acid (GABA)ergic system, acting on GABA-A receptors to promote relaxation and reduce sympathetic nervous system activity. [150] Additionally, these essential oils have been shown to influence serotonin and dopamine pathways, further contributing to mood enhancement and stress relief. .[151–155] On the other hand, essential oils such as blumea balsamifera, eucalyptus, peppermint, and ginger exhibit antioxidative, analgesic, and anti-inflammatory properties by modulating inflammatory mediators such as nuclear factor kappa B (NF-κB) and cyclooxygenase-2 (COX-2)[156–158], reducing oxidative stress via scavenging reactive oxygen species (ROS), and enhancing microcirculation, which aids in muscle recovery and pain reduction.[159–162] Such effects are brought about by terpenes and terpenoids, which constitute the bioactive elements of essential oils.[163] Their absorption can occur via inhalation, ingestion or through the skin. Small, lipophilic terpenoid molecules have a greater capacity to penetrate to the bloodstream, enhancing the skin treatment's effectiveness.[164] Despite these promising benefits, more research is needed to fully understand the efficacy of essential oils, particularly whether they would provide benefits when used during a pre-competition massage session.

Therefore, the main aim of this study was to evaluate the effect of a brief pre-competition massage on sprint performance in competitive athletes, applied in two timings, pre and post warm-up. Moreover, another aim was to examine the efficacy of different massage oils used for sports massage on sprinting performance. To clarify the research focus, the study specifically aims to evaluate the effect of massage on sprint performance, and further investigates whether the use of essential oils enhances these effects. We hypothesized that the application of massage would be beneficial for sprinting performance and that the

use of essential oils during sports massage might further augment the possible benefits of massage on sprinting performance.

Methodology

Subjects

Forty (N=40) competitive male athletes (34 competitive level track sprinters and6 soccer, center forwards, with past or parallel track and field experience) (aged 20.87 ± 2.82 years) fulfilled the inclusion criteria and participated in this study. Inclusion criteria included participants aged >18 years with an active athletic membership (registered with a sports club and federation). Exclusion criteria included dermatological diseases, allergies to massage oil, a history of overtraining syndrome, having a muscle injury in the last 6 months, any acute or chronic condition that would limit the ability of the volunteer to participate in the study and refusal to give written informed consent.

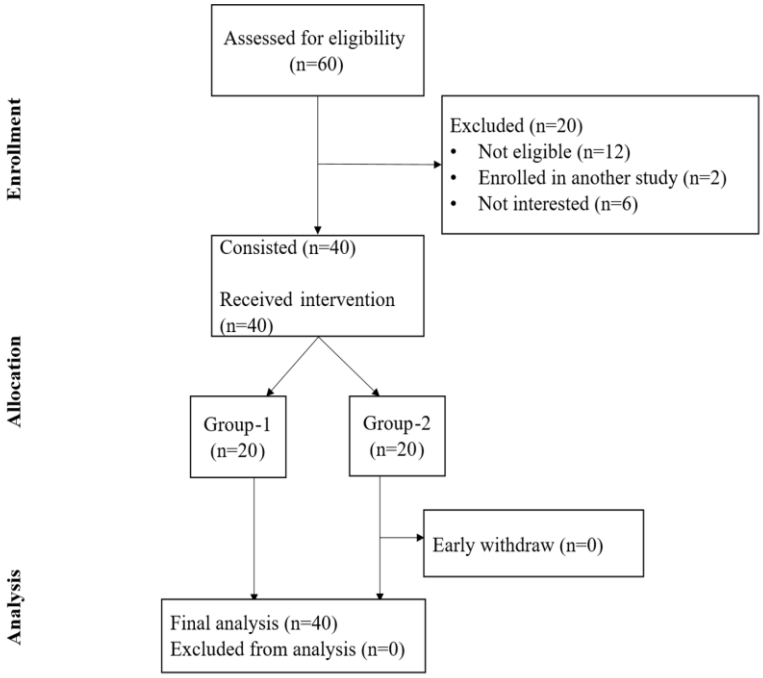
The study was approved by the Human Research and Ethics Committee of the University of Thessaly (1864/08-12-2021). All participants gave their written informed consent prior to study participation.

Study Design

Participants were randomly divided into two groups. Group 1 (N=20) received a 5-min sports massage application after the warm-up followed by the sprint trial, and Group 2 (N=20) received a 5-min sports massage application before the warm-up followed by the sprint trial. Both groups were assessed in three different conditions: a) Control condition (CON): participants followed the same standard warm-up as the other groups, which consisted of (10 min jogging, 5 min active stretching, and 4 X 60 m moderate intensity runs). Then they put on their spikes, walked to their starting block and (at 5 min post warm-up) performed a timed 60-m sprint; b) Activation Essential Oil condition (AEO): participants received a sports massage using a commercially

available activation essential massage oil, the composition of which is provided in the "Massage Oil" section; c) baby-oil condition (BO): participants received a sports massage using a commercially available standard massage oil (baby-oil). All conditions were separated by one week, and participants were randomly assigned to different oil applications using a computer-generated randomization sequence. The researcher who analyzed the data remained blinded to the assigned group (Figure 1). All testing sessions took place at the same time of day to control for any training or timing effects. Physical activity and training load were kept constant during the 3-week study period, while participants were instructed to follow the same daily routine to the extent possible.

A CONSORT diagram (Figure 1) summarizes recruitment, enrollment and dropout rates. Final enrollment included 40 participants.



Procedure

All measurements were conducted indoors at the National Track and Field Stadium of Trikala in Thessaly, Greece, on the indoor track lane (80-meter length, 5 lanes width), with a constant temperature of 20°C (indoor heating). Participants wore running shoes for their warm-up and spike shoes for their timed 60-m max sprint trial. They wore shorts or sports leggings and kept the same outfit for all testing sessions.

For Group 1, participants completed first a warm-up session. This included 10 minutes of jogging, 5 min active stretching. The active stretching consisted of dynamic stretches such as leg swings, hip circles, torso twists, high knees, jumping jacks and lunges. Each exercise was performed for 20-30 seconds (or 8-12 repetitions), with short breaks of 5-10 seconds in between. This was followed by 4 X 60 m moderate intensity runs (interspersed with 1 min active recovery, i.e., walking). Participants then received a sports massage, in the massage room of the stadium, lasting for 5 min. At 5 min after the completion of the massage session, having changed shoes, participants completed a 60-m max sprint trial.

For Group 2, participants completed their 5 min sports massage session first, then they completed their warm-up (as above). At 5 min after the warm-up session, participants completed a 60-m max sprint trial. All sports massage sessions were performed by the same certified sports masseur.

Sprint time was recorded when the athlete passed through 30m and when they reached the 60m finish-line by two experienced researchers blind to the group or the condition that the participants attended. After the sprint trial, participants changed shoes and performed jogging for 5 minutes at a low intensity, followed by stretching exercises.

All participants were continuously monitored and guided for the timely implementation of their allocated protocol. Before the massage session and in order to keep the participants blind with regards to the type of oil applied (AEO or BO condition), a nose clip (INDEX, 55609) was placed on the participant's nose, so they could stay naïve on the two different oil massage products used. The CON condition was always conducted first. Subsequently, randomization ensured that each participant

had an equal opportunity to be assigned first to either the AEO or BO condition, thereby minimizing bias and preserving the integrity of the study results (Figure 2).

Figure 2. Study Flow

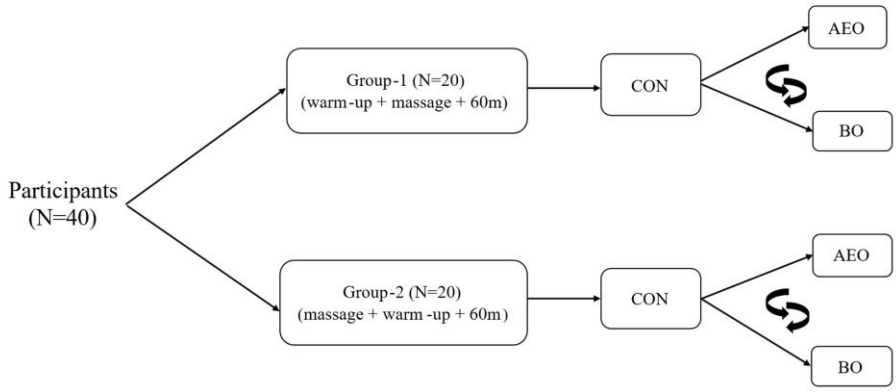


Figure 2. Study Flow Chart. Participants were randomized into 2 groups and participated in 3 different trial sessions. (CON) = control protocol, no massage and 60-m maximum sprint; (AEO) = massage application using essential activation oil and 60-m maximum sprint; (BO) = massage application using baby oil and 60-m maximum sprint.

Massage Sessions

A stimulating type of massage was used as the pre-competition sports massage intervention in this study. The techniques were performed on specific leg muscle groups, including the gastrocnemius, the biceps femoral and quadriceps, while excluding the pelvic area. The total duration of the pre-competition massage was 5 minutes. The brevity of the massage session was intentional, considering that: a) a longer duration of massage is often commented[165,166] upon as a negative aspect of pre-competition massage, b) in our study, the specific duration was considered sufficient for the emphasis placed on legs and enough for the selected sports massage techniques[102,167]. Techniques included: i) Effleurage (moderate to high intensity palmar sliding) and ii) tapotement; including tapping, cupping, hacking and puffer (fingertip strikes), hacking (side palm strikes), and pounding (closed fist strikes) on the posterior and anterior surfaces of the lower leg, (Table 1). The same massage techniques and order of movement applications was used in all massage conditions and each session was time and content-monitored. No massage nor oil was applied during the CON condition.

Table 1. Anterior and Posterior Thigh Massage Protocol (Including Posterior Thigh, Calf and Anterior Thigh).

Massage Technique	Rate (movements per minute)	Time (duration) in seconds
1. Effleurage (palmar sliding technique) (Photo 1)	60 reps/min	90
2. Hacking (Photo 2)	30-40 shakes/min	60
3. Tapotement (Photo 3)	170-200 contacts/min	60
4. Pounding (Photo 4)	25 strikes/min	90

Sports Massage Technique Description

The massage protocol was applied to the anterior and posterior thigh muscles, as well as the calf muscles, following a standardized sequence of techniques with controlled intensity and rhythm. Participants were placed in a prone position for the massage of the posterior thigh and calf muscles and in a supine position for the massage of the anterior thigh muscles, lying on an ergonomic massage table. This positioning ensured optimal access to the muscles and the uniform application of techniques (Figure 3).

Initially, Effleurage, a moderate to high-intensity palmar sliding technique, was applied to the anterior and posterior thigh muscles. The movements followed the natural direction of the muscle fibers, starting from the insertion and moving toward the origin. The pace was maintained at 60 repetitions per minute, with a total duration of 90 seconds (Photo 1).

Next, the Hacking technique, a form of percussive massage involving light, rapid chopping motions with the lateral edge of the hands, was applied to the posterior thigh muscles and calves. These movements were performed at a rate of 30-40 shakes per minute, with a total duration of 60 seconds (Photo 2).

Following this, the Tapotement technique, consisting of light and repetitive fingertip tapping, was applied to both the anterior and posterior thigh muscles. The pace ranged between 170-200 contacts per minute, with a duration of 60 seconds (Photo 3).

Finally, the Pounding technique was applied, involving dynamic, rhythmic strikes with the fists, primarily targeting the calf muscles and posterior thigh muscles. The rate was maintained at 25 strikes per minute, with a total duration of 90 seconds (Photo 4).

Figure 3. Sports Massage Techniques.

Photo 1. Effleurage Technique (palmar sliding)

Photo 2. Hacking Technique

Photo 3. Tapotement Technique

Photo 4. Pounding Technique

Massage Oil

The activation essential massage oil (AEO) contained a mixture of carrier oils, of green olive oil, avocado oil, sesame oil, natural wax, propolis oil, cocoa butter, and contained cinnamon, oregano, sage, lemon, eucalyptus, nutmeg, orange, and spearmint, essential oils which carry natural terpenes. The mixture is commercially available as a pre-exercise massage oil, with similar products circulating worldwide.

The control massage oil was a commercially available "Johnson's baby oil" (https://www.johnsonsbaby.com/baby-products/johnsons-baby-oil), composed of 99% mineral oil (a refined petroleum product) and <1% fragrance (Benzyl Acetate, BicycloNonalactone, Isopropyl Myristate, Mefrosol) from a well-known manufacturer. This specific oil was scented and free from naturally occurring terpenes and terpenoids. Similar mineral oils are also produced by other manufacturers.

Sprinting Capacity - Speed

Time completing the 60 meters distance (and time at the 30-m mark) was recorded via a standard official stopwatch (CASIO, 80TW-1EF) used by two experienced track and field athletics officials' referees, who were also involved as researchers in this study. The accuracy and precision of the referees' ability for time recording was assessed against the gold standard approach, which is the photoelectric sensors (Photocells Witty Gate). For this particular task, a subset of the participants (N=13 male sprinters) was timed during a 60m maximum sprint using both timekeeping techniques (stopwatch vs photoelectric sensors). We found no statistically significant differences between the two approaches (N=13, stopwatch 7.62 ± 0.66, vs photoelectric sensors 7.82 ± 0.65, p=0.447) while the mean differences between the two approaches was 0.20 ± 0.03sec.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 29 (SPSS Inc., Chicago, U.S.A.). Data were checked for normal distribution (Shapiro-Wilk test) and average data are presented as mean±SD. An independent T-test was used to examine if there were significant differences in basic characteristics between Group 1

(post-warm-up massage) and Group 2 (pre-warm-up massage). A General Linear Model with Repeated Measures ANOVA (GLM) was used to examine the main effect of sports massage for all participants across all conditions. Moreover, GLM was used to examine the effect of timing of the massage application (i.e. 30-m and 60-m sprint time performance between pre or post warm-up massage groups). In addition, the effect of type of massage oil used was examined (i.e., 30-m and 60-m sprint time performance between (BA) or (AEO) groups). Furthermore, to account of individual variability, Δ-change values were calculated (AEO time against CON sprint time, BO time against CON sprint time) and an independent T-test was used to examine possible group differences. The significance level was set at $p \leq 0.005$.

Power Analysis

Sample size calculations were conducted using G*Power 3.1. The post-hoc "GLM": Repeated measures, within factors" method was used to calculate the power analysis. The resulting minimum required sample size to achieve 80% power was 40 for 2-sided group-1 and group-2 errors 5% [(Effect size 0.37, Critical F 3.11, Ndf 2, Ddf 76, Power (1-β err pob) = 0.82 (82% power)].

Results

Subject characteristics are shown in Table 2. No statistically significant differences in basic characteristics ($p>0.005$) were found between participants assigned to Group 1 and Group 2.

Table 2. Basic characteristics of study participants.

Parameters	All Participants	Group 1	Group 2	P Value
N	40	20	20	-
Age (years)	20.62 ± 3.33	20.05 ± 2.65	21.20 ± 3.79	0.281
Body weight (kg)	71.21 ± 7.21	70.88 ± 6.74	71.55 ± 7.48	0.769
Body height (cm)	1.79 ± 0.48	1.80 ± 0.05	1.78 ± 0.05	0.301
BMI (kg/m²)	22.24 ± 2.22	22.00 ± 1.90	22.50 ± 2.46	0.480
Years of competitive training	4.98 ± 2.43	4.25 ± 2.07	5.70 ± 2.60	0.058

Note: Data are presented as Mean ±SD. Significance level $p\leq0.05$; BMI: Body Mass Index.

Overall, a statistically significant independent main effect of massage on 60-m sprint performance for the entire sample was found, [$F(2,78) = 5.304$, $p\leq0.005$]. In addition, using sports massage time of application as a covariate in the comparison between the two conditions (pre warm-up vs post warm-up massage), a significant main effect of timing of massage application on 60-m sprint performance was found [$F(1,38)= 9.560$, $p\leq0.005$). Specifically, the 60-m sprint trial time was faster overall in Group 1 (post warm-up massage) compared to Group 2 (pre warm-up massage) [$F(1.94,1.596) = 5.32$, $p=0.008$] (Table 3).

Table 3. Average group sprint performance characteristics.

Parameters	**All Participants (95% CI)**	**Group 1 (95% CI)**	**Group 2 (95% CI)**	**P Value (Effect size: partial η^2)**
N	40	20	20	-
30m sprint (sec)	3.98 ± .24 (3.91 to 4.06)	4.02 ± .19 (3.94 to 4.1)	3.95 ± .29 (3.82 to 4.08)	0.220 (0.285)
60m sprint (sec)	7.52 ± .38 (7.4 to 7.64)	7.37 ± .34 (7.22 to 7.52)	7.67 ± .37 (7.51 to 7.83)	**0.008 (0.844)**

Note: Data are presented as Mean ±SD. Significance level $p \leq 0.05$; p values refer to the differences between Group 1, and Group 2.

No statistically significant differences were found in the 30-m mark split time between groups. Furthermore, using sports massage as a covariate in the comparison between two massage oils (AEO vs BO) showed that AEO was superior to BO, while time in the 60-m sprint trial was faster when AEO was used [F (9.560):7.42 ± 0.37 vs 7.45 ± 0.43, $p \leq 0.005$].

Performance changes for both groups when using massage activation essential oil (AEO condition) are shown in Table 4. A statistically significant difference between groups was found in the 60-m sprint time, with faster times recorded in Group 1 (% Δ-change: -4.7% ± 0.35, % vs -10.5% ± 0.27, $p \leq 0.005$). No statistically significant differences were observed in the 30-m sprint time.

Table 4. Sprint performance using the activation essential oil (AEO condition), as sprint time (sec) per group (percentage delta-change (%) is indicated in parentheses).

Parameters	**Group 1** **(95% CI)**	**Group 2** **(95% CI)**	**P Value** **(Effect size: partial η^2)**
N	20	20	-
30m sprint (sec) (%Δ-change)	4.05 ± .20 (3.96 to 4.14) (-0.5% ± 0.20)	4.08 ± .26 (3.97 to 4.19) (-6.5% ± 0.27)	0.191 (0.129) (0.952)
60m sprint (sec) (%Δ-change)	7.27 ± .36 (7.11 to 7.43) (-4.7% ± 0.35)	7.57 ± .33 (7.43 to 7.71) (-10.5% ± 0.27)	**0.004 (0.868)** (0.221)

Note: Data are presented as Mean ±SD; %Δ-Change was calculated using the CON values as reference point; Significance level $p \leq 0.005$; p values refer to the differences between Group 1, and Group 2.

Furthermore, performance changes for both groups when using massage baby oil (BO condition) are shown in Table 5. No statistically significant differences ($p > 0.05$) were observed in the 60-m sprint time, although a tendency for faster times in Group 1 compared to Group 2 was observed (% Δ-change: -3.8% ± 0.27, $p \leq 0.005$, vs -1.5% ± 0.36, $p \leq 0.005$). Likewise, no statistically significant differences were observed in the 30-m sprint time.

Table 5. Sprint performance using the baby oil (BO condition), as sprint time (sec) per group (percentage delta-change (%) is indicated in parentheses).

Parameters	**Group 1 (95% CI)**	**Group 2 (95% CI)**	**P Value (Effect size: partial η^2)**
N	20	20	-
30m sprint (sec) (%Δ-change)	4.03 ± .21 (3.94 to 4.12) (-6.5% ± 0.20)	4.08 ± .22 (3.98 to 4.18) (-1.9% ± 0.25)	0.866 (0.232) (0.156)
60m sprint (sec) (%Δ-change)	7.26 ± .35 (7.11 to 7.41) (-3.8% ± 0.27)	7.64 ± .41 (7.46 to 7.82) (-1.5% ± 0.36)	0.163 (0.996) (0.169)

Note: Data are presented as Mean ±SD; %Δ-Change was calculated using the CON values as reference point; Significance level $p \leq 0.05$; p values refer to the differences between Group 1, and Group 2.

Discussion

To the best of our knowledge, this is the first study to investigate the timing effect of a brief sports massage on sprinting performance. We show that pre-competition sports massage seems to have an overall beneficial effect on 60-m sprint performance, especially, when it is applied after the warm-up session, improving sprint time by 3.91%. In addition, it seems that massage performed with an activating essential oil has an additional positive effect compared to regularly used baby oil, especially when the activating oil is used for a massage applied after the athlete's warm-up. Additionally, no differences were observed in the 30-m mark split time between groups, suggesting that the benefits of the sports massage may become more evident in the latter half of the sprint.

In the current experimental study, the parameter that improved the most was the 60-m sprint time, by 0.30sec (± 0.03). In contrary to our findings, Moran et al. found that a combination of a stimulating massage and a standard warm-up applied before the start of the race did not affect sprinting performance.[168] Differences in the massage protocol and application techniques could explain the lack of agreement between the two studies. Indeed, the massage performed in the study of Moran et al., lasted 3 times longer compared to our protocol (10-15 minutes), something that could have stressed the tissues or might have affected pliability or other properties of skeletal muscles.[168] Their findings suggest that pre-competition massage alone could negatively impact sprint performance, potentially due to increased muscle relaxation or altered neuromuscular function. The longer duration of massage may have contributed to these effects by promoting excessive muscle relaxation or altering the neuromuscular response, while our shorter protocol likely did not produce the same level of relaxation or fatigue. In contrast, the combination of massage and warm-up appeared to mitigate these effects. Future research could explore the impact of combining massage with an active warm-up in our protocol to determine whether it influences sprint performance differently. Additionally, future research could consider repeating the study with a group that receives a longer massage duration, which may provide additional insight into the potential effects of prolonged massage on sprint performance. Similarly, Fletcher investigated the effects of three different warm-ups, with particular focus on pre-competition massage, which consisted of 9 minutes of fast, superficial effleurage (30 strokes per minute) and petrissage (60 strokes per minute) applied to key lower-limb muscle groups. The

massage was administered with light to moderate pressure while participants were in a supine position with knees flexed. The study found that pre-competition massage alone had a negative effect on 20-meter sprint performance, likely due to decreased musculotendinous stiffness, while its combination with a traditional warm-up did not provide additional benefits over warm-up alone.[169] Interestingly, Mine et al. systematically examined a series of studies on pre-exercise massage and concluded that prolonged massage sessions (lasting >9 min) may have negative effects on lower limb maximum strength, sprint performance and jump height.[170] In our study the applied sports massage lasted for 5 min and included hacking and rapid movements, that seem to improve blood circulation.[171] According to recent literature and the present results, a brief pre-competition sports massage has been shown to be beneficial.[172] Possible mechanisms to explain the positive effects could include an improvement of range of motion (ROM) without jeopardizing muscle tone, particularly when combined with other massage techniques. Tapotement alone may not significantly impact ROM, but its effects could be enhanced when incorporated with other methods that target muscle relaxation and flexibility.[173] Additionally, an increase in the flow in the lymphatic system overall promotes general blood circulation in the massaged muscle groups, which may contribute to improved recovery and performance.[174,175] Furthermore, an important mechanism through which massage can influence myofascial function is the increase in hyaluronic acid (HA) production, which improves the sliding of fascial tissues and reduces friction between muscle structures, thereby facilitating mobility and muscle function. [176] Additionally, the stimulation of nerve endings located in the fascia can trigger inhibitory responses in the central nervous system, contributing to the reduction of muscle tone and promoting relaxation.[177,178] Regarding the application of essential oil (EO), the positive effects of massage and the activation of essential oils (AEO) on sprint performance can be explained through mechanisms related to recovery and the improvement of muscle function. AEO, which includes essential oils such as eucalyptus, mint, and orange, contains natural terpenes that have been shown to reduce muscle tension and fatigue, aiding in performance improvement during high-intensity exercise, such as sprinting.[179] Moreover, some researchers propose that sports massage prior to subsequent performance can improve athletes' sense of readiness and perceived energy levels, as well as enhance blood flow, promote vasodilation and stimulate the release of endorphins[180] and increase circulation.[181] All those changes may improve athlete’s self-confidence and state of vigilance to compete.

In recent years massage sessions increasingly incorporate essential oils in the oil mixture. To our knowledge, this is the first study to investigate the use of a commercially available mixture of "activation essential oils" applied during the sports massage session on sprinting performance in competitive athletes. We show that activation oil seems to have a beneficial effect on 60-m sprint performance, specifically when it is combined with a brief massage applied after the warm-up session. Again, the parameter mainly improving was the 60-m sprint time, compared to baby oil condition. We have not investigated the possible mechanisms of action. We minimized, to a degree possible, the effect of inhalation by blocking that intake route using a nose clip. There are limited studies using essential oils during massage sessions and assessing performance. Relevant literature suggests that the types of essential oils used may activate the nervous system, stimulating blood circulation, reducing muscle and joint soreness.[175,182–185] Paoli et al. studied the effect of sports massage using ozonized oil in competitive cyclists and found that this particular type of massage oil increased blood lactate removal, improved performance, and reduced the perception of fatigue.[186] In another study, Hongratanaworakit et al. investigated the stimulant effect of jasmine oil during massage and found that jasmine oil caused a significant increase of breathing rate, blood oxygen saturation, and systolic and diastolic blood pressure in the intervention group, indicating an increase in autonomic arousal.[187] It should be noted however, not all of the available studies controlled for inhalation of essential oils. Still, taking together our study results and the limited available published data, it appears that pre-competition sports massage using activation essential oils can provide further benefits in aspects related to performance and fatigue. Further research is however needed to shed more light on the mechanisms of action, whether allowing for inhalation of the essential oils would improve acute performance, and whether athletes and coaches can use essential oil products to achieve better performances and overall ranking in the long run. Additionally, future studies should compare the effects of short-duration versus long-duration massage after warm-up to determine optimal application strategies for athletic performance.

In the current study, we have to acknowledge some significant strengths and some weaknesses. Some limitations that need to be acknowledged is the study design and the fact that only males were included in the study, which may limit the generalizability of the findings to female athletes. A crossover design could have provided more evidence on the effectiveness of the intervention. Another limitation is that the sprint recordings were done by using manual stopwatches and not by photoelectric sensors. This could have induced

some small measurement errors or inconsistency in our results, perhaps explaining the lack of statistical significance for the 30-m split time measurements. Additionally, while the CON condition was always administered first and remained fixed, the BO and AEO conditions were randomized, which may have influenced the outcomes and introduced a potential sequencing effect. Still, the subset analysis using 13 of the 40 participants, did not show statistically significant differences between the two assessing approaches with hand measurement error being smaller that the calculated differences for the 60-m times (see results section). Another weakness of our study is the lack of assessment of the subjective feeling of relaxation or readiness after the massage session (whether applied pre or post warm-up). This could have helped us conclude whether the essential oils would have supported the athletes emotionally rather than physically to complete their sprint trial. Still, the majority of the participants declared a positive feeling overall. Another weakness that needs to be acknowledged is the fact that the masseur was not blind to the type of massage oil applied. Among the main strengths of our study is the blinding of the time recorders for the type of group or massage session. In addition, participants of the study where blind regarding the type of oil used during the massage since their nose was blocked using a nose clip. And perhaps most importantly, and as indicated by the times achieved, in contrast to other studies reporting no effects or negative effects of massage, our study participants demonstrated good to excellent sprinting ability (on par with European competitive collegiate, national and international level) thereby adding ecological value to our findings.

Conclusions

In conclusion, the findings of the current study indicate a positive effect of pre-competition massage on sprint performance, particularly when applied before the warm-up. That positive effect was better sustained by the application of essential oils (vs standard baby oil). Such findings can hold significant practical value for athletes. In sports such as sprinting, the observed statistically significant improvements, however small, may prove crucial for an athlete's performance and podium standings. In that sense, this simple and practical application that can acutely improve athletes' performance warrants further work, to decipher possible long-term effects, and pinpoint mechanisms of action. These findings suggest that incorporating pre-competition massage, particularly with essential oils, into athletes' routines could be a simple yet effective strategy to enhance sprint performance. Coaches and sports practitioners may consider integrating this approach into warm-up protocols to maximize its benefits in competitive settings.

Study 2

Massage Positively Influences Daytime Brain Activity and Reduces Arousal State in Poor Sleepers: A Randomized Controlled Trial.

Status: Accepted

Journal: BMC Complementary Medicine and Therapies

Impact Factor: 3.3

Clinical Trial Registry number: NCT06780072

This study has been accepted as: *Massage Positively Influences Daytime Brain Activity and Reduces Arousal State in Poor Sleepers: A Randomized Controlled Trial*. Ilias Ntoumas, Christina Karatzaferi, Fotini Boubougiatzi, Nefeli Manakou, Artemis Aslanidi, Christoforos D. Giannaki, Fotini Papanikolaou, Efthimios Dardiotis, Eleftherios Lavdas, Giorgos K. Sakkas; in BMC Complementary Medicine and Therapies [32f811c4-1751-49d9-a933-3d5e1c5c9554]

Abstract

Background: Daytime napping is used as a strategy to complement insufficient night-time sleep and improve daytime mental and physical performance. Massage can play a crucial role in promoting relaxation and wellness at various settings including the work place.

Purpose: The purpose of the present study was to investigate the effect of two different types of manual massage sessions on day-time napping in poor sleepers.

Methods: This was a randomized, single blind, placebo-controlled, three arm, interventional clinical trial. Fifteen participants (aged 21.6 ± 1.3years) participated in three different conditions over one week apart: 1) 30-minute Sports massage condition (ACT), 2) 30-minute Relaxation massage condition (REL) and 3) control condition with no massage. Brain activity was monitored using a polysomnography EEG system, while vitals and relaxation/stress state were assessed by validated questionnaires and functional tests. The Pittsburgh Sleep Quality Index Score >5 was used as cut off for distinguishing poor sleeper.

Results: Results showed significant differences between the three conditions, with muscle tone to be reduced by 7.2% after ACT session ($p=0.000$) and relaxation scores to be increased by 23.4% after REL session ($p=0.008$). In addition, Sleep Latency N1 was improved only after the REL session compared to other two conditions ($p=0.037$).

Conclusions: In conclusion, massage can positively impact the quality and quantity of daytime napping and may serve as a complementary intervention to enhance mental well-being, reduce work related stress, improve performance and promote overall a healthier living.

Trial Registration: Retrospectively registered (registration date: 16/01/2025; trial registration number at ClinicalTrials.gov: NCT06780072)

Keywords: Sports Massage; Relaxation Massage; EEG; RSQ; Handgrip

Introduction

In the quest for optimal physical and mental performance and recovery, people are constantly exploring various strategies to enhance their overall well-being.[188] Daytime napping helps mitigate the effects of inadequate nighttime sleep, allowing people to reduce fatigue and potentially improve physical performance.[189] Research has also shown that strategically timed naps can significantly boost athletic performance, improve cognitive function, and reduce daytime fatigue.[190,191]

Short naps lasting between 10 to 60 minutes are ideal for quickly boosting alertness and cognitive function.[192] Additionally, they can facilitate a complete sleep cycle, including REM sleep, which is crucial for both physical and mental recovery.[193] Massage therapy, recognized for its ability to alleviate muscle soreness, improve circulation, and induce relaxation and it might play a crucial role in facilitating a good night sleep.[194]

In athletes a massage therapy serves as both a proactive and reactive measure in optimizing sports and exercise performance, ensuring athletes are physically and mentally prepared for competition while also facilitating their recovery, minimizing the risk of injury.[195,196] and particularly effective in alleviating pain.[197198] Massage therapy significantly contributes to improving night sleep efficiency as well as the duration of sleep onset.[199]

From a biochemical point of view, massage promotes the release of serotonin, a hormone that enhances the sense of wellbeing.[200] In addition, serotonin is a biosynthetic precursor of melatonin and an active neurotransmitter, whose levels affect various functions of the body including sleep promotion,[201] while can play a significant role in mental health as it regulates mood and emotional well-being.[202]

These mechanisms highlight the potential of massage therapy to improve sleep quality. While most studies focus on its effects on nocturnal sleep, there is growing interest in how daytime napping, combined with massage therapies, may enhance cognitive performance, physical recovery, and well-being. Previous research suggests that daytime napping can improve both mental and physical performance and reduce fatigue after both normal and partial sleep deprivation.

Several non-pharmacological strategies have been proposed to facilitate the initiation and improve the quality of daytime naps. Environmental modifications, such as reducing ambient light and noise, maintaining a comfortable room temperature, and establishing consistent nap routines, appear to play a pivotal role in creating optimal conditions for rest.[203] Moreover, relaxation interventions, including the use of calming music combined with essential oil inhalation, have demonstrated positive effects on autonomic nervous system balance, promoting parasympathetic activity conducive to sleep.[204] Similarly, massage therapy has been shown to stimulate parasympathetic activation following physical exertion, supporting recovery and rest.[205] These interventions, by reducing stress and enhancing relaxation, can significantly improve the effectiveness of midday naps, which are increasingly recognized as important for cognitive function, physical recovery and overall well-being.

Nowadays, massage has evolved into various types that are specialized for the treatment of various health problems.[206] The most well know and frequently used types of massage are the “sports massage” and the “relaxation massage”. Sports massage has been proven to enhance athletic performance, as well as help athletes recover after competition[207] while the Deep Relaxation massage is used exclusively for the relaxation and psychological discharge.[208] More specifically, the relaxation-therapeutic massage uses pressure that is deeply relaxing, but not painful, smooth gliding strokes that are both rhythmic and flowing, which increases blood circulation and promotes a general sense of relaxation.[206,209] Even thought, these 2 very common types of massage have been applied for many years in various settings, it is not clear whether massage affects brain function and state of alertness.

Therefore, the primary aim of the current study was to investigate the effect of two different types of manual massage sessions on day-time napping using objective (EEG - brain activity) and subjective (questionnaires) measurements of relaxation in poor sleepers.

Methodology

Trial Design

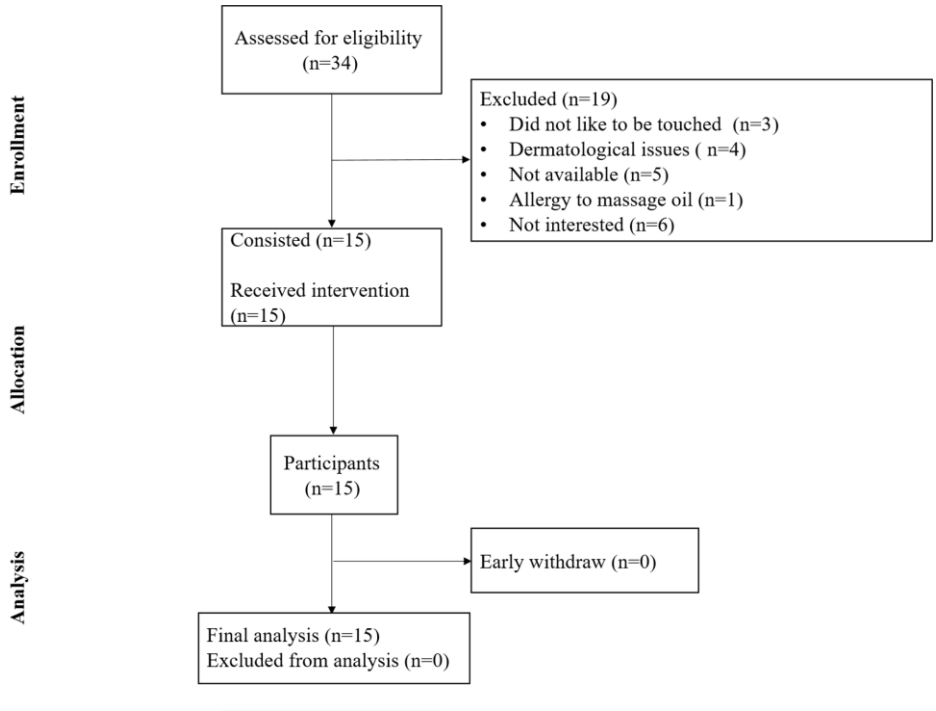
This study is a randomized, single blind, placebo-controlled, three arm, interventional clinical trial to investigate the effect of two different types of manual massage sessions on day-time napping in poor sleepers.

Subjects

Fifteen (N=15) participants (age 21.6 ± 1.3 years, 10F/5M) from the local community were recruited through advertisements at the University of Thessaly students' union center. The participants assessed for the inclusion and exclusion criteria and voluntarily agreed to participate in the study (Figure 1). The inclusion criteria required participants to be over 18 years of age, of either sex, and to have a Pittsburgh Sleep Quality Index (PSQI) score >5, indicating some type of sleep disturbances. Exclusion criteria included a history of mental illness, dermatological diseases, allergies to massage oil, epilepsy, or any acute or chronic medical conditions that could limit participation in the study.

Figure 1. Consort Diagram.

A CONSORT diagram summarizes recruitment, enrollment and dropout rates.



Study Design

Subjects were randomly assigned by the study director (GKS) into 3 conditions each one week apart using a pseudo-random number generators system. 1) the control condition (CON) where subjects did not receive any intervention, while they were rested for 35 min on a massage bed; 2) the activation condition (ACT) where subjects received an activation (Sports) massage session lasting for 30 min and rested for 5 min without any interference; and 3) the relaxation condition (REL) where subjects received a relaxation massage session lasting for 30 min and rested for 5 min without any interference (Figure 2). All conditions were separated by one week apart and took place the exact time of the day, while the order of the various conditions was randomly assigned. All massage sessions were delivered by a professional masseur, while the researchers analyzing the data and the participants were blind to the assigned group. All measurements were conducted in the laboratory under controlled conditions, with a constant room temperature of 22°C. The study was approved by the Human Research and Ethics Committee of the University of Thessaly (2094-2/08-02-2023). All Subjects gave their written informed consent prior to study participation.

Figure 2. Study Flow Chart.

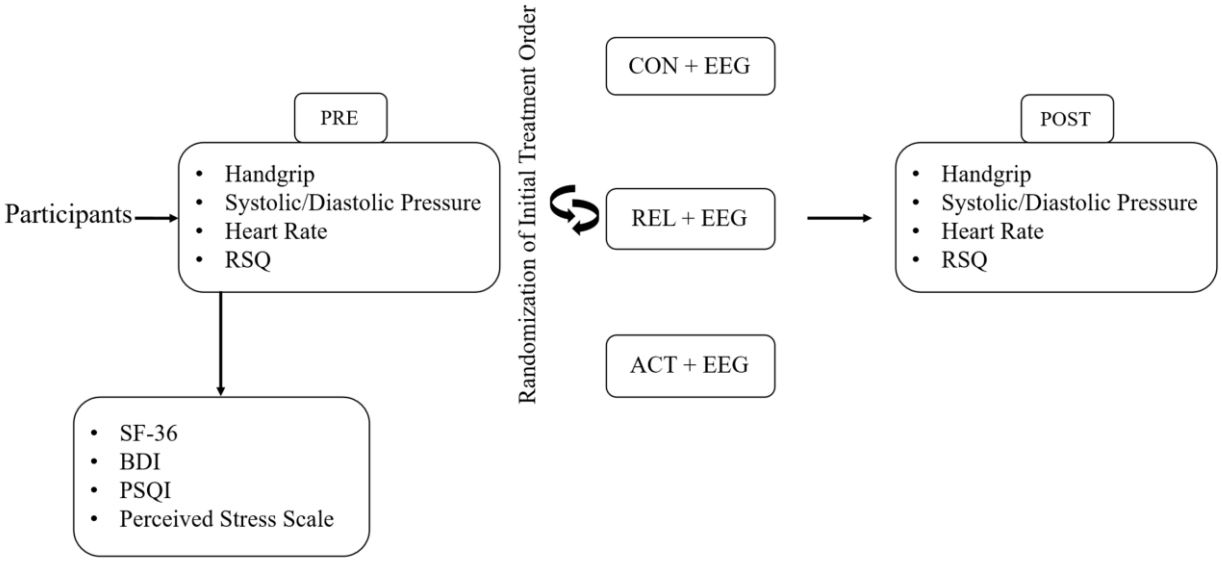


Figure 2. Subjects were assigned in random order to each of the three different sessions over a continuous three-week period. (CON)= control protocol; (REL)= relaxation protocol; (ACT)= activation protocol; (RSQ)= Relaxation State Questionnaire; SF-36= 36-Item Short Form Survey Instrument; BDI= Beck's Depression Inventory; (EEG)= Polysomnography recordings were taken continuously during the 35-minute resting period in each condition.

Procedure

All measurements were performed in the Lifestyle Medicine Laboratory, at the Department of Physical Education and Sports Science of Trikala, in Thessaly, Greece between April to September 2024.

Before the initiation of the study, subjects completed a series of questionnaires and measurements related to overall health. Subjects were connected to a portable polysomnographic EEG/EOG system (HST-mit-tablet, SOMNOmedics AG, Randersacker, Germany) for the recording of brain activity. Before and after each condition, subjects completed a relaxation sensation questionnaire (RSQ) for assessing the state of relaxation and performed 3 maximum handgrip attempts for assessing the level of muscle strength. Measurements of vital signs such as resting heart rate and blood pressure also recorded. During the intervention period, participants were given the instructions to stay awake. This was also reinforced by the various manipulations and body maneuvers induced during the massage session from the masseur as well as using various verbal questions such as “are you OK”, “how do you feel”, “do you feel any discomfort” etc. During the “rest phase” participants were free to either sleep or stay awake with the only restriction to stay calm on bed for 5 minutes.

Data Analysis

Data analysis included the final 5 minutes of EEG called “Rest phase” representing the resting time when participants were left alone without any interaction with the masseur.

Measuring Instruments

Body Composition

Body composition was assessed using anthropometric measurements including BMI, and bioimpedance (Tanita DC-360 S, Serinth) under standard methodology.

Questionnaires

The following questionnaires were administered using the interview method by experienced researchers.

- The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality and the existence of any sleep abnormalities.[210]
- The Short Form survey 36-item 36 quality of life questionnaire (SF-36) was used to assess the quality of life.[211]
- The Beck Depression Inventory (BDI) questionnaire was used to assess depressive symptoms and signs.[212]
- The Perceived Stress Scale (PSS) was used to assess the level of stress.[213]
- The Relaxation State Questionnaire (RSQ) was used to assess state of relaxation.[214]

Brain Activity / Arousal Assessment

The Home Sleep Test (HST) (www.somnomedics.de), was used to assess brain activity during napping periods. This is a portable sleep monitoring system that enables the recording of various sleep parameters in a natural setting, as the patient's bedroom. EEG signals were analyzed in 30 sec epochs using the SOMNOmedics PSG analysis software (Domino panel ver. 3.0.0.8) and manual editing. The setup for the polysomnography (PSG) involved the use of the Home-Sleep-Test REM+ device, which records various sleep parameters, including EEG, EOG, and EMG. EEG measurements were obtained using silver/silver chloride electrode sets, placed in four

specific locations that allow for the monitoring of key brain regions associated with sleep cycles. These locations were selected based on the standardized 10/20 system to ensure accurate representation of the frontal, central, and occipital regions, facilitating a comprehensive analysis of the sleep architecture. The use of these electrodes provides high-fidelity recordings essential for evaluating both the depth and quality of sleep stages.

For EEG, the electrode is positioned in the frontopolar region, specifically at Fp1 (left side) and M1, allowing for the monitoring of brain activity. The EOG electrodes are placed near the left and right eyes to record eye movements, which is crucial for analyzing sleep stages, including REM sleep. The system is designed for ease of use: a tablet guides the patient through the sensor application process. Once the test begins, the tablet records data that the sensors transfer via Bluetooth. After the sleep study is completed, all data is automatically transferred from the tablet to a cloud platform for comprehensive analysis, ensuring seamless and accurate evaluation of sleep parameters such as brain activity, eye movements, and muscle tone. EEG analysis was reported as followed: Total Sleep Time (total amount of sleep time scored during the total recording time); Sleep Efficiency (Total sleep time/Time in bed); Sustained Sleep Efficiency (Total sleep time/Time in bed – Sleep latency stage 2); Sleep latency is defined as the time from lights off to the start of the first epoch of any stage of sleep, including stage N1 (or any other stage). If no sleep is observed, the sleep latency is typically recorded as 20 minutes; Sleep Latency N1 specifically refers to the time from lights out to the onset of the N1 stage of sleep; Sleep Latency N2 (the period of time between time in bed and sleep onset stage 2); REM Latency (the amount of time elapsed between the onset of sleep to the first REM stage).[215]

Handgrip strength assessment

The handgrip test was used for the assessment of maximum isometric strength of the hand and arm muscles (Marsden MG-4800 Hand Dynamometer) and used as a measurement of muscle tone alertness.[216] Reduction of muscle strength after the intervention, was assessed as reduction of muscle tone.

Massage Sessions

Activation (Sports) massage

The activation (sports) type of massage[167] was used as one of the massage interventions. This technique was performed on a full body with more attention given to specific leg muscle groups such as the feet, the gastrocnemius, the femoral biceps and quadriceps and in upper body muscle groups such as the triceps, the rhomboid, the deltoid, the trapezius and head areas. Briefly, this type of massage involves a wide range of techniques that include effleurage, palmar sliding, pounding and hacking (Table 1). The total duration of the activation massage was 30 minutes.

Table 1. Activation/Sports Massage Protocol (Full body).

Massage Technique	Rate	Focus Area	Time (duration) in minutes
Effleurage (start)	Slow to Moderate (smooth and continuous strokes)	full body (upper and lower limbs)	5
Palmar Sliding	Moderate to Fast (smooth, gliding palm movements)	hamstrings, gastrocnemius	7
Hacking	Moderate to Deep (slow, circular movements with pressure)	trapezius, rhomboids, upper back, shoulders	6
Pounding	Moderate (closed fist strikes, rhythmic)	upper and lower limbs, gastrocnemius	7
Effleurage (finish)	Moderate (smooth and continuous strokes)	full body (upper and lower limbs)	5

Relaxation massage

The Relaxation type of massage[217] was used as the second type of intervention in this study. This technique is designed to promote deep relaxation, reduce stress and enhance overall well-being. It is characterized by the use of four primary techniques performed on the full body, including the palms and feet. Specifically, these techniques consist of effleurage (long, smooth, gliding strokes), petrissage (light pressure, rhythmic movements) and vibration gentle shaking movements (Table 2). In addition to these, the technique also incorporates rhythmic movements and deep light pressure to enhance relaxation and alleviate tension. The total duration of the Relaxation massage was 30 minutes.

Table 2. Relaxation Massage Protocol (Full body).

Massage Technique	Rate	Focus Area	Time (duration) in minutes
Effleurage (start)	Slow to Moderate (smooth and continuous strokes)	full body (upper and lower limbs)	5
Petrissage	Gentle (light pressure, rhythmic movements)	hamstrings, calves, back, shoulders	8
Light Vibration	Slow (gentle shaking movements)	upper back and lower back	5
Light Kneading	Slow and Rhythmic	neck, arms, upper back and lower back, calves	7
Effleurage (finish)	Slow (smooth and relaxing strokes)	full body (upper and lower limbs)	5

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 29 (SPSS Inc., Chicago, U.S.A.) An independent samples T-test was used to examine differences in baseline characteristics and questionnaires between male and female subjects. A General Linear Model (GLM) Repeated Measures ANOVA was used to assess changes in all parameters among the 3 different scenarios. A Bonferroni post-hoc test was performed to assess individual differences. To assess normality, the Shapiro-Wilk test was used alongside graphical representations, including the Normal Q-Q plot, Detrended Normal Q-Q plot, and Box Plot. The significance level was set at 5%. Beyond significance testing (p-value), effect size was also considered to evaluate the magnitude of the effect.

Power Analysis

Sample size calculations were conducted using G*Power 3.1. The post-hoc "GLM" - Repeated measures, within factors" method was used to calculate the power analysis. The resulting minimum required sample size to achieve 85% power was 14 for 2-sided group-1 and group-2 errors 5% [(Effect size 0.60, Critical F 4.10, Ndf 2, Ddf 10, Power (1-β err pob) = 0.86 (86% power)].

Trial registration

The trial was registered under the title "Impact of Massage on Daytime Napping (TakeAnap)" with the full protocol accessible through ClinicalTrials.gov website. Trial registration number: NCT06780072

Results

Subject characteristics are presented in Table 3. No statistically significant differences were found between male and female participants.

Table 3. Baseline Characteristics.

Parameters	Values
N	15
Sex	5M/10F
Age (years)	21.6 ± 1.3
BMI (kg/m²)	22.9 ± 2.7
Fat (%)	17.3 ± 7.5
Muscle Mass (kg)	51.8 ± 11.6
SF-36 Total Score	72.6 ± 14.4
SF-36 Physical Summary	69.9 ± 18.9
SF-36 Mental Summary	67.0 ± 14.7
Beck Depression Inventory	13.1 ± 7.8
Pittsburgh Sleep Quality Index	13.0 ± 4.8
Perceived Stress Scale (PSS)	19.7 ± 3.0

Note: Data are presented as Mean ±SD. An independent t-test was used to assess differences between males and females. Significance level $P<0.05$; BMI: Body Mass Index.

Furthermore, Table 4 presents the mean PSQI component scores.

Table 4. PSQI Component Scores.

Parameters	Values (Mean ± SD)
Subjective Sleep Quality	1.19 ± 0.8

Sleep Latency (min.)	0.14 ± 0.6
Sleep Duration (hours)	7.26 ± 1.1
Habitual Sleep Efficiency (%)	2.28 ± 0.9
Sleep Disturbances	2.14 ± 0.8
Use of Sleep Medication	0.57 ± 0.8
Daytime Dysfunction	1.57 ± 1.3

Note: Data are presented as Mean ±SD. The values for each subcategory of the Pittsburgh Sleep Quality Index range from 0 to 3, with 0 representing the best possible score and 3 indicating the most problematic outcome.

Pre and Post-intervention assessments among the 3 different conditions are shown in Table 5. Significant differences within groups were found in handgrip strength (muscle tone) before and after all conditions. Statistically significant effects were observed in RSQ among the three sessions [$F(5,70) = 5.855$, $p=0.001$], with RSQ increasing significantly after the REL massage session by 23.4% ($p=0.002$), indicating a robust improvement in relaxation.

Specifically, handgrip strength decreased after both ACT and REL massage sessions, with percentage changes of -7.2% ± 3.2 ($p=0.000$) and -4.8% ± 3.3 ($p=0.006$), respectively, showing a clear reduction in muscle tone. Statistically significant differences were also found in the Δ-change of the aforementioned values. RSQ increased most notably after the REL massage (%Δ-change: 34.2 ± 5.0, $p=0.038$), while systolic pressure decreased after the ACT massage session (%Δ-change: -1.2 ± 1.0, $p=0.012$). In addition, no statistically significant difference was found in resting heart rate across all sessions ($p>0.05$).

In Table 6, brain activity parameters are presented. A statistically significant effect was found in Sleep Latency N1 among the three sessions [$F (2, 32) = 6.193$, $p=0.037$], indicating that the sports/activation massage session had a greater impact on the arousal state ($p= 0.062$). Although the p-value for Sleep Latency N1 improvement was close to the threshold of statistical significance, the effect size was substantial (0.608), suggesting that activation massage may have a meaningful impact, although it should be interpreted with caution as it does not meet the standard threshold of $p<0.05$.

No side effects or signs of discomfort were reported during the duration or after the study.

Table 5. Pre and Post Intervention assessment among the 3 different conditions.

Variables	CON			ACT			REL		
	Pre (Mean ± SD) (95% CI)	**Post (Mean ± SD) (95% CI)**	**P Value* (Effect size-*d*) (Δ-change%)**	**Pre (Mean ± SD) (95% CI)**	**Post (Mean ± SD) (95% CI)**	**P Value* (Effect size-*d*) (Δ-change%)**	**Pre (Mean ± SD) (95% CI)**	**Post (Mean ± SD) (95% CI)**	**P Value* (Effect size-*d*) (Δ-change%)**
N	**15**	**15**	**-**	**15**	**15**	**-**	**15**	**15**	**-**
RSQ	34.8 ± 5.7 (31.9 to 37.7)	37.4 ± 4.8 (35 to 39.8)	0.417* (0.493) (14.3% ± 5.0)	33.9 ± 5.2 (31.3 to 36.5)	37.5 ± 5.2 (34.9 to 40.1)	0.683* (0.692) (16.8% ± 5.4)	32.1 ± 5.1 (29.5 to 34.7)	39.6 ± 4.9*** (37.1 to 42.1)	0.168* (1.499) (**23.4% ± 5.0**)**
Systolic Pressure (mmHg)	112.5 ± 10.1 (107 to 118)	109.3 ± 10.9 (104 to 115)	**0.030** (0.304) (-3.8% ± 1.0)	114.1 ± 9.0 (110 to 119)	108.6 ± 13.2 (102 to 115)	**0.012** (0.469) (-1.2% ± 1.0)	112.6 ± 9.2 (108 to 117)	110.0 ± 9.4 (105 to 115)	0.568 (0.279) (-0.1% ± 0.9)
Diastolic Pressure (mmHg)	68.1 ± 6.5 (64.8 to 71.4)	70.8 ± 7.9 (66.8 to 74.8)	0.184 (0.373) (5.1% ± 0.7)	71.1 ± 6.5 (67.8 to 74.4)	67.4 ± 6.9 (63.9 to 70.9)	0.995 (0.551) (-1.2% ± 0.6)	68.0 ± 5.4 (65.3 to 70.7)	69.0 ± 5.4 (66.3 to 71.7)	0.316 (0.185) (2% ± 0.5)
Heart Rate (Bits/min)	78.6 ± 15.2 (70.9 to 86.3)	66.8 ± 12.9 (60.3 to 73.3)	**0.001** (0.837) (-12.1% ± 15.4)	81.9 ± 12.7 (75.5 to 88.3)	73.8 ± 10.4 (68.5 to 79.1)	0.082 (0.697) (-12.2% ± 12.7)	75.4 ± 12.5 (69.1 to 81.7)	73.7 ± 15.6 (65.8 to 81.6)	0.093 (0.120) (-6.6% ± 13.2)
Handgrip Strength (Kg)	23.3 ± 2.1 (22.2 to 24.4)	22.8 ± 3.2 (21.2 to 24.4)	**0.002** (0.184) (-4% ± 2.9)	23.5 ± 2.4 (22.3 to 24.7)	22.2 ± 3.5 (20.4 to 24)	**0.000** (0.433) (-7.2% ± 3.2)	23.2 ± 2.4 (22 to 24.4)	22.0 ± 3.4 (20.3 to 23.7)	**0.006** (0.407) (-4.8% ± 3.3)

Note: Data are presented as Mean ±SD. Significance level P<0.05; RSQ: Relaxation Scales Questionnaire; CON: control; ACT: activation massage; REL: relaxation massage; Δ-Change: % difference compared to Pre values; Paired t test: Means of pre-post measurements between (CON-ACT-REL) protocols. *Differences between the Δ-changes were assessed using a GLM Repeated Measures test; RSQ: CON vs ACT vs REL, P=0.010. **Differences between the %Δ-changes were assessed using an ANOVA test; RSQ: CON vs REL, P=0.008 and ACT vs REL, P=0.038 (Bonferroni PostHoc Test). ***Differences between protocols (CON-ACT-REL) were assessed using a GLM Repeated Measures test; RSQ: [F(5,70) = 5.855, P=0.001], and particularly for RSQ: Pre-REL vs Post-REL, P=0.002 (Bonferroni Post Hoc Test).

Table 6. Brain activity Pre and Post Intervention assessment among the 3 different conditions (Rest Phase - 5 min).

Variables	**CON** **(Mean ± SD)** **(95% CI)**	**ACT** **(Mean ± SD)** **(95% CI)**	**REL** **(Mean ± SD)** **(95% CI)**	**P Value*** **(Effect size-E)**
Total Sleep Time **(min.)**	2.0 ± 2.1 (0.86 to 3.14)	2.6 ± 2.2 (1.4 to 3.8)	1.3 ± 1.9 (0.27 to 2.33)	0.067 (0.207)
Sleep Efficiency **(%)**	25.1 ± 32.4 (7.5 to 42.7)	54.0 ± 44.1 (30 to 78)	33.6 ± 40.4 (11.6 to 55.6)	0.125 (0.149)
Sustained Sleep Efficiency **(%)**	41.3 ± 38.8 (20.2 to 62.4)	62.0 ± 42.9 (38.7 to 85.3)	33.8 ± 40.3 (11.9 to 55.7)	0.117 (0.164)
Sleep Latency N1 **(min)**	2.3 ± 2.3 (1.05 to 3.55)	2.9 ± 1.7* (1.98 to 3.82)	0.04 ± 0.08 (-0.0301 to 0.11)	**0.037** (0.608)

Sleep Latency N2 (min)	1.0 ± 1.6 (0.13 to 1.87)	0.9 ± 1.3 (0.193 to 1.61)	0.0 ± 0.0 (0 to 0)	0.410 (0.182)

Note: Data are presented as Mean ±SD. Significance level P<0.05; *a trend: ACT vs REL, P=0.062.

Discussion

To the best of our knowledge, this is the first study to assess the effects of two distinct and fashionable types of massage on daytime brain activity among poor sleepers, employing both objective and subjective measurements. A group of poor sleepers was selected due to their consistently more pronounced and stable sleep disturbances, such as insomnia, which are typically characterized by more stable and pronounced sleep issues compared to other sleep disorders.These individuals often present with distinct sleep patterns and characteristics that differ significantly from those diagnosed with clinical insomnia.[218] The primary outcome of this investigation reveals that, when subjective assessments of relaxation were employed, the Relaxation massage demonstrated a significantly greater effect, resulting in a 23.4% increase in relaxation (RSQ) score (Table 5). As expected, objective EEG recordings showed a significant increase in Sleep Latency N1 following the Relaxation massage (REL) condition, indicating a reduction in pre-sleep arousal. Specifically, Sleep Latency N1 increased by 0.6 minutes (approximately 26%), from 2.3 ± 2.3 to 2.9 ± 1.7 minutes consistent with the calming and parasympathetic activation effects typically associated with relaxation massage (Table 6). Furthermore, concerning objective variables, individuals undergoing Sports/Activation massage exhibited a significant decrease in handgrip strength (-7.2%, p=0.000), indicating a reduction in muscle tone. This observation was concurrent with a decline in systolic blood pressure, suggesting the promotion of muscle relaxation in these individuals (Table 5). It appears that a 30-minute full-body sports massage provides benefits in people experiencing poor sleep. In our study, sports massage appears to have a more pronounced effect on reducing arousal levels due to its greater ability to activate the parasympathetic nervous system (PNS) compared to relaxation massage. This activation of the PNS promotes relaxation and recovery while simultaneously diminishing the hyperactivity of the sympathetic nervous system (SNS), which is associated with stress and muscle soreness.[219,220]

Through more intense and targeted techniques, sports massage may effectively reduce muscle tension, aiding athletes in achieving quicker recovery and improved the sense of relaxation.[221] This could explain why poor sleepers, who may experience stress and physical strain, benefit from this technique. In our study, participants scored an average of 19.7 ± 3.0 on the Perceived Stress Scale (PSS), indicating a moderate level of stress and verified by the SF36 physical component summary (Table 3). According

to the PSS scale, scores ≥ 27 indicate elevated stress levels, which suggests that our participants experienced moderate stress during the study period.[222] This aligns with the potential benefits of sports massage in alleviating stress-related physical strain.

It seems that sports massage could have significant implications for health and performance, influencing sleep therapy, rehabilitation and help reduce anxiety levels and improve the quality of life.[91]

Indeed, in the study by Field et al., was found that massage therapy can improve the mental and physical health of depressed pregnant women by increasing levels of dopamine and serotonin while reducing levels of cortisol and norepinephrine, which is associated with lower anxiety, better sleep, and fewer depressive symptoms. High levels of cortisol, often referred to as the "stress hormone," can lead to negative health outcomes, including increased anxiety and disrupted sleep patterns; thus, the ability of massage to lower cortisol levels is particularly beneficial for stress management.[223]

Additionally, research by Bazzichi et al. suggests that massage therapy, with strokes directed from the lower extremities upward towards the cranial region, may serve as an effective tool for reducing muscle stiffness and enhancing autonomic nervous system function. This is characterized by a reduction in sympathetic tone and an increase in parasympathetic tone.[224] In a study utilizing EEG, massage therapy performed on an automatic spine bed with a roller massaging the muscles along the spine, moving up and down from the cervical to the coccygeal vertebrae, particularly when combined with infrared heating, significantly improved physical functioning, increased parasympathetic response, and reduced psychological stress and anxiety levels. The novelty of using EEG in this study provides more accurate and immediate insights into the effects of massage on brain arousal, highlighting the relationship between massage and sleep quality.[225] A study by Ventura et al. demonstrated that a parent-led massage routine during the first four months of an infant's life resulted in detectable changes in the electroencephalogram (EEG) during sleep, including increased spectral power in sleep spindles, elevated EEG amplitude, and reduced interhemispheric coherence.[226]

Furthermore, it seems that a full-body sports massage can enhance blood circulation to the muscles, aiding in the delivery of oxygen and nutrients while removing metabolic waste.[227] Additionally, this enhanced blood flow can contribute to the recovery process

by reducing muscle soreness and fatigue.[228] Through more intense and targeted techniques, sports massage may effectively reduce muscle tension, aiding athletes in achieving quicker recovery and improved the sense of relaxation[229]. This could explain why poor sleepers, who are likely exposed to higher levels of stress and physical strain, experience greater relief through this technique. It seems, the duration of massage appears to play a crucial role in muscle relaxation and neuromuscular response, with longer sessions potentially causing excessive relaxation, an effect that may not occur with shorter protocols.[230] This phenomenon could have significant implications for muscle performance and functionality, making the appropriate selection of massage duration essential depending on the desired outcome. Furthermore, sports massage exerts its effects through mechanisms that enhance blood circulation and activate the lymphatic system, aiding in the transport of nutrients and the removal of metabolic waste.[231] Additionally, sports massage impairs postexercise muscle blood flow and "lactic acid" removal.[232] Moreover, increased blood flow and the production of hyaluronic acid, which reduces friction between muscle structures, facilitate muscle relaxation and recovery, while the improvement in range of motion (ROM) provides additional functional benefits[233] and rehabilitation.[234] Therefore, both the duration and technique of massage are key factors in determining its overall impact on muscle relaxation and recovery.

Another study revealed the immediate neurophysiological effects of different types of massage on healthy adults, indicating that Swedish/Relaxation massage, using gentle strokes and gliding manoeuvres (i.e., effleurage, petrissage, longitudinal and transverse foulage, the latter two involving thumb sliding over tendons, ligaments, or muscles to separate these tissues), activates specific brain regions associated with consciousness during cognitive tasks, influencing neural activity and the management of mood disorders.[235] Similarly, in another study by Shen et al., it was found that a single acute Swedish massage applied to the plantar surface of the right foot increased resting state activation in two brain regions (sACC and RSC/PCC), which are important nodes in the default mode network and are critical for self-awareness and arousal.[236]

Contrary to our original hypothesis that relaxation massage would have the largest effect in reducing arousal levels, only the Sports/Activation massage, lasting 30 minutes, demonstrated a significant beneficial effect on relaxation by increasing Sleep Latency N1. Analysis revealed a positive effect on Sleep Latency N1 following the

Sports/Activation massage, indicating that participants were able to fall asleep faster after this type of massage. This implies that participants experienced a more rapid entry into the N1 sleep stage, characterized by light sleep and marking the initial phase of the sleep cycle.[237] Faster entry into the N1 sleep stage offers numerous benefits, particularly for athletes.[238] This efficient transition results in less time spent awake attempting to fall asleep, leading to higher sleep efficiency and increased total sleep duration. Poor sleepers often have difficulty falling asleep, wake up multiple times during the night, or rise early in the morning without feeling rested. Interestingly, those who report high or low levels of distress regarding their sleep issues tend to have similar severity and duration of the problem.[239]

In contrast, individuals with clinical insomnia experience persistent sleep disturbances occurring at least three times per week. These disturbances are frequently associated with psychological issues such as anxiety and depression, along with a heightened state of alertness during the day struggling most of the time to both initiate and/or maintain sleep at night.[240]

It is known that enhanced sleep efficiency and napping positively impacts cognitive functions such as memory attention and decision making, all of which are vital for any type of performance.[241,242] Improved sleep quality also contributes to higher energy levels, reduced daytime fatigue, and better mood and mental health, collectively enhancing the person's overall well-being and performance.[243,244]

In the present study, we must acknowledge both some significant strengths and unforeseen limitations. One of the primary strengths of our study is the combination of both objective and subjective type of methodology used to assess relaxation and brain activity. In addition, a blinding process of analysing the data was applied, since all researchers involved in the analysis were unaware of the type of session. Finally, the use of a real time EEG monitoring system provided an objective measurement of the brain activity that is valuable for understanding the immediate effects of massage on the brain.

One limitation that requires acknowledgment is the disparity in sample size between female and male subjects. This imbalance could have resulted in minor errors in measurement data or inconsistencies in our results. Another limitation of our study is that the EEG system used was part of a full-night EEG-EOG polysomnography system with only 4 EEG channels, rather than the 10-24 channels typically used in neurological EEG systems. This limitation may have impacted the ability to capture finer details of

sleep architecture. In addition, poor sleepers were separated by good sleepers using a validated questionnaire and not the gold standard methodology which is the full night polysomnography. Finally, another weakness that needs to be acknowledged is that the day of the massage session was not controlled for the menstrual cycle of the female participants. This could have an impact of relaxation and arousal levels.

Future research should explore the long-term effects of repeated massage sessions on various populations, with a particular focus on athletes and individuals with sleep disorders.

Conclusions

The Relaxation type of massage improves overall feelings of relaxation; leading to a faster and longer napping period in people with poor sleep quality. Further research is necessary to ascertain the mechanism by which massage can alter brain activity and whether these techniques can exert the same effect on individuals with insomnia or stress and anxiety disorders over the long term.

Study 3

The Impact of Relaxation Massage Prior to Bedtime on Sleep Quality and Quantity in People with Symptoms of Chronic Insomnia: A Home-Based Sleep Study

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Abstract

Background: Manual massage is an effective treatment approach for reducing general stress and promoting an overall sense of well-being. Relaxation massage aims to alleviate psychophysiological tension, enhance both blood and lymphatic circulation, and promote mental and physical relaxation. It is particularly beneficial for those with anxiety-related symptoms (such as generalized anxiety disorder and social anxiety) and sleep disorders, aiming to improve calmness and promote sleepiness.

Aims: The purpose of the present study was to assess the effectiveness of a single session of relaxation massage prior to bedtime on sleep quality and quantity indices in individuals with symptoms of chronic insomnia.

Methods: In total, 20 (N= 20) healthy individuals (aged 25.5 ± 12.0 years; 6F/14M) with a score on the Athens Insomnia Scale of ≥ 16 participated under three different conditions over one week apart: (1) a 45 min relaxation mas-sage condition (REL), (2) a 45 min sham massage condition (PLA), and (3) a control condition with no massage. Sleep activity was monitored using a portable polysomnographic system.

Results: A statistically significant effect was observed between sleep efficiency across the three sessions (p= 0.034), with a notable effect in the relaxation massage (REL) session (p= 0.045). Additionally, sustained sleep efficiency showed a statistically significant difference among the sessions (p= 0.005).

Conclusions: Relaxation massage prior to bedtime could be used as an effective and safe non-pharmacological approach for improving sleep efficiency and potentially restoring the fragmented sleep of individuals with symptoms of insomnia.

Keywords: sleep; well-being; health; EEG; efficiency; sleepiness; lifestyle

Introduction

Sleep is a naturally occurring state for both the mind and body, marked by changes in consciousness, decreased sensory responsiveness, lowered muscle activity, and the suppression of almost all voluntary muscles [245]. There is no fixed amount of hours of sleep per night, however, it is recommended that for a healthy adult the minimum hours of uninterrupted sleep are approximately 6-8 hours[246]. In the modern western societies, sleep deprivation seems to become the new epidemic[247]. Indeed, sleep disorders have greatly increased in all age groups and they are related mostly to an unhealthy lifestyle [248]. In particular, insomnia is one of the most common sleep disorders, that affects health and quality of life of the sufferer [249]. Recent global statistics shows that sleep disorders affect almost 10% of the general population, with chronic insomnia reaching the 33% of those [250]. Insomnia has been associated with reduced cardiorespiratory fitness (CRF), which is a significant risk factor for cardiovascular diseases [251]. Specifically, the study by Zou et al., demonstrated a significant association between insomnia and lower CRF, suggesting that insomnia may affect cardiometabolic health through physical fitness [252]. On the contrary, poor physical fitness may also exacerbate insomnia, creating a bidirectional relationship between these conditions [253]. Furthermore, poor sleep quality, associated with insomnia, has been linked to an increased risk of developing chronic conditions associated with modern lifestyle, including diabetes, hypertension, dyslipidemia, metabolic syndrome and cardiovascular diseases [254,255]. Studies suggest that insomnia negatively impacts health through mechanisms such as elevated cortisol levels, reduced immunity and increased sympathetic activity, all of which contribute to the development of chronic non-communicable diseases [256].

The most common treatment of insomnia is pharmacological, however, these drugs come with significant side effects, can become addictive with prolonged use and they do not help to restore sleep quality [257]. Cognitive Behavioral Therapy for Insomnia (CBTi) is the first-line treatment for insomnia. Additionally, Acceptance and Commitment Therapy (ACT) has proven effective in improving sleep quality and emotional regulation. Specifically, Zakiei et al., showed that ACT significantly enhanced sleep quality and emotional processing in individuals with insomnia, with benefits lasting up to 12 weeks [258].

Lifestyle medicine is a branch of medicine that aims to maintain optimal health and prevent, treat and reverse chronic diseases via lifestyle changes [259]. This approach is

based on eight pillars, one of which is improving sleep hygiene [260]. Lifestyle medicine proposes a series of interventions to improve sleep quality [261] and one of those is to promote relaxation and calmness before bed-time. Toward this direction, we have explored the impact of full body relaxation massage prior to bed-time with the aim to promote relaxation and help people with insomnia symptoms improve their sleep quality and quantity. Massage therapy is a healing practice that dates back thousands of years [123] and it has been used as a tool to reduce stress levels, improve blood circulation and muscle relaxation as well as to promote an overall sense of calmness [262].

The application of massage has been shown to reduce stress and fatigue [263], improve sleep quality [264], reduce the severity of sleep disorders[265], reduce pain [266] and contribute to the overall physical and mental well-being [267]. The technique of relaxation massage focuses on promoting psychosomatic relaxation through gentle, rhythmic movements and deep light pressure [268]. It employs long, continuous strokes aimed at reducing stress and inducing a deep sense of relaxation, without targeting intense muscle pressure or enhancing blood circulation, as seen in other forms of massage, such as Swedish or sports massage [269]. The gentle nature of the technique allows for the activation of the parasympathetic nervous system, contributing to a decrease in heart rate, relaxation of the nervous system and improvement in mental health [270].

Therefore, the primary aim of the current study was to assess the effect of a single session of relaxation massage prior to bed-time on sleep quality and quantity indices, in individuals suffering from symptoms of insomnia. By investigating these parameters, we seek to determine whether relaxation massage can serve as an effective non-pharmacological intervention for improving sleep patterns and reducing sleep disturbances in individuals with chronic insomnia symptoms. The findings will contribute to the growing body of evidence regarding the potential therapeutic benefits of massage therapy for sleep disorders and overall well-being.

Methodology

Subjects

Twenty (N=20) healthy participants (aged, 25.5 ± 12.0years, 6F/14M) fulfilled the inclusion criteria and participated in this study (Figure 1). Inclusion criteria included subjects of both sexes, aged >18 years and score of ≥16 on the Athens Insomnia Scale (AIS-8). Exclusion criteria included a history of mental illness, dermatological diseases, allergies to massage oil and any acute or chronic condition that would limit the ability of the patient to participate or consent in the study.

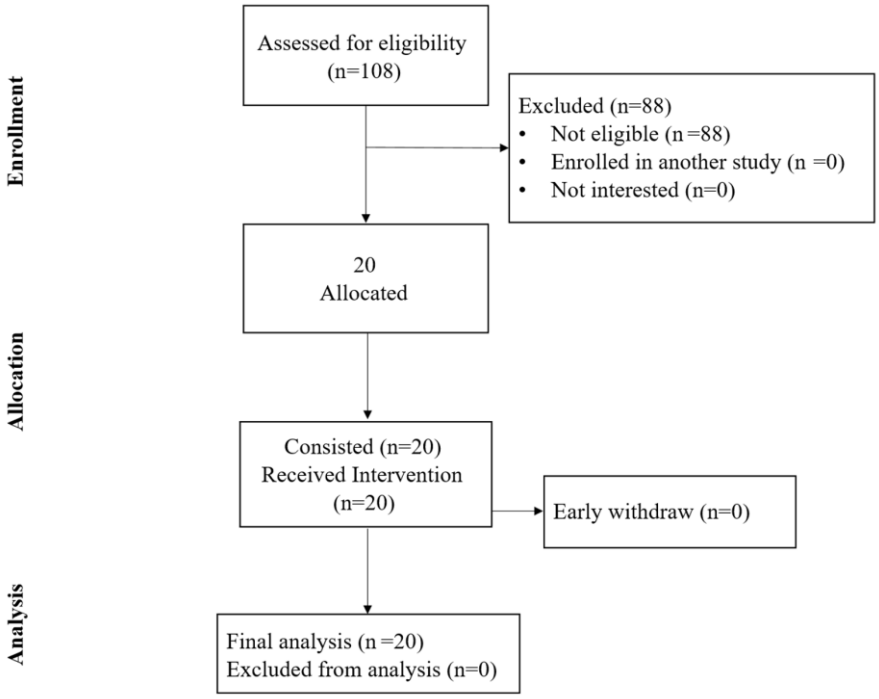


Figure 1. Consort Diagram.

Study Design

Subjects participated in 3 different sessions, each 7-days apart for 3 continuous weeks. More particular, “Session 1” is the control (CON) session where participants did not receive any massage session and followed their usual bed-time routine. For “Session 2”, participants received a relaxation massage (REL) session lasting for 45 minutes prior to bed time followed by their usual bed-time routine. For “Session 3”, participants received a

"sham" massage (PLA) session lasting for 45 minutes prior to bed time followed by their usual bed-time routine. While Session 1 was always performed first, Sessions 2 and 3 were randomly assigned to each participant (Figure 2). Both massage sessions were delivered by a professional masseur while the researcher analyzing the data was blind to the assigned session. Sleep quality and quantity were assessed in all three sessions. The study was approved by the Human Research and Ethics Committee of the University of Thessaly (2334-3/4-2/7.2.2024). All Subjects gave their written informed consent prior to study participation.

Procedure

All studies were conducted at subjects' own homes. Massage session took place at the participant's bedroom prior to bed time, using a portable massage bed.

The initial screening required that all participants should score ≥16 on the Athens Insomnia Scale (AIS-8). A daily sleep questionnaire was provided for participants to complete for the next five consecutive days prior to the initiation of the study and repeated after session 2 and 3. Additionally, prior to the initiation of the study, all participants filled out a series of validated questionnaires regarding quality of life, depression score, sleep quality, stress and general fatigue.

During the in-house visits, researchers arrived one hour before the subject's usual bedtime and prepared them for the study. After each visit, subjects were connected to the portable polysomnography system and left alone to follow their bedtime routine. The study recording was completed when the participant woke up and disconnected the system.

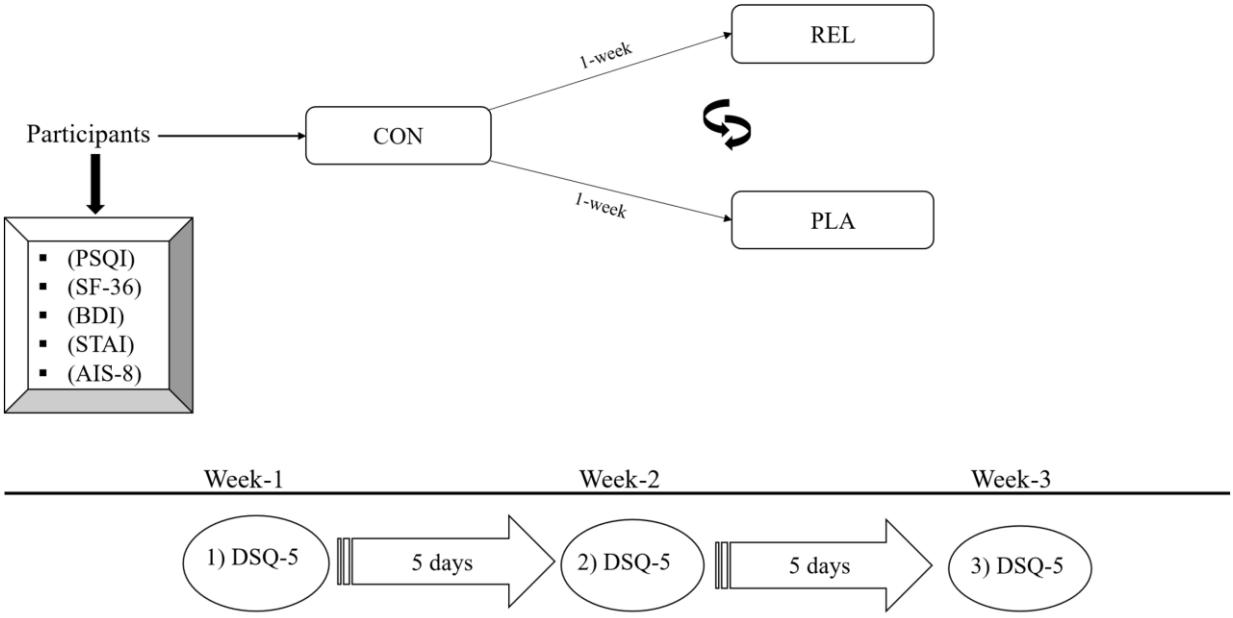


Figure 2. Study Flow Chart. Subjects were assigned in random orders to each of the two massage sessions. Note: (CON) Control protocol; (REL) Relaxation massage protocol; (PLA) Placebo/sham massage protocol; (PSQI) Pittsburgh Sleep Quality Index; (BDI) Beck's Depression Inventory; (STAI) State-Trait Anxiety Inventory; (DSQ-5) Daily Sleep Questionnaire-5 days; (AIS-8) Athens Insomnia Scale. The order of either the REL and PLA allocation was random. CON was performed always first as a baseline polysomnographic assessment.

The CON condition was always conducted first in order. Then, randomization ensured that each participant had an equal opportunity to be assigned first to either the REL or PLA conditions, thereby minimizing bias and preserving the integrity of the study results.

Questionnaires

The following questionnaires were administered:

The Athens Insomnia Scale [271], the Daily Sleep Questionnaire-5 days (DSQ-5) [272] and the Pittsburgh Sleep Quality Index (PSQI) [273] were used to assess sleep quality and sleep abnormalities [274].

The Short Form survey 36-item 36 quality of life questionnaire (SF-36) was used to assess the health-related quality of life [211].

The Beck Depression Inventory (BDI) questionnaire was used for the assess symptoms of depression [275].

The State – Trait Anxiety Inventory (STAI) was used to assess the stress levels [276].

Sleep Quality and Quantity Assessment

A portable sleep monitoring system was used to assess sleep quality and quantity (Home Sleep Test, SOMNOmedics, GmbH, Germany). The system records EEG, EOG, and EMG signals overnight. EEG data were analyzed in 30-second epochs using SOMNOMedics PSG analysis software (Domino panel ver. 3.0.0.8) with manual editing. The HomeSleepTest REM+ device was used for PSG, with electrodes placed according to the 10/20 system on key brain regions: Fp1 (left) and M1 for EEG, and near the eyes for EOG. This setup ensures accurate monitoring of sleep architecture and high-fidelity recordings of brain activity and eye movements.

Analysis of the sleep study was reported as followed: Total Sleep Time (total amount of sleep time scored during the total recording time); Sleep Efficiency (Total sleep time/Time in bed); Sustained Sleep Efficiency (Total sleep time/(Time in bed – Sleep latency stage 2); Sleep Latency (the period of time it takes for a person to fall asleep after they have gone to bed and tried to initiate sleep); Sleep Latency N1 (the period of time between wakefulness and when sleep begins); Sleep Latency N2 (the period of time between time in bed and sleep onset stage 2); REM Latency (the amount of time elapsed between the onset of sleep to the first REM stage).

Massage Session

Relaxation Massage

A relaxation type of massage was used as main massage intervention in this study. This technique is designed to promote deep relaxation, reduce stress, and enhance overall well-being. It is characterized by the use of five primary techniques performed on the full

body, including the palms and feet. Specifically, these techniques consist of effleurage (long, gliding strokes), petrissage (kneading and squeezing), tapotement (rhythmic tap-ping), friction (deep, circular rubbing), and vibration or shaking movements (Table 1). In addition to these, the technique also incorporates rhythmic movements and deep light pressure to enhance relaxation and alleviate tension. It is designed to promote relaxation, increase blood circulation, relieve muscle tension, improve flexibility and promote relaxation and reduce pain [277]. The total duration of the Relaxation massage was 45 minutes.

Table 1. Relaxation Massage Protocol (Full body).

Massage Technique	Rate	Time (Duration) in Minutes
1. Effleurage (start)	Slow to moderate (smooth and continuous strokes)	7
2. Petrissage	Moderate (kneading pressure, rhythmic)	10
3. Tapotement	Moderate to fast (quick, light tapping movements)	4
4. Friction	Moderate to deep (slow, circular movements with pressure)	6
5. Vibration	Moderate to fast (gentle or firm shaking/vibrating)	4
6. Effleurage (finish)	Slow (light strokes)	7

Placebo "Sham" massage (PLA)

The Sham massage (PLA) was used as a control session, without applying the deeper techniques that characterize the Relaxation massage in order to eliminate the influence of the human touch sensation on participant's skin. This massage consisted only of superficial oil application movements over the entire body, without any added pressure or deep muscle manipulation. Oil was used to facilitate smooth gliding, mimicking the sensation of a full massage, but without the intensity or techniques aimed at muscle tissue relaxation. The total duration of the sham massage was also 45 minutes.

Table 2. "Sham" Massage Protocol (Full body).

	Massage Technique	Rate	Time (Duration) in Minutes
1.	Effleurage (start)	Very slow to slow (light, smooth strokes)	10
2.	Superficial gliding strokes	Slow (gentle, superficial movements)	20
3.	Effleurage (finish)	Very slow (light strokes)	15

Massage Oil

Massage oil was a commercially available baby oil, composed 99% of mineral oils and <1% fragrance (Benzyl Acetate, BicycloNonalactone, Isopropyl Myristate, Mefrosol) (www.johnsonsbaby.com). Baby oil, typically made from mineral oil (a refined petroleum product) and sometimes scented with fragrances, is generally free from naturally occur-ring terpenes.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 29.0 (IBM Corporation, Armonk NY, USA). An independent samples t-Test was conducted to assess significant differences in basic characteristics between male and female participants. A General Linear Model-Repeated Measures was used to examine if there are significant differences in the sleep parameters and sleep diary data between the 3 sessions. To assess normality, the Shapiro-Wilk test was used alongside graphical representations, including the Normal Q-Q plot, Detrended Normal Q-Q plot, and Box Plot. The significance level was set at 5%. Beyond significance testing (p-value), effect size was also considered to evaluate the magnitude of the effect.

Power Analysis

Sample size calculations were conducted using G*Power 3.1. [278]. The post-hoc "GLM: Repeated measures, within factors" method was used for the power analysis. Based

on an expected medium effect size of 0.25 (Cohen's f), a significance level of $\alpha = 0.05$, and a desired power (1-β) of 0.82 (82%), the resulting minimum required sample size was calculated to be 20 participants. The critical F-value was 3.16 with (Ndf) = 2 and (Ddf) = 54.

Results

The subject characteristics and questionnaire scores are presented in Table 3. No statistically significant differences were observed between male and female participants ($p > 0.05$), except for in body weight ($t(18) = 4.478$; $p < 0.001$) and body height ($t(18) = 6.478$; $p < 0.001$).

Table 3. Baseline Characteristics.

Variables	All Participants (Mean ± SD)	Female (Mean ± SD)	Male (Mean ± SD)	*p*-Value (Cohen's, d)
N	20	6	14	-
Age (years)	25.5 ± 12.00	27.33 ± 7.57	30.42 ± 13.62	0.611 (0.28)
Body weight (kg)	76.1 ± 14.89	60.08 ± 10.07	83.08 ± 10.69	**<0.001** (2.19)
Body height (cm)	176 ± 0.09	164 ± 0.05	181 ± 0.05	**<0.001** (3.20)
BMI	24.5 ± 1.74	24.60 ± 2.62	25.51 ± 2.80	0.951 (0.33)
Athens Insomnia Scale	16.95 ± 1.08	18.16 ± 3.06	16.42 ± 1.08	0.071 (0.94)
36-Item Short Form Health Survey (SF-36) Score	85.24 ± 6.59	82.13 ± 7.86	88.34 ± 3.72	0.204 (1.00)
Beck Depression Inventory (BDI)	15.12 ± 4.38	14.75 ± 3.77	15.50 ± 5.50	.830 (0.15)
Pittsburgh Sleep Quality Index (PSQI)	19.12 ± 5.38	18.50 ± 3.10	19.75 ± 7.54	0.770 (0.21
Anxiety Perception Scale	21.50 ± 4.40	20.75 ± 3.86	22.25 ± 5.37	0.666 (0.32)

Note: Data are presented as Mean ±SD. Significance level P≤0.05.

The sleep parameters are presented in Table 4. A statistically significant effect was observed on sleep efficiency [$F(2,28) = 4.287$; $p = 0.034$] and sustained sleep efficiency [$F(2,28) = 3.897$; $p = 0.045$] across the three sessions, indicating a statistically significant effect of the relaxation massage session ($p = 0.037$ and $p = 0.052$, respectively).

Table 4. Sleep parameters after the 3 different sessions.

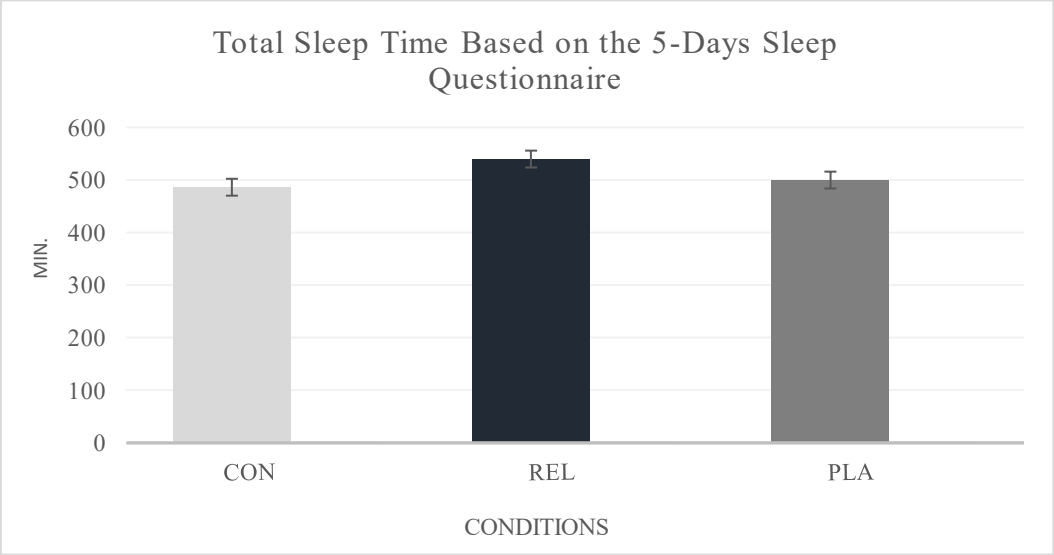
Variables **N = 20**				
	(CON) (95% CI)	**(PLA) (95% CI)**	**(REL) (95% CI)**	***p*-Value (Effect size: partial η^2)**
Total Sleep Time (TST) (hour.min.)	5.66 ± 2.0 (4.65 to 6.67)	5.82 ± 1.77 (4.92 to 6.72)	6.31 ± 1.53 (5.54 to 7.08)	0.259 (0.092)
Sleep Efficiency [%]	84.54 ± 12.29 (78.3 to 90.8)	81.10 ± 12.20 (74.9 to 87.3)	89.87 ± 9.44* (85.1 to 94.7)	**0.034** (0.234)
Sustained Sleep Efficiency [%]	84.19 ± 13.34 (77.4 to 90.9)	84.24 ± 11.55 (78.4 to 90.1)	90.11 ± 9.4* (85.3 to 94.9)	**0.045**** (0.218)
Sleep Latency [min.]	1.62 ± 2.33 (0.6 to 2.64)	0.65 ± 0.72 (0.334 to 0.966)	2.15 ± 3.35 (0.68 to 3.62)	0.188 (0.123)
Sleep Latency N1 [min.]	1.36 ± 1.94 (0.378 to 2.34)	1.24 ±1.51 (0.476 to 2)	3.48 ± 3.97 (1.47 to 5.49)	0.057 (0.235)
Sleep Latency N2 [min.]	9.82 ± 11.61 (3.94 to 15.7)	8.64 ± 11.49 (2.83 to 14.4)	14.24 ± 17.99 (5.14 to 23.3)	0.317 (0.084)
Deep Sleep Latency [min.]	33.08 ± 20.05 (23 to 43.2)	35.22 ± 32.41 (18.8 to 51.6)	41.52 ± 37.51 (22.5 to 60.5)	0.607 (0.037)
REM latency [min.]	98.67 ± 88.21 (54.1 to 143)	91.56 ± 81.97 (50.1 to 133)	128.70 ± 83.26 (86.6 to 171)	0.382 (0.083)
Wake Index	20.26 ± 11.44 (14.5 to 26)	19.13 ± 13.86 (12.1 to 26.1)	15.80 ± 10.55 (10.5 to 21.1)	0.304 (0.081)
Wake > 3 min. Index	2.40 ± 1.72 (1.53 to 3.27)	2.46 ± 1.84 (1.53 to 3.39)	2.20 ± 2.54 (0.91 to 3.49)	0.858 (0.010)

Note: Data are presented as Mean ±SD. Significance level P≤0.05; CON: control; PLA: placebo - "sham massage; REL: relaxation massage; Differences between the 3 protocols using a GLM Repeated Measures test; *Sleep Efficiency: PLA vs REL, P=.037; and *Sustained Sleep Efficiency: PLA vs REL, P=.045 (Bonferroni Post-Hoc Test); **a trend in Sustained Sleep Efficiency: CON vs REL, P=.052, (Bonferroni Post-Hoc Test).

Additionally, the 5-Day Sleep Questionnaire (sleep diary) analysis revealed a statistically significant difference in total sleep time across the three sessions (CON, REL, and PLA) ($F(2, 32)= 8.083$; $p = 0.002$), with the REL condition being the most effective. Specifically, participants in the CON condition recorded a total of 486.2 min± 1.26 of sleep over the 5-day period, followed by participants in the REL condition, who exhibited the

highest total sleep time, with 539.75min ± 1.41. 41. Participants in the PLA condition had a total of 499.8 min ± 1.45 of sleep over the same period (Figure 3).

Figure 3. Effect of Three Different Conditions on Total Sleep Time Based on the 5-Days Sleep Dairy.



Note: No statistical differences were found. (CON): Control protocol; (REL): Relaxation massage protocol; PLA: "Sham" massage protocol.

Discussion

To the best of our knowledge, this is the first study to evaluate the acute effects of Relaxation Massage (REL) prior to bed-time on sleep quality and quantity in individuals with symptoms of insomnia, using objective full-night measurements. The study showed that relaxation massage significantly improved sleep quality by improving sleep efficiency by 9.19 minutes (10.80%) and Sustained Sleep Efficiency by 5.99 minutes (6.96%), (Table 4).

Relaxation massage, a gentler form of Swedish massage, uses light pressure through slow, rhythmic movements, incorporating techniques such as effleurage, petrissage, tapotement, friction and vibration. These methods aim to alleviate fatigue and enhance energy levels by promoting relaxation, relieving muscular tension, and improving overall wellbeing [279]. One potential mechanism underlying the efficacy of the Relaxation massage involves the application of techniques such as myofascial release, which not only alleviates muscle tension but also enhances blood circulation. Additionally, the rhythmic and gentle pressure applied during the massage can stimulate the parasympathetic nervous system, resulting in reductions in heart rate and blood pressure [280]. Further research highlights the evolutionary significance of tactile perception throughout life, with social touch playing a critical role in emotional regulation and stress relief. Social touch, including friendly skin-to-skin contact, not only promotes relaxation but also enhances mental health [281]. This effect is particularly evident during periods of physical isolation, such as the COVID-19 pandemic, where the absence of social touch exacerbated psychological challenges. Studies like those by Dione et al. and Elias & Abdus-Saboor deepen the understanding of the biological foundation of touch and its therapeutic applications, showing that tactile stimulation contributes to reducing anxiety and sleep disorders while improving overall well-being [282,283]. Additionally, tactile interactions seem to strengthen the sense of social connection and support, emphasizing their importance for psychological well-being and coping with everyday challenges [284–286]. Such physiological responses may further facilitate a sense of calmness, overall well-being and create a feeling of readiness to sleep [287].

Furthermore, our study differs significantly from similar research, such as those by V. W. H. Wong and Dedhia et al., which focus on populations with underlying medical conditions, such as heart failure and chronic kidney diseases. While these studies evaluated the effectiveness of repeated interventions, our study examined the immediate acute effects of a single relaxation massage session in individuals with severe symptoms of insomnia. Our

approach is pioneering, as we objectively recorded the immediate effects of massage on sleep using a portable polysomnography system, providing precise data on brain activity during sleep. In contrast, previous studies primarily relied on subjective tools, such as the Pittsburgh Sleep Quality Index (PSQI), which lack the reliability offered by brain activity measurements.

Polysomnographic EEG analysis revealed a positive effect of REL massage on Sleep Efficiency, indicating that participants were falling asleep easier and faster, alleviating one of the most prominent symptoms of insomnia which is the difficulty of falling asleep [288].

Another positive outcome of our study is the improvement of Sustained Sleep Efficiency following the REL intervention. Sustained Sleep Efficiency, defined as the ratio of total sleep time to the total time spent in bed, reflects the ability to maintain uninterrupted sleep throughout the night. This positive change enhances the overall body's recovery processes, as the time spent in bed is utilized more effectively, resulting in higher quality sleep [289] and facilitating the physiological and psychological restorative functions essential for optimal health [290].

This improvement could be translated to a further reduced nocturnal awakenings and promoted overall restorative sleep something that is supported by our finding from the polysomnography study and the 5-day sleep diary [291]. Indeed, Total Sleep Time was numerically improved by both objective and subjective measurements indicating that REL massage could help individuals alleviate insomnia symptoms.

A number of studies have shown that a massage therapy, in various settings, can significantly improve sleep quality, particularly in individuals experiencing sleep disturbances due to medical conditions, however only one study so far have used the gold standard methodology which is the full night polysomnography. For instance, Kaewcum et al., examined a Swedish technique massage indicating that it promotes relaxation and regulates brain activities related to sensory processing [292].

Moreover, studies involving cancer survivors have demonstrated that massage therapy leads to longer sleep duration and better sleep quality, as measured by both self-reported questionnaires and objective assessments [293,294]. Similarly, among nurses working rotating night shifts, massage has been shown to reduce sleep disturbances and alleviate fatigue [295]. In patients in intensive care units (ICUs), back massages have been found to

improve both subjective and objective sleep quality, increasing sleep duration and reducing anxiety [296]. These findings suggest that even a brief intervention, such as a 10-minute back massage, can have significant effects on sleep quality and comfort. In contrary to adults, a study on children with autism did not find any immediate improvement in sleep patterns after aromatherapy massage [297], which may be attributed to factors such as treatment duration or the environment in which it was administered.

Additionally, studies on cardiac surgery patients have explored the effects of massage therapies on sleep and related outcomes. For instance, a trial involving foot reflexology in patients undergoing coronary artery bypass graft (CABG) surgery found no significant improvement in sleep quality, though pain intensity was significantly reduced in the intervention group [298]. On the other hand, foot reflexology was shown to significantly improve sleep conditions in post-cardiac surgery patients, with notable improvements in sleep scores following the intervention, suggesting that these types of massage therapies can be an effective complementary approach to the traditional medical care in improving sleep after surgery [299]. Additionally, massage therapy has been found to improve sleep in breast cancer patients, with significant reductions in sleep disturbances and increased restfulness at night [293]. Although, individual responses may vary depending on the method of application and the personal preferences, massage therapy remains a promising non-pharmacological complementary approach for improving sleep quality, particularly in those with chronic conditions or undergoing medical treatments.

Furthermore, an adequate sleep ensures hormonal regulation processes that contribute to overall health and well-being [300,301]. For instance, growth hormone [302], predominantly released during deep sleep, plays a crucial role in tissue repair, muscle growth, and metabolic regulation [303]. Additionally, melatonin, known as the sleep hormone, helps regulate the circadian rhythm [304], enhancing sleep quality and facilitating the transition between sleep and wakefulness [305]. Adequate sleep also ensures the regulation of cortisol levels, the hormone associated with stress, which can reduce anxiety and depressive symptoms when maintained at optimal levels [306]. Furthermore, improved hormonal balance resulting from sufficient sleep is associated with enhanced physical health, increased energy levels, better cognitive function, and overall quality of life. Thus, sufficient sleep is essential for maintaining hormonal equilibrium and promoting a healthy state in individuals [307].

Overall enhanced sleep quality contributes to improved physical health, hormonal regulation consisted anti-inflammatory effects and psychological well-being, thereby reducing symptoms of depression and anxiety [92,308–310].

In the present study, we must acknowledge both some significant strengths and unforeseen limitations. One of the primary strengths of our study is the analysis of the objective methodology used to assess sleep quality and quantity. Furthermore, all measurements were conducted in the participants' homes, allowing them to feel more comfortable during the assessment. This setting ensured that the sleep data collected accurately reflected their nightly sleep patterns. In addition, the massage session took place prior to bed-time at participants “safe & comfortable” environment simulating even more the pragmatic conditions. Finally, the blinding process that applied in analyzing the data was very important in preventing any potential bias. Finally, the use a PSG EEG monitoring system provided an objective measurement of the brain activity that is valuable for understanding the immediate effects of massage on the brain. One limitation that requires acknowledgment is the disparity in sample size between male and female subjects. This imbalance could have resulted in minor errors in measurement data or inconsistencies in our results. Another limitation of our study is that the sleep assessment was not conducted by a full polysomnography system but using a portable EEG home-based sleep screening system. Even though this system is validated over the full night PSG, still data should be viewed with caution. Finally, this study was not control for the menstrual cycle of the female participants.

Conclusions

In conclusions, the findings of the current study support the notion that relaxation massage prior to bed-time could be used as an effective and safe non-pharmacological complementary approach for improving sleep efficiency [311] and potentially restore fragmented sleep of individuals with symptoms of insomnia [312]. Consequently, these results highlight the potential of relaxation massage as a scientifically supported intervention for improving sleep patterns and potentially overall well-being, warranting further investigation into its broader therapeutic applications [313].

Future research should explore the long-term effects of repeated massage sessions on various populations, with a particular focus on individuals with sleep disorders and stress-related issues.

Study 4

New Generation Automatic Massage Chairs for Enhancing Daytime Naps: A Crossover Placebo-Controlled Trial.

Status: Submitted

Journal: Health Policy and Technology

Impact Factor: 3.4

Clinical Trial Registry number: NCT06784700

New Generation Automatic Massage Chairs for Enhancing Daytime Naps: A Crossover Placebo-Controlled Trial. Ilias Ntoumas, Nikolas Antoniou, Christoforos D. Giannaki, Fotini Papanikolaou, Aggelos Pappas, Efthimios Dardiotis, Christina Karatzaferi, Giorgos K. Sakkas

Abstract

Objective: Modern technology is transforming the field of massage, enhancing relaxation and wellness through innovative devices.

Purpose: The aim of the present study was to examine the effectiveness of various massage protocols available on automatic electric massage chair (AEMC) prior to daytime nap on relaxation and indices of sleep quality.

Methods: This study is a randomized, single blind, placebo-controlled, four arm, interventional clinical trial. Twelve healthy individuals (21.8 ± 2.2 years, 6F/6M) were randomly assigned in four different conditions: 1) the Control (CON) condition involving a 30-min rest on a switch-off massage chair, 2) the Easy-Sleep (ES) massage session design to promote sleep, 3) the Fatigue-Recovery (FR) massage session designed to reduce muscle fatigue, and 4) the Worker-Mode (WM) massage session designed to promote muscle relaxation. During the four conditions, participants sat inside the massage chair for a 30-min, followed immediately by an additional 30-min period of lying down on a proper double bed. Brain activity was monitored using a polysomnography EEG system, while validated tests and questionnaires assessed vitals and the state of relaxation.

Results: The ES massage significantly reduced muscle tone by 12% and heart rate by 22% ($p= 0.008$ and $p= 0.007$, respectively). Additionally, it increased subjective sleepiness by 4.5% and Sleep Efficiency by 5.7% compared to control condition ($p\leq 0.005$).

Conclusions: It is evident that the use of AEMC can reduce tension and improve feelings of relaxation. The Easy Sleep program seems to be a promising non-pharmacological approach for enhancing relaxation and promoting daytime sleep, acting as a non-pharmacological tool to reduce stress, improve sleep quality and promote workplace wellbeing.

Clinical Trials Number: NCT06784700

Keywords: Daytime nap; Massage Chair, EEG; Sleepiness Scale; Handgrip; Heart Rate

Introduction

The fast-paced nature of modern lifestyle very often, contributes to increased stress before bedtime that negatively impacts many aspects of sleep quality, highlighting the need for interventions that promote relaxation. One of those interventions is daytime napping. Naps are typically defined as short periods of sleep, usually lasting from 10 to 30 minutes, taken during the day to supplement nighttime rest. Naps can enhance cognitive and physical performance, improve mood, and increase alertness, making them an effective strategy for mitigating all cause fatigue [314,315]. Bibliographic evidence suggests that brief afternoon naps can provide numerous benefits for health and cognitive function, enhancing alertness, mood, and performance on demanding tasks. While the effects of sleep interventions have been widely investigated, the role of the various relaxation objects that promote sleep or calmness remain less thoroughly explored. Recent studies have indicated that ergonomic chairs, bean bags or specialized sleep chairs, may promote physiological relaxation through muscle unloading and activation of the parasympathetic nervous system, leading to improved sleep quality and longer sleep duration.[316] These findings highlight the significance of the sleep environment in facilitating recovery and underscore the potential beneficial effect of using specialized seating as a supplementary tool for managing fatigue and stress in everyday life especially at workplace.

Another potential method to mitigate pre-sleep stress is massage therapy [7]. Massage can reduce stress and anxiety [287,317,318], contributing to better sleep quality [319] however, this approach may not be feasible for everyday usage due to differences in sleep schedules and financial constraints. A more convenient and accessible alternative, could be the usage of automatic electrical massage chairs (AEMC).

AEMC offer a non-pharmacological alternative for achieving relaxation and improving sleep quality, particularly for individuals with high working stress levels [320]. Many studies from the last decade demonstrate that massage chairs provide significant physical and mental health benefits, including stress reduction, alleviation of mental fatigue and pain, enhanced muscle flexibility and overall improvement in quality of life [321].

Massage chairs offer many automatic massage options for alleviating muscle tension and reduce fatigue contributing to improved functionality, well-being [322] and promote sleep [323], however, scientific evidence to support those claims are very scarce and most claims are based on manufactures non-published data. Indeed, the effects of massage

can vary significantly depending on factors such as the targeted body region, the type of massage technique, the applied pressure and the setting (private vs public place). Thus, while some general benefits have been reported, specific outcomes may differ between massage chair's protocols. Furthermore, scientific evidence supporting these claims remains limited, as many reported benefits derive from unpublished manufacturer data.

Therefore, the purpose of the present study was to examine the effectiveness of various automatic massage protocols available on AEMCs on relaxation and indices of sleep quality in healthy individuals prior to daytime nap.

Based on the design and aims of the current study, it was hypothesized that the ES-massage would be the most effective condition in promoting relaxation and improving sleep quality among the four protocols tested.

Methodology

Trial Design

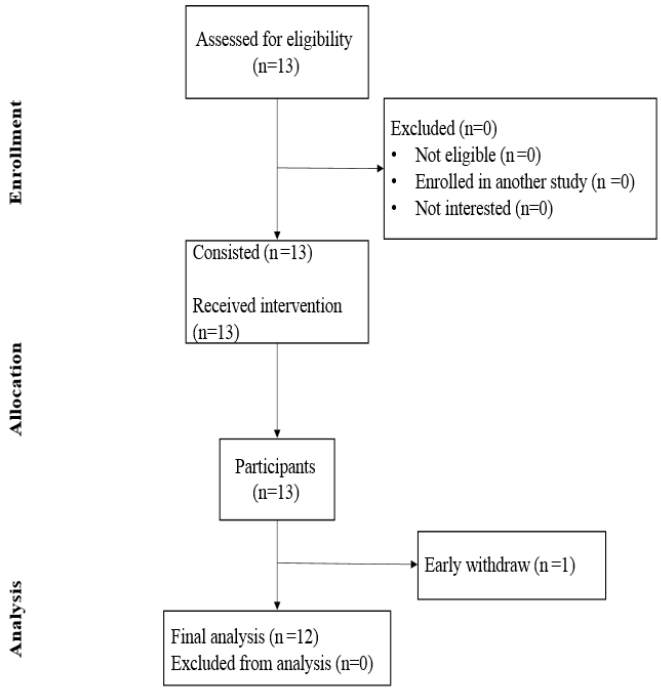
This study is a randomized, single blind, placebo-controlled, four arm, interventional clinical trial to investigate the effectiveness of various automatic massage protocols available on AEMCs on relaxation and indices of sleep quality in healthy individuals prior to daytime nap. The study is fully complied with the CONSORT criteria for reporting clinical trial data.

Participants

Twelve (N=12) healthy individuals (age 21.8 ± 2.2 years, 6F/6M) fulfilled the inclusion criteria and voluntarily participated in this study (Figure 1). Inclusion criteria included subjects of both sexes, aged >18 years and ability to consent. Exclusion criteria included a history of mental illness, sleep disorders, history of epilepsy, and any acute or chronic condition that would limit the ability of the patient to participate in the study.

Figure 1. Consort Diagram.

A CONSORT diagram summarizes recruitment, enrollment, and dropout rates.



Study Design

Subjects were randomly assigned into 4 conditions: 1) the control condition (CON), where subjects did not receive any massage program; instead, they rested for 30 min on an automatic switch-off electric massage chair and subsequently lay down for an additional 30 min on a proper double-bed; 2) the “Easy-Sleep” condition (ES), subjects received a preselected massage program for 30 minutes, followed by an additional 30 minutes of lying down on the same double bed; 3) the “Fatigue-Recover” condition (FR), subjects received a pre-selected massage program for 30 minutes, followed by an additional 30 minutes of lying down on the same double bed; 4) the “Worker-Mode” condition (WM), subjects received a preselected massage program for 30 minutes, followed by an additional 30 minutes of lying down on the same double bed, (Figure 2). All conditions were conducted on the same exact time of the day, one week apart, while the order of the various conditions was randomly assigned. To control for factors influencing sleep, participants were instructed to maintain consistent sleep patterns and avoid alcohol, caffeine and intense physical activity 24 hours prior to each session. The researchers analyzing the data were blinded to the assigned groups. All measurements were conducted at the same sleep lab, at the same time of the day, under controlled conditions, with a constant temperature of 22°C, and dimmed low lighting (5 lux), while any possible external sound was masked using white noise sound at 432 Hz and 55 decibels. The study was approved by the Human Research and Ethics Committee of the University of Thessaly (2334-4/4-2/7.2.2024). All Subjects gave their written informed consent prior to study participation. The study has been registered as a clinical trial at ClinicalsTrials.gov (NCT06784700).

Figure 2. Study Flow Chart.

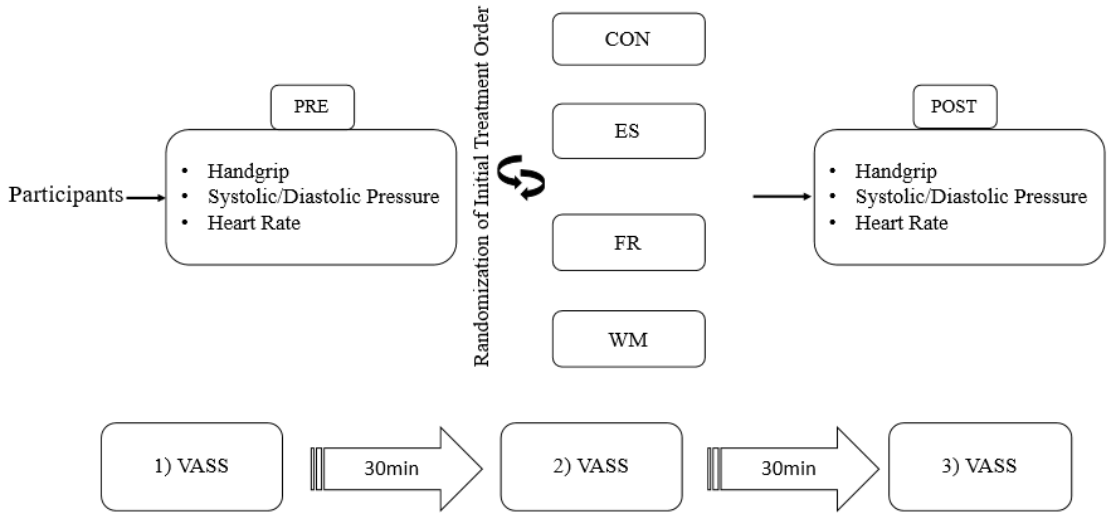


Figure 2. Study Flow Chart. Subjects assigned in random order in all 4 different conditions in 4 continuous weeks. (EEG)= Electroencephalography; (CON)= control protocol; (ES)= easy sleep auto massage auto-program condition; (FR)= fatigue recover massage auto-program condition; (WM)= worker mode massage auto-program condition; VASS: visual analog Sleepiness Scale; Start: 1) Participants completed the VAS Scale prior to the initiation of the measurement; 2) after massage: Participants also completed the VASS exactly 30 min after the transition from the electrical automatic massage chair to the bed; 3) after nap: Participants also completed the VASS exactly 30 minutes after waking up from the nap in the bed.

Data Analysis

The data collection period was structured into a single phase, lasting 60 min (30 min massage chair + 30 min nap time).

Procedure

All measurements were performed in a sleep lab. Before the initiation of the study, participants completed a visual analog Sleepiness Scale (VASS), measurement related to overall health and connected to the portable EEG/EOG polysomnography system (HST-mit-tablet, SOMNOmedics, Germany). Participants were fitted inside the automatic massage chair for 30 min and moved to a double bed for 30 more minutes after the completion of the pre-selected massage session. The sleepiness was assessed at baseline, after the massage session and after the 30min "nap time".

Additionally, at the start and end of each condition, participants performed three maximum handgrip attempts to assess muscle tone, and measurements of vital signs, such as heart rate and blood pressure, were taken. The study concluded after 60 minutes of recording. Participants were free to sleep or remain awake during the intervention period.

All experimental sessions were conducted between 9:00 a.m. and 6:00 p.m., with each participant maintaining the same testing time across all four conditions.

Body Composition

Body composition was assessed using anthropometric measurements, including BMI and bioelectrical impedance analysis with a Tanita DC-360S device (Tanita Corporation, Tokyo, Japan), following standard methodology [324].

Sleepiness Scale (VASS)

The visual analog sleepiness scale was used to assess levels of sleepiness among participants, employing a 1-10 rating system as usual. Specifically, the levels of the scale were as follows: 0-2 indicated "no sleepiness", 3-5 indicated "moderate sleepiness", 6-8 indicated "high sleepiness" and 9-10 indicated "very high sleepiness".

Brain Activity / Sleep Architecture

A portable sleep monitoring system was used to assess sleep quality and quantity (Home Sleep Test, SOMNOmedics, GmbH, Germany). The system records EEG, EOG, and EMG signals overnight. EEG data were analyzed in 30-second epochs using SOMNOmedics PSG analysis software (Domino panel ver. 3.0.0.8) starting with automatic analysis with manual editing. The HomeSleepTest REM+ device was used for PSG, with electrodes placed according to the 10/20 system on key brain regions: Fp1 (left) and M1 for EEG, and near the eyes for EOG. Analysis of the sleep study was reported as followed: Total Sleep Time (total amount of sleep time scored during the total recording time); Sleep Efficiency (Total sleep time/Time in bed); Sustained Sleep Efficiency (Total sleep time/(Time in bed – Sleep latency stage 2); Sleep latency is defined as the time from lights off to the start of the first epoch of any stage of sleep, including stage N1 (or any other stage); Sleep Latency N1 specifically refers to the time from lights out to the onset of the N1 stage of sleep; Sleep Latency N2 (the period of time between time in bed and sleep onset stage 2; REM Latency (the amount of time elapsed between the onset of sleep to the first REM stage); Wakes (the number of times an individual wakes up during the sleep period or transitions to full wakefulness after sleep onset); WASO (was defined as the total duration (in minutes) of wakefulness occurring after the onset of sleep and before final awakening).

Handgrip strength assessment

The handgrip test was used for the assessment of maximum isometric strength of the dominant hand and arm muscles (Marsden MG-4800 Hand Dynamometer) and used as a measurement of muscle tone alertness [325]. Reduction of muscle strength after the intervention, was assessed as reduction of muscle tone.

Massage Session

Automatic Electric Massage Chair (AEMC)

The Z1 Full Body 4D Massage Chair (Z1-SL Massage Chair, China, www.back2life.gr) (Picture 1) was used in the current study. The Z1-SL chair features a curved rail mechanism for both S-shaped (horizontal) and L-shaped (vertical) massages,

covering areas from the head down toes. It includes 58 air cushions for air compression massage, while intelligent mechanical arms, rotating 360°, follow the body's contour, scanning and targeting specific areas for treatment. The massage chair contains twelve automated programs varying in intensity, while the roller mechanism adjusts to body widths of 3 to 22 cm for focusing on application to areas like the cervical spine, back, and lower back.

Picture 1: Automatic Electric Massage Chair (model: Z1-SL Full Body 4D).

Massage Auto-Programs of the AEMC

The three preselected automatic massage programs were designed by the manufacturer to promote relaxation, alleviate muscle tension, and support recovery by targeting specific muscle groups through various massage techniques. The muscle groups that received the massage effect were divided into two main sections (upper and lower body), and each section is comprising three subcategories as described in (Table 1).

Table 1. Specification of the 4 different conditions.

Massage Muscle Groups		CON (min.)	(ES) (min.)	(FR) (min.)	(WM) (min.)
I.	**Cervical Spine and Shoulders**	**-**	22	13	14
II.	**Back and Hands**	**-**	18	13	21
III.	**Spinal Area**	**-**	8	11	10
IV. V.	**Gluteal Muscles and Biceps Femoris**	**-**	6	7	11
VI.	**Gastrocnemius (calf)**	**-**	17	16	18
VII.	**Heels and Feet**	**-**	20	18	17

Note: CON: Control; ES: Easy Sleep massage program; FR: Fatigue Recover massage program; WM: Worker Mode massage program.

Easy Sleep program

The Easy Sleep (ES) program is designed to induce full-body relaxation through gentle, slow movements and mild air compression, making it ideal for pre-sleep use. The techniques include kneading, tapping, rolling and deep tissue massage, focused on the following muscle groups.

Fatigue Recovery program

The Fatigue Recovery (FR) program is designed to relax muscles and relieve fatigue after an intense workday, enhancing blood circulation and promoting muscle recovery. Techniques include kneading, tapping, rolling and deep tissue massage, applied to the following muscle groups.

Worker-Mode program

The Worker-Mode (WM) program is designed for individuals who spend extended hours sitting or engaged in intense work. It alleviates tension in the shoulders, back,

and lower back vising techniques like kneading, tapping, rolling and deep tissue massage, applied to the following muscle groups.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 29.0 (IBM Corporation, Armonk NY, USA). An independent samples t-Test was conducted to assess significant differences in basic characteristics between male and female participants. A General Linear Model (GLM) Repeated Measures ANOVA was used to compare within subject's differences between the 4 conditions (CON-ES-FR-WM). Moreover, a General Linear Model (GLM) Repeated Measures ANOVA was used to assess changes in EEG parameters among the 4 different conditions. A Bonferroni post-hoc test was performed to assess individual differences. To assess normality, the Shapiro-Wilk test was used alongside graphical representations, including the Normal Q-Q plot, Detrended Normal Q-Q plot, and Box Plot. The significance level was set at 5%. Beyond significance testing (p-value), effect size was also considered to evaluate the magnitude of the effect.

Power Analysis

Sample size calculations were conducted using G*Power 3.1 [326]. The post-hoc "GLM": Repeated measures, within factors" method was used to calculate the power analysis. The post-hoc power analysis revealed that with a sample size of 12 participants the study achieved 99% power using sleep efficiency as a primary outcome [(Effect size= 1.5609, Critical F= 2.8915, Ndf 3, Ddf 33, Power (1-β err pob) = 0.9999 (99% power)].

Trial Registration

The trial was registered under the title "The Usefulness of Automatic Massage Chairs Before Bedtime in Sleep Quality (RoboSleep)" with the full protocol to be accessible through ClinicalTrials.gov website. Trial registration number: NCT06784700

Data Availability

Data are available at ClinicalTrials.gov for the study with registration number: **NCT06784700**

Results

Subject characteristics are presented in Table 2. No statistically significant differences were found between male and female participants, as the groups were equally distributed and the statistical analysis showed no significant difference ($p>0.05$).

Table 2. Baseline Characteristics.

Parameters	Values
N	12
Sex	6M/6F
Age (years)	21.8 ± 2.2
Body Height (cm)	171.1 ± 9.7
Body Weight (kg)	68.1 ± 9.3
BMI (kg/m²)	23.17 ± 1.2
Fat (%)	19.5 ± 6.6
Muscle Mass (kg)	53.2 ± 13.5

Note: Data are presented as Mean ±SD. Significance level $P<0.05$; BMI: Body Mass Index.

Pre and Post intervention assessments among the four different conditions are shown in Table 3. Significant differences within groups were observed in handgrip strength (muscle tone) and heart rate before and after all conditions. Additionally, significant differences were found in diastolic pressure during the easy sleep (ES) and worker mode (WM) conditions (Table 3). In particular, handgrip strength was reduced after the CON, ES, FR and WM condition accordingly (%Δ-change: -12.31% ± 11.5; %Δ-change: -11.85% ± 11.5; %Δ-change: -12.42% ± 11.4; %Δ-change: -15.32% ± 9.9, p=0.005). Statistically significant differences were also found among Δ-change of the aforementioned values. Moreover, heart rate was reduced after the ES, FR and WM condition accordingly (%Δ-change: -21.59% ± 22.8; %Δ-change: -14.69 ± 15.1; %Δ-change: -15.32% ± 9.9, p=0.007). Heart rate decreased mainly after WM condition (p=0.040). Also, diastolic pressure was reduced after both ES and WM conditions accordingly (%Δ-change: -7.81% ± 9.9, p≤.005; -11.45 ± 14.0, p≤0.005).

Table 3. Pre and Post Intervention Assessment Among the 4 Different Protocols with Electric Automatic Massage Chair.

Variables	CON			ES			FR			WM		
	Pre (95% CI)	**Post (95% CI)**	**P Value (Cohen's, d) (Δ-change%)**	**Pre (95% CI)**	**Post (95% CI)**	**P Value (Cohen's, d) (Δ-change%)**	**Pre (95% CI)**	**Post (95% CI)**	**P Value (Cohen's, d) (Δ-change%)**	**Pre (95% CI)**	**Post (95% CI)**	**P Value (Cohen's, d) (Δ-change%)**
N	**12**	**12**	**-**	**12**	**12**	**-**	**12**	**12**	**-**	**12**	**12**	**-**
Systolic Pressure (mmHg)	128.6 ± 22.4 (116 to 141)	119.4 ± 10.4 (114 to 125)	0.118 (0.526) (-7.19% ± 24.7)	116.9 ± 9.3 (112 to 122)	116.3 ± 11.5 (110 to 123)	0.840 (0.057) (-0.50% ± 14.8)	123.4 ± 13.6 (116 to 131)	118.0 ± 13.7 (110 to 126)	0.076 (0.395) (-4.32% ± 19.3)	123.0 ± 14.0 (115 to 131)	118.1 ± 12.0 (111 to 125)	0.116 (0.375) (-3.99% ± 18.4)
Diastolic Pressure (mmHg)	72.7 ± 9.9 (67.1 to 78.3)	66.9 ± 8.5 (62.1 to 71.7)	0.076 (0.628) (-8% ± 13.0)	70.3 ± 7.2 (65.7 to 74.9)	64.8 ± 6.7 (61 to 68.6)	**0.004** (0.790) (-7.81% ± 9.9)	71.8 ± 12.7 (64.6 to 79)	64.9 ± 9.3 (59.6 to 70.2)	0.051 (0.619) (-9.62% ± 15.8)	71.3 ± 10.2 (65.5 to 77.1)	63.1 ± 9.6 (57.7 to 68.5)	**0.003** (0.827) (-11.45% ± 14.0)
Heart Rate (Bits/min)	74.0 ± 10.0 (68.3 to 79.7)	75.4 ± 16.9 (65.8 to 85)	0.729 (0.100) (1.81% ± 19.7)	85.7 ± 22.1 (73.2 to 98.2)	67.2 ± 5.8 (63.9 to 70.5)	**0.007** (1.145) (-21.59% ± 22.8)	75.3 ± 12.6 (68.1 to 82.5)	64.2 ± 8.3 (59.5 to 68.9)	**0.000** (1.040) (-14.69% ± 15.1)	74.1 ± 9.3 (68.8 to 79.4)	63.4 ± 8.7 (58.5 to 68.3)	**0.001***** (1.118) (-14.49 ± 12.8)
Handgrip Strength (Kg)	34.3 ± 8.8 (28.4 to 38.4)	30.1 ± 7.4 (25.9 to 34.3)	**0.001** (0.516) (-12.31% ± 11.5)	34.2 ± 8.7 (21.7 to 46.7)	30.1 ± 7.5 (25.9 to 34.3)	**0.008*** (0.504) (-11.85% ± 11.5)	33.4 ± 7.2 (29.3 to 37.5)	29.3 ± 8.7 (24.4 to 34.2)	**0.019** (0.513) (-12.42% ± 11.4)	33.4 ± 7.5 (29.2 to 37.6)	28.3 ± 7.1 (24.3 to 32.3)	**0.002**** (0.698) **(-15.32% ± 9.9)**

Note: Data are presented as Mean ±SD. Significance level P<0.05; CON: Control; ES: Easy Sleep massage program; FR: Fatigue Recover massage program; WM: Worker Mode massage program; Δ-Change: % difference compared to Pre values; Paired t-Test: Means of pre-post measurements between (CON-ES-FR-WM) protocols. *Differences between the Δ-changes were assessed using a GLM Repeated Measures test; Heart Rate: CON vs ES vs FR vs WM, P=0.007. **Differences between the Δ-changes were assessed using an ANOVA test; CON vs WM, P=0.040 (Bonferroni Post-Hoc Test). ***Differences between protocols (CON-ACT-REL) were assessed using a GLM Repeated Measures test; Heart Rate: [F(3,33)= 5.503, P=0.015], and particularly for Post CON vs Post WM.

Comparative analysis of VASS across all conditions is presented in Table 4. Sleepiness scores increased significantly from the start to the middle and finish phases across all conditions ($p \leq 0.005$). Pairwise comparisons using the Bonferroni post-hoc test revealed significant differences between VAS scores after the massage programs and after the nap for all conditions ($p \leq 0.005$). Sleep parameters are reported in Table 4.

Table 4. VAS Sleepiness Scale Across Three Phases for Four Automatic Electric Massage Chair Protocols.

Sleepiness Scale	**Baseline**	**After Massage chair (Δ-change%)**	**After Nap (Δ-change%)**	**P Value**
N	**12**	**12**	**12**	**-**
(CON)	2.91 ± 2.0	5.66 ± 2.5* (2.75% ± 0.5)	7.00 ± 2.0* (4.09% ± 0.0)	**<0.001**
(ES)	3.08 ± 1.8	5.83 ± 1.8* (2.75% ± 0.0)	7.58 ± 2.3* **(4.50% ± 0.5)**	**<0.001**
(FR)	3.25 ± 1.7	5.91 ± 2.1* (2.66% ± 0.4)	7.66 ± 2.2* (4.41% ± 0.5)	**<0.001**
(WM)	4.08 ± 2.1	6.75 ± 1.5* (2.67% ± 0.6)	7.75 ± 2.2* (3.67% ± 0.1)	**<0.001**

Note: Data are presented as Mean ±SD. Significance level P<0.05; CON: Control; ES: Easy Sleep massage program; FR: Fatigue Recovery massage program; WM: Worker mode massage program; *Differences between pairwise comparisons were assessed using an ANOVA test; CON: Start phase vs Middle phase, P<0.001 and Start phase vs Finish phase, P=0.000 (Bonferroni Post-Hoc Test); EA: Start phase vs Middle phase, P<0.001, Start phase vs Finish phase, P=0.000 and Middle phase vs Finish phase, P=0.004 (Bonferroni Post-Hoc Test); FR: Start phase vs Middle phase, P<0.001, Start phase vs Finish phase, , P<0.001 and Middle phase vs Finish phase, P=0.017(Bonferroni Post-Hoc Test); WM: Start phase vs Middle phase, P=0.000 and Start phase vs Finish phase, P=0.002 (Bonferroni Post-Hoc Test); The Δ-changes were assessed using a GLM Repeated Measures test, revealing significant differences in sleepiness scores across phases.

A statistically significant effect was observed for Sleep Efficiency across the four conditions [$F(3,33) = 8.978$, $p \leq 0.001$], with the ES condition showing the greatest impact compared to the others ($p \leq 0.005$). The difference (Δ-change) in Sleep Efficiency between the CON and ES conditions was 5.69% ± 28.3, indicating a notable improvement. Importantly, all participants successfully achieved sleep in each condition. Total Sleep Time (TST) and Sleep Efficiency (SE) were recorded and analyzed (Table 5).

In the ES massage condition, participants reached an average TST of 26.76 ± 11.8 minutes and SE of 43.44 ± 18.7%. These values confirm that participants entered measurable sleep stages during the nap trials, validating the sleep data collected.

Table 5. Sleep Parameters among the 4 different conditions.

Variables	**CON (95% CI)**	**ES (95% CI)**	**FR (95% CI)**	**WM (95% CI)**	**P Value (Effect size: partial η^2)**
N	**12**	**12**	**12**	**12**	-
TST (min)	20.60 ± 12.5 (13.5 to 27.7)	26.76 ± 11.8* (20.1 to 33.4)	25.74 ± 13.8 (17.9 to 33.5)	25.06 ± 13.6 (17.4 to 32.8)	0.239 (0.121)
Sleep Efficiency (%)	37.75 ± 21.2 (25.8 to 49.8)	43.44 ± 18.7* (32.8 to 54)	25.74 ± 13.8 (17.9 to 33.5)	25.06 ± 13.6 (17.4 to 32.8)	**<0.001** (0.449)
Sustained Sleep Efficiency (%)	41.88 ± 18.5 (31.4 to 52.4)	49.74 ± 17.9 (39.6 to 59.8)	39.45 ± 25.0 (25.4 to 53.6)	42.03 ± 21.0 (30.1 to 53.9)	0.413 (0.079)
Sleep Latency (min)	8.43 ± 13.2 (0.96 to 15.9)	8.36 ± 10.3 (2.53 to 14.2)	3.79 ± 5.0 (0.96 to 6.62)	7.47 ± 12.7 (0.28 to 14.7)	0.556 (0.049)
Sleep Latency N1 (min)	8.75 ± 13.1 (1.34 to 16.2)	9.53 ± 10.3 (3.7 to 15.4)	7.28 ± 9.0 (2.19 to 12.4)	8.10 ± 12.9 (0.8 to 15.4)	0.864 (0.010)
Sleep Latency N2 (min)	17.73 ± 15.4 (9.02 to 26.4)	11.25 ± 11.3 (4.86 to 17.6)	7.93 ± 13.4 (0.35 to 15.5)	16.31 ± 14.5 (8.11 to 24.5)	0.306 (0.123)
Wakes (index)	8.91 ± 3.36 (7.01 to 10.8)	9.75 ± 3.4 (7.83 to 11.7)	8.91 ± 4.1 (6.59 to 11.2)	8.75 ± 4.4 (6.26 to 11.2)	0.861 (0.018)
Wake > 3 min (index)	2.09 ± 0.8 (1.64 to 2.54)	2.09 ± 1.1 (1.47 to 2.71)	2.45 ± 1.6 (1.55 to 3.36)	2.72 ± 1.5 (1.87 to 3.57)	0.587 (0.054)
WASO (Wake After Sleep Onset) (min.sec)	30.25 ± 11.1 (24 to 36.5)	26.79 ± 8.1 (22.2 to 31.4)	27.04 ± 10.5 (21.1 to 33)	29.4 ± 12.7 (22.2 to 36.6)	0.803 (0.032)

Note: Data are presented as Mean ±SD. Significance level $P<0.05$; CON: Control; ES: Easy Sleep massage program; FR: Fatigue Recover massage program; WM: Worker Mode massage program; TST: Total Sleep Time; *Differences between pairwise comparisons were assessed using an ANOVA test; TST: CON vs ES, $P=0.050$; Sleep Efficiency: ES vs FR, $P=0.014$ and ES vs WM, $P=0.003$ (Bonferroni Post-Hoc Test). Total duration of recording 60 minutes.

Discussion

To the best of our knowledge, this is the first study to investigate the effects of automatic electrical massage chair protocols on body relaxation and sleep efficiency using objective and subjective measurements.

The main outcome of the current study, when objective measurements of relaxation were used, was that the Easy Sleep massage program had the most considerable effect, reducing heart rate by -21.59% (Table 3). In a subjective scale utilizing the VASS, a significant increase in sleepiness was observed, with the ES massage program showing the most pronounced effect, resulting in a 4.50% increase (Table 4). Furthermore, objective measurements using an PSG-EEG indicated a significant increase in sleep efficiency after the implementation of the ES program compared to CON, with an improvement of 17.7 minutes (Table 5). Beyond the expected outcomes of relaxation and improved sleep quality, the ES-massage also exerts significant physiological effects on the body, which help explain the results observed in the present study. Massage techniques such as kneading, tapping and deep tissue pressure appear to activate skin and muscle receptors, leading to the stimulation of the parasympathetic nervous system.[327] This activation results in a reduction of heart rate, as evidenced by the observed decrease of -21.59%, and an increase in blood circulation, thereby enhancing the uptake of oxygen and nutrients in the muscles and throughout the body.[328] In addition, massage techniques focusing on the neck and shoulder areas, as indicated in Table 5, may reduce muscle tension in these regions, which are often associated with stress and pain that negatively affect sleep quality.[329]

The current study shows that a 30-minute full-body ES massage chair program benefits both objective measures and subjective experiences in healthy individuals. The ES protocol incorporates techniques such as kneading, tapping, deep tissue and rolling, specifically designed to promote muscle relaxation, enhance blood circulation, and alleviate muscular tension. Particularly, the majority of the massage duration, 22 out of 30-minutes (73% of the total time), was focused on the cervical (neck) and shoulder regions of the upper-body (Table 5), targeting these areas to maximize the sense of relaxation, comfort and relief. While there are no directly comparable studies, a study by Hongmin Chu et al., assessed the effectiveness of an electric massage chair among office workers using a subjective scale, demonstrated that the massage chair effectively

alleviated neck and shoulder pain, and a modest improvement was also observed in quality-of-life score [330].

Additionally, a significant portion of the total duration of the ES massage program was focused on the area of heel and foot (70%), (Table 1). A study by Gökbulut et al., found that foot massage applied in menopause women, increases the average daily sleep duration and reduces levels of fatigue and anxiety [331]. Regarding achilles tendon massage, the most effective approach seems to be the effleurage movements where it involves applying stretching motions along the periphery of the achilles tendon area. According to recent findings, this approach not only effectively reduces pain symptoms in patients with achilles' tendinopathy but also promotes an overall muscle relaxation [332,333].

Furthermore, with the ES program, it is recorded the largest decrease in heart rate by -21.55%, indicating a significant parasympathetic activation promoting relaxation and reducing stress levels, in agreement with a study by Fu et al. demonstrating a significant reduction of heart rate, and improving heart rate variability [334]. Regarding the reduction of muscle tone, the WM program demonstrated a substantial reduction in handgrip strength scores by 15%. This is mainly due to the fact that the WM program primarily focuses on the areas of the hands and back, with 21 out of 30min massage time allocated in those muscles. Studies on the use of AEMC are very limited, with only one similar to ours utilizing objective EEG measurements for the assessment of brain activity. In particular, Jeong-Hwan et al., found that 20-minute sessions with an AEMC in addition to a binaural sound significantly reduced levels of mental fatigue and improved cognitive function [335].

In another study by Khairudin et al., the use of AEMC on labor pain in primiparous women showed a significant reduction in pain levels, indicating that mechanical massage may serve as a viable, non-invasive alternative approach for pain management during pregnancy and labor [336].

Additionally, massage therapy using AEMC appears to have a positive effect on chemotherapy-related side effects [337], as well as some preventive value, particularly in managing musculoskeletal discomfort in populations heavily impacted by work related musculoskeletal overused issues [338]. This underscores the importance of incorporating massage and similar interventions as part of a preventive approach for high-risk groups like musicians alleviating muscle tension and enhancing physical resilience over time.

Another important type of users that seems to be benefited by AEMC is the professional athletes. A study by Juncheng Xie et al. [339], demonstrated that the massage performed by AEMC, significantly impacted the reduction of vagus nerve tone and accelerated the elimination of metabolites such as lactate, thereby enhancing recovery from exercise training. These findings suggest that AEMC may serve as a more efficient tool for rapid athlete recovery, providing stronger recuperative benefits compared to other traditional methods.

From a hormonal point of view, there are evidence that massage promotes the release of serotonin [200], while a study by Ji Yeon Baek et al., reported that long-term use of the AEMC can reduce anxiety in adults, as the intervention resulted in significant decreases in cortisol and serum DHEA-S (dehydroepiandrosterone sulfate) levels, along with improvements in mood and health status [340].

It is evident therefore, that the use of massage chairs can benefit not only people with increased stress or various health issues, but also in totally healthy individuals for sustaining a healthy lifestyle or promoting a power nap for boosting their cognitive function or improve creativity.

In the present study, we must acknowledge both some significant strengths and unforeseen limitations. The primary strengths are the combination of both objective and subjective methods used to assess relaxation and brain activity. In addition, a blinding process of analyzing the data was applied, since all researchers involved in the analysis were unaware of the type of session. Finally, the use of a real-time EEG monitoring system provided an objective measurement of the brain activity that is valuable for understanding the immediate effects of massage on the brain activity.

One limitation is the small sample size even though the study had more than 95% power to detect statistically significant differences for the primary outcome. Another important limitation is that we cannot precisely identify the specific muscle groups targeted during the automatic massage session since there was no use of EMG recording. Furthermore, the menstrual cycle of female participants was not controlled study however, none of the female participants were during the menstrual phase.

Conclusions

Massage routines such the Easy Sleep, that focuses on massaging the cervical and shoulder regions seems to maximize the sense of relaxation and comfort, are among the most effective protocols for promoting sleep efficiency. These findings support the use of automatic electrical massage chairs as a non-pharmacological tool for promoting relaxation and enhancing the feeling of dossing. Further research is needed to explore its broader applications in populations with sleep disorders.

Study 5

The long-term usage of the new generation massage chairs on quality and quantity of sleep-in individuals suffering from insomnia symptoms.

Status: under preparation

Clinical Trial Registry number: NCT06788288

The long-term usage of the new generation massage chairs on quality and quantity of sleep-in individuals suffering from insomnia symptoms. Ilias Ntoumas, Nikolas Antoniou, Christoforos D. Giannaki, Efthimios Dardiotis, Christina Karatzaferi, Giorgos K. Sakkas

Abstract

Objective: Modern technology is reshaping the massage industry, improving relaxation and well-being with pioneering devices. The automatic massage chairs stand as a testament to this evolution, integrating ergonomic design with advanced massage techniques to facilitate the sleep quality and enhance overall well-being.

Aim: The aim of the current study was to assess the long-term impact of the new generation massage chairs in aspects relate to sleep and quality of life in individuals with severe symptoms of insomnia.

Methods: Twelve individuals with symptoms of insomnia (mean age 43.4 ± 12.3 years, 5F/7M) assessed by the Athens Insomnia Scale scores (≥16) participated in a randomized clinical trial. Participants were assessed in three different timepoints: at baseline, after one month of daily massage chair usage (30 min/day, primarily before bedtime), and again one month after without the massage chair. Assessments included EEG polysomnography and validated questionnaires on sleep quality and psychological well-being.

Results: Massage chair usage significantly imp roved sleep quality, with the PSQI scores to be improved by 18% (p=0.022) and Total Sleep Time to be increased by 30.7% post-intervention (p=0.050).

Conclusions: The findings of this study highlight the therapeutic potential of modern massage chairs as a non-pharmacological intervention for individuals with severe symptoms of insomnia. The significant and sustained improvements in sleep quality and duration, observed both immediately after the intervention and almost lasting one month following its cessation, suggesting that the consistent use of automated massage may contribute to long-term sleep regulation and overall well-being.

Keywords: Massage Chair; EEG; Insomnia; Sleep; Well-being

Introduction

Sleep is a critical component of overall health, yet approximately 1/3 of adults experience some type of sleep deficiency, often linked to insomnia [341]. Poor sleep disproportionately affects individuals with lower socioeconomic status, educational attainment, and social standing further compounding disparities in health and quality of life [342]. The importance of sleep quality for health and well-being is well documented, with insomnia and poor sleep linked to an elevated risk of mortality, diabetes, hypertension, cardiovascular diseases, coronary heart disease, obesity, impaired function, and mental disorders [343,344]. Beyond individual health impacts, poor sleep has significant economic implications, with annual losses of approximately 680 billion dollars reported in just five Organization for Economic Cooperation and Development (OECD) countries [345]. Together, these findings emphasize the widespread prevalence and profound consequences of poor sleep quality.

Research highlights that pre-sleep stress is associated with diminished sleep quality [346], while stress also disrupts both sleep timing and consistency, two key factors for healthy sleep-in adults [347,348]. Such disruptions undermine the restorative functions of sleep and exacerbate health risks, underscoring the importance of strategies to reduce stress and promote relaxation before bedtime.

Massage therapy could potentially be an effective method for reducing stress and anxiety therefore also improving sleep quality [7,349]. However, regular access to professional massage therapy is often impractical due to scheduling conflicts and financial barriers. A more convenient and accessible alternative, could be the usage of automatic electrical massage chairs (AEMC). Specifically, AEMC offer a non-pharmacological alternative for achieving relaxation and improving sleep quality, particularly for individuals with high working stress levels [320]. Massage chairs offer many automatic massage options for alleviating muscle tension and reduce fatigue contributing to improved functionality, well-being [322] and promote sleep [323], however, scientific evidence to support those claims are very scarce and most claims are based on manufactures non-published data.

To address these limitations, we wanted to test the hypothesis that a pre-sleep massage using a massage chair would have a beneficial effect, that could lead to a deeper state of relaxation, which in turn could improve overall sleep quality.

Therefore, the purpose of the present study was to investigate the effects of long-term usage of an AEMC before bedtime on sleep quality and quantity during a full-night sleep in a home setting.

Methodology

Participants

Twelve (N=12) individuals with symptoms of insomnia (age 43.4 ± 12.3 years, 5F/7M) fulfilled the inclusion criteria and participated in this study (Figure 1). Inclusion criteria included subjects of both sexes, aged >18 years and score of ≥16 on the Athens Insomnia Scale (AIS-8). Exclusion criteria included a history of mental illness, history of epilepsy and any acute or chronic condition that would limit the ability of the patient to participate in the study.

Study Design

All assessments took place in the participants' homes, where a portable polysomnographic EEG system (HST-mit-tablet, SOMNOmedics AG, Randersacker, Germany) was used to monitor sleep architecture. Before any intervention, participants followed their regular bedtime routine for one night, during which baseline sleep activity was recorded using the EEG system. Additionally, subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) (Baseline/Pre).

During the intervention phase, an automatic 4D massage chair was placed in each participant's bedroom. Participants were instructed to use the chair daily for at least 30 minutes before bedtime, selecting from 12 pre-programmed relaxation massage modes. The daily usage of the chair was remotely monitored via an integrated tracking system coupled with a smart plug (Tapo P100, TP-Link, China) to ensure compliance. Sleep quality was assessed using polysomnography and PSQI questionnaires one month after the intervention (Post-1).

Following the one-month intervention, the massage chair was removed and participants resumed their usual bedtime routine. Sleep quality was again assessed using polysomnography and PSQI questionnaires one month after the chair removal (Post-2).

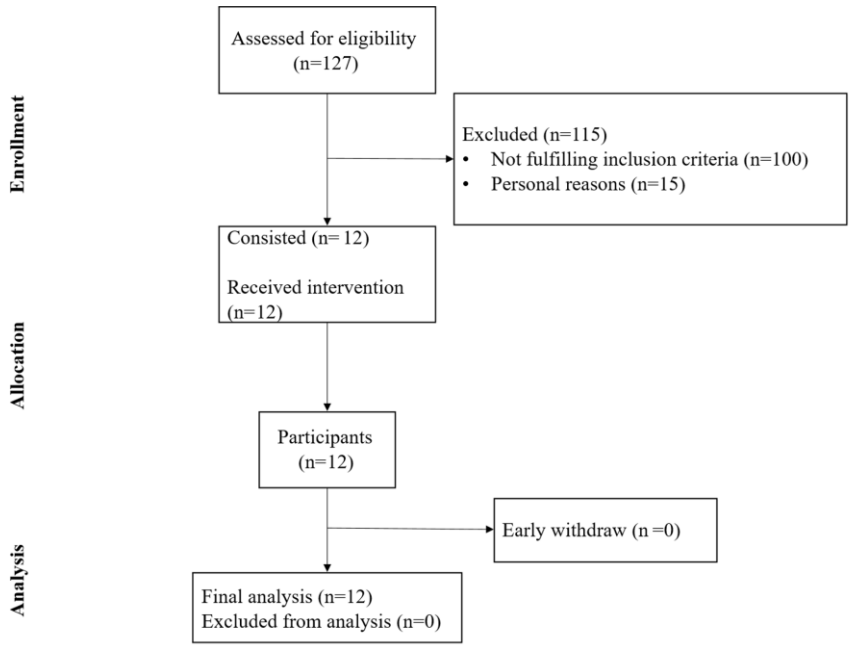
All measurements were conducted under similar conditions to minimize variability, with participants free to sleep naturally during the recordings.

The researchers analyzing the data were blinded to the assigned groups. The study was approved by the Human Research and Ethics Committee of the University of Thessaly (2334-5/4-2/7.2.2024). All patients gave their written informed consent prior to study

participation. The study has been registered as a clinical trial at ClinicalsTrials.gov (NCT06788288).

Figure 1. Consort Diagram.

A CONSORT diagram summarizes recruitment, enrollment and dropout rates.



Procedure

The study consisted of three consecutive phases:

- **Phase 1 (Pre):** Participants underwent initial assessments prior to any intervention, maintaining their usual bedtime routine.
- **Phase 2 (Post-1):** The automatic massage chair was placed in each participant's home, preferably in their bedroom. Participants were instructed to use the chair daily for at least 30 minutes before bedtime, selecting the Easy-Sleep massage program or any other that make them relax. Participants underwent the Post-1 assessments after the one-month intervention, maintaining again their usual bedtime routine.
- **Phase 3 (Post-2):** The massage chair was removed from the participant's house. Participants underwent the Post-2 assessments after the one month no intervention, maintaining again their usual bedtime routine. (Figure 2)

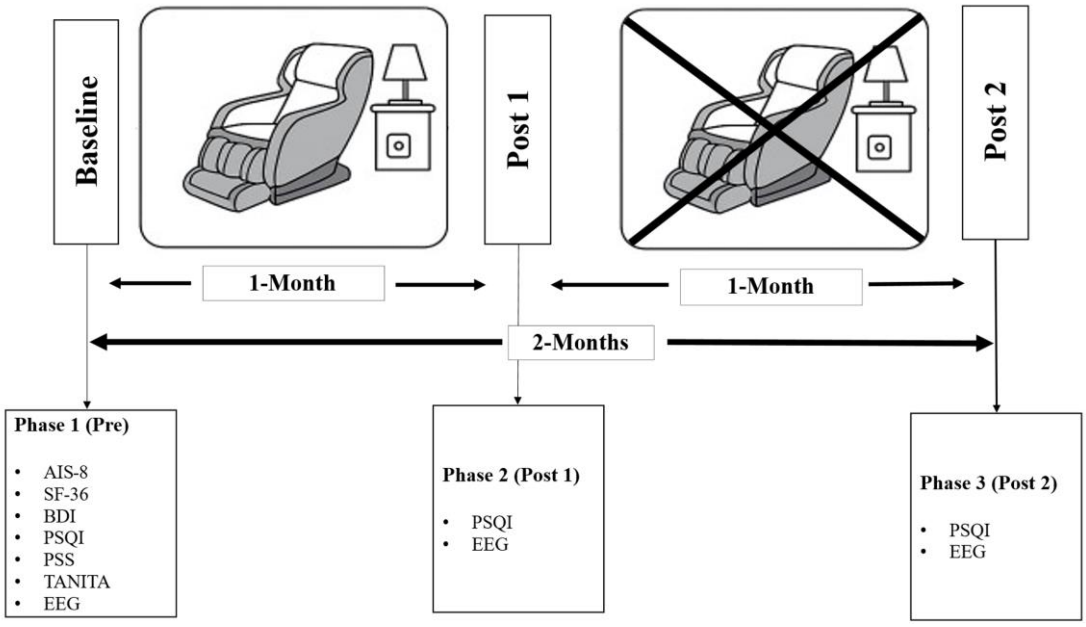


Figure 2. Study Flow Chart. Participants were randomized into 2 groups and participated in two continuous months. Note: (CH) Group with massage chair; (NCH) Group with no-massage chair; (AIS-8) Athens Insomnia Scale; (SF-36) 36-Item Short Form Survey Instrument; (BDI) Beck's Depression Inventory; (PSQI) Pittsburgh Sleep

Quality Index; (PSS) Perceived Stress Scale; (BIA) Bioelectrical Impedance Analysis; (EEG) Electroencephalography.

Questionnaires

The following questionnaires were administered using the interview method by experienced researchers.

- The Athens Insomnia Scale [271] and the Pittsburgh Sleep Quality Index (PSQI) [210] were used to assess sleep quality and the existence of any sleep abnormalities.
- The Short Form survey 36-item 36 quality of life questionnaire (SF-36) was used to assess the health-related quality of life.[211]
- The Beck Depression Inventory (BDI) questionnaire was used for the assessment of depressive symptoms.[212]
- The Perceived Stress Scale (PSS) was used to assess the stress levels.[213]

Body Composition

Body composition was assessed using anthropometric measurements, including BMI and bioelectrical impedance analysis with a Tanita DC-360S device (Tanita Corporation, Tokyo, Japan), following standard methodology.[324]

Compliance Monitoring

Compliance to the intervention protocol was monitored throughout the 30 days massage phase using a smart plug (Tapo P100, TP-Link, China), which recorded the daily electrical activation of the massage chair. Usage data revealed that the chair was utilized on average for 27.4 out of 30 days, resulting in an overall compliance rate of 91.2% ± 3.6 which is considered a very high adherence rate to the intervention protocol.

Sleep Assessment

A portable sleep monitoring system was used to assess sleep quality and quantity (Home Sleep Test, SOMNOmedics, GmbH, Germany). The system records EEG, EOG, and EMG signals overnight. EEG data were analyzed in 30-second epochs using SOMNOmedics PSG analysis software (Domino panel ver. 3.0.0.8) starting with automatic analysis with manual editing. The HomeSleepTest REM+ device was used for PSG, with electrodes placed according to the 10/20 system on key brain regions: Fp1 (left) and M1 for EEG, and near the eyes for EOG. Analysis of the sleep study was reported as followed: Total Sleep Time (total amount of sleep time scored during the total recording time); Sleep Efficiency (Total sleep time/Time in bed); Sustained Sleep Efficiency (Total sleep time/(Time in bed – Sleep laten-cy stage 2); Sleep latency is defined as the time from lights off to the start of the first epoch of any stage of sleep, including stage N1 (or any other stage); Sleep Latency N1 specifically refers to the time from lights out to the onset of the N1 stage of sleep; Sleep Latency N2 (the period of time between time in bed and sleep onset stage 2; REM Latency (the amount of time elapsed between the onset of sleep to the first REM stage); Wakes (the number of times an individual wakes up during the sleep period or transitions to full wakefulness after sleep onset).

Massage Session

Automatic Electric Massage Chair (AEMC)

In our study, we utilized the Z1 Full Body 4D Massage Chair (Z1-SL Massage Chair, China, www.back2life.gr) (Picture 1). The Z1-SL chair features a curved rail mechanism for both S-shaped (horizontal) and L-shaped (vertical) massages, covering areas from the head down toes. It includes 58 air cushions for air compression massage, while intelligent mechanical arms, rotating 360°, follow the body's contour, scanning and targeting specific areas for treatment.

The chair integrates a 4D massage system with professional techniques such as kneading, tapping, shiatsu, stretching, air compression, roller, and thermal massage. These techniques allow multidimensional effects in width, length, and depth, tailored to individual needs. Twelve automated programs vary in intensity, and the roller

mechanism adjusts to body widths of 3 to 22 cm for focused application to areas like the cervical spine, back, and lower back.

The chair's infrared preheating function (carbon fiber-based) enhances relaxation and circulation by heating the back, pelvis, and thighs. This feature, combined with an extendable foot section and an airbag/roller system, ensures comfort for individuals of different sizes, providing muscle relaxation, fatigue relief, and improved blood circulation.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 29 (SPSS Inc., Chicago, U.S.A.). An independent samples t-test was used to examine differences in baseline characteristics between male and female participants. A General Linear Model (GLM) Repeated Measures ANOVA was conducted to assess changes in the Pittsburgh Sleep Quality Index (PSQI) and all sleep parameters across the three intervention phases (Pre, Post-1, Post-2). Where significant effects were found, Bonferroni post-hoc tests were performed to identify pairwise differences. Data normality was assessed using the Shapiro-Wilk test along with graphical methods including Normal Q-Q plots and Box plots. Data are presented as mean ± standard deviation (SD), unless otherwise stated. The significance level was set at 0.05. Effect sizes were also considered to evaluate the magnitude of observed effects.

Power Analysis

Sample size calculations were conducted using G*Power 3.1. [326]. The post-hoc “GLM”: Repeated measures, within factors” method was used to calculate the power analysis. The post-hoc power analysis revealed that with a sample size of 12 participants the study achieved 99% power using Total Sleep Time (TST) as a primary outcome [(Effect size= 0.7451241, Critical F= 3.4433568, Ndf 2, Ddf 22, Power (1-β err pob) = 0.9998133 (99% power)]. For the secondary outcome which is Sleep Efficiency (%), the post-hoc power analysis revealed that with a sample size of 12 participants the study

achieved 83% power [(Effect size= 0.4101516, Critical F= 3.4433568, Ndf 2, Ddf 22, Power (1-β err pob) = 0.8360917 (83% power)].

Trial registration

The trial was registered under the title “The Long-term Impact of Massage Chairs on Sleep Quality (autosleepilot)” with the full protocol to be accessible through ClinicalTrials.gov website. Trial registration number: NCT06788288

Data Availability

Data are available at ClinicalTrials.gov for the study with registration number: NCT06788288

Results

Subject characteristics are presented in Table 1. No statistically significant differences were found between male and female participants ($p>0.05$).

Table 1. Baseline Characteristics.

Parameters	Values
N	12
Sex	7M/5F
Age (years)	43.4 ± 12.3
Body Height (cm)	175.5 ± 8.9
Body Weight (kg)	80.0 ± 17.7
BMI (kg/m²)	25.5 ± 3.8
Fat (%)	26.4 ± 5.9
SF-36 (Total)	69.9 ± 5.8
SF-36 (PH)	73.9 ± 6.8
SF-36 (MH)	68.3 ± 10.0
BDI	9.9 ± 6.0
PSS	15.8 ± 2.8
AIS-8	18.0 ± 2.1
PSQI	10.8 ± 4.1

Note: Data are presented as Mean ±SD. Significance level $P<0.05$; BMI: Body Mass Index; SF-36: 36-Item Short Form Survey Instrument; SF-36 (PH): 36-Item Short Form Survey Instrument - Physical Health Component; SF-36 (MH): 36-Item Short Form Survey Instrument - Mental Health Component; BDI: Beck's Depression Inventory; PSS: Perceived Stress Scale. AIS-8: Athens Insomnia Scale.

Pre, Post-1 and Post-2 intervention sleep assessments are presented in (Table 2 and Figure 3). Significant differences were observed in the Pittsburgh Sleep Quality Index (PSQI) questionary across the three phases. Specifically, PSQI scores decreased significantly in both Post-1 and Post-2 phases (%Δ-change: -18% ± 3.9 and -14.8% ± 3.9, respectively; $p=0.022$), in comparisons to baseline (Pre) indicating an improvement in sleep quality following the interventions and maintained for one more month (Post-2).

Table 2. Sleep Quality Index Across Assessment.

Variables	Pre (95% CI)	Post-1 (Δ-change%) (95% CI)	Post-2 (Δ-change%) (95% CI)	P Value (Effect size: partial η²)
N	**12**	**12**	**12**	**-**
PSQI	10.8 ± 4.1 (8.48 to 13.1)	8.8 ± 3.7 (-18% ± 3.9) (6.71 to 10.9)	9.2 ± 4.0 (-14.8% ± 3.9) (6.94 to 11.5)	**0.022*** (0.352)

Note: Data are presented as Mean ±SD. Significance level P<0.05; PSQI: Pittsburgh Sleep Quality Index; Pre: Initial assessments without massage chair and usual bedtime routine; Post-1: Measurements after 1 month of massage chair use at home; usage remotely monitored; Post-2: Measurements 1 month after removal of the massage chair. *A statistically significant decrease in PSQI was observed between Post-1 and Post-2 (Δ-change%; paired t-test, p=0.000), indicating further improvement in score after 1 month of massage chair use at home.

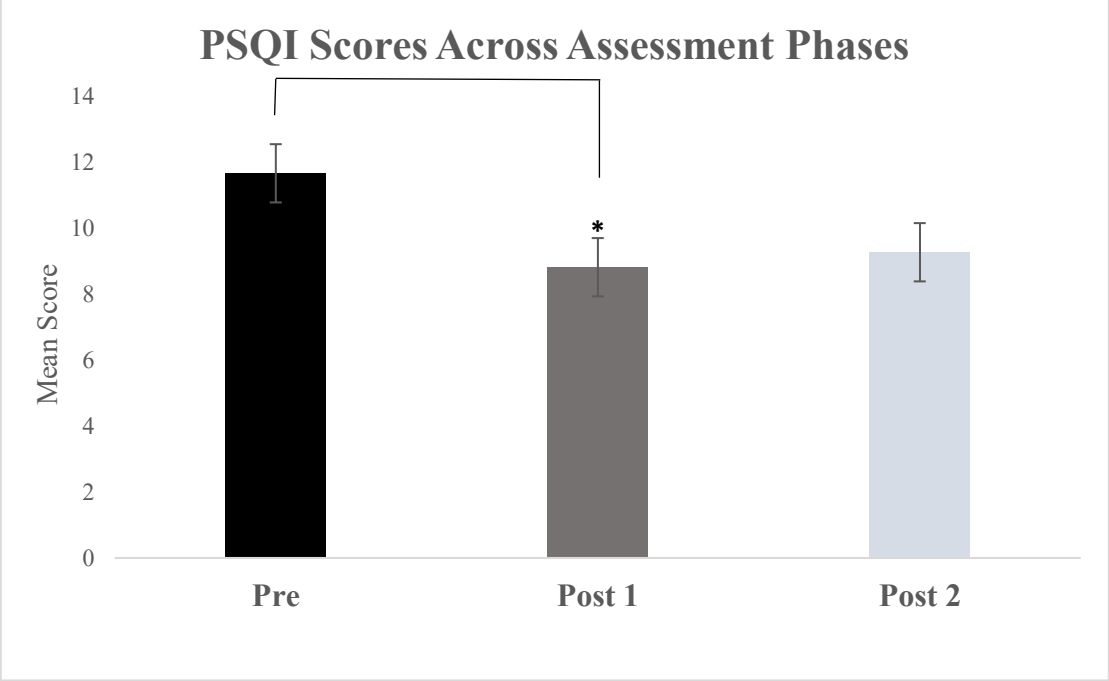


Figure 3. PSQI Scores Across Assessment Phases. Note: Statistical differences were found. *Differences between the 3 protocols were assessed using a GLM repeated measures test: Post-1 vs Post-2, p= 0.005, (Bonferroni's Post-hoc test); Pre: Initial assessments without massage chair and usual bedtime routine; Post-1: Measurements after 1 month of massage chair use at home; usage remotely monitored; Post-2: Measurements 1 month after removal of the massage chair.

Polysomnographic sleep parameters are reported in (Table 3 and Figure 4). A statistically significant effect was observed for Total Sleep Time (TST) across the three phases [F(2,16) =4.435, p=0.050], with the Post-1 phase showing the largest magnitude of change. The difference (Δ-change) in TST between Pre and Post-1 was 30.7% ± 1.6, while the change between Pre and Post-2 was 41% ± 1.6, indicating a marked increase in total sleep duration following the interventions. The difference in Total Sleep Time (TST) between Post-1 and Post-2 was 10.3% ± 1.6 and was statistically significant (p=0.033), indicating further improvement in sleep quantity even after the removal of the massage chair.

Although, no other sleep parameters reached statistical significance, several showed clinically relevant trends. For example, Sustained Sleep Efficiency increased by 17.7% ± 13.2 (p=0.215). These findings, although not statistically significant, may indicate positive effects worthy of further investigation in larger samples.

Table 3. Comparative Sleep Parameters across Assessment.

Variables	**Pre** **(95% CI)**	**Post-1** **(Δ-change%)** **(95% CI)**	**Post-2** **(Δ-change%)** **(95% CI)**	**P Value** **(Effect size: partial η^2)**
N	12	12	12	-
TST **(Hours.min)**	3.9 ± 1.8 (2.88 to 4.92)	5.1 ± 1.4 (30.7% ± 1.6) (4.31 to 5.89)	5.5 ± 1.4 (41% ± 1.6) (4.71 to 6.29)	**0.050*** (0.357)
Sleep Efficiency **(%)**	76.1 ± 8.4 (71.3 to 80.8)	76.1 ± 8.1 (0% ± 8.2) (71.5 to 80.7)	85.0 ± 9.7 (11.6% ± 9.0) (79.5 to 90.5)	0.288 (0.144)
Sustained Sleep Efficiency **(%)**	70.3 ± 15.5 (61.5 to 79.1)	82.8 ± 11.0 (17.7% ± 13.2) (76.6 to 89)	85.4 ± 9.9 (21.4% ± 12.7) (79.8 to 91)	0.215 (0.183)

Sleep Latency (min)	20.5 ± 12.3 (13.5 to 27.5)	43.4 ± 13.2 (111.7% ± 12.2) (35.9 to 50.9)	11.9 ± 2.2 (-41.9 ± 7.2) (10.7 to 13.1)	0.102 (0.281)
Sleep Latency N1 (min)	42.5 ± 18.1 (32.3 to 52.7)	46.8 ± 15.9 (10.1% ± 17) (37.8 to 55.8)	25.0 ± 11.4 (-41.1 ± 14.7) (18.6 to 31.4)	0.128 (0.239)
Sleep Latency N2 (min)	27.7 ± 19.2 (16.8 to 38.6)	48.4 ± 12.7 (74.7% ± 15.9) (41.2 to 55.6)	11.8 ± 15.4 (-57.4% ± 17.3) (3.09 to 20.5)	0.154 (0.230)
Deep Sleep Latency	56.3 ± 20.5 (44.7 to 67.9)	82.9 ± 42.6 (42.2% ± 31.5) (58.8 to 107)	32.9 ± 21.0 (-41.5 ± 20.7) (21 to 44.8)	0.127 (0.238)
Wakes (index)	18.5 ± 13.5 (10.9 to 26.1)	19.1 ± 13.8 (41.4% ± 13.6) (11.3 to 26.9)	19.1 ± 9.0 (41.4% ± 11.2) (14 to 24.2)	0.992 (0.001)
Wake > 3 min (index)	3.8 ± 3.3 (1.93 to 5.67)	3.3 ± 2.7 (-13.1 ± 3.0) (2.27 to 5.33)	3.5 ± 2.8 (-7.8 ± 2.7) (1.92 to 5.08)	0.928 (0.007)

Note: Data are presented as Mean ±SD. Significance level P<0.05; TST: Total Sleep Time; Pre: Initial assessment during participants' usual bedtime routine without the massage chair.; Post-1: Measurements after one month of massage chair use at home (usage remotely monitored).; Post-2: Measurements one month after the removal of the massage chair.*A statistically significant increase in Total Sleep Time (TST) was observed between Post-1 and Post-2 (Δ-change%; paired t-test, p=0.033), indicating further improvement in sleep quantity even after the removal of the massage chair.

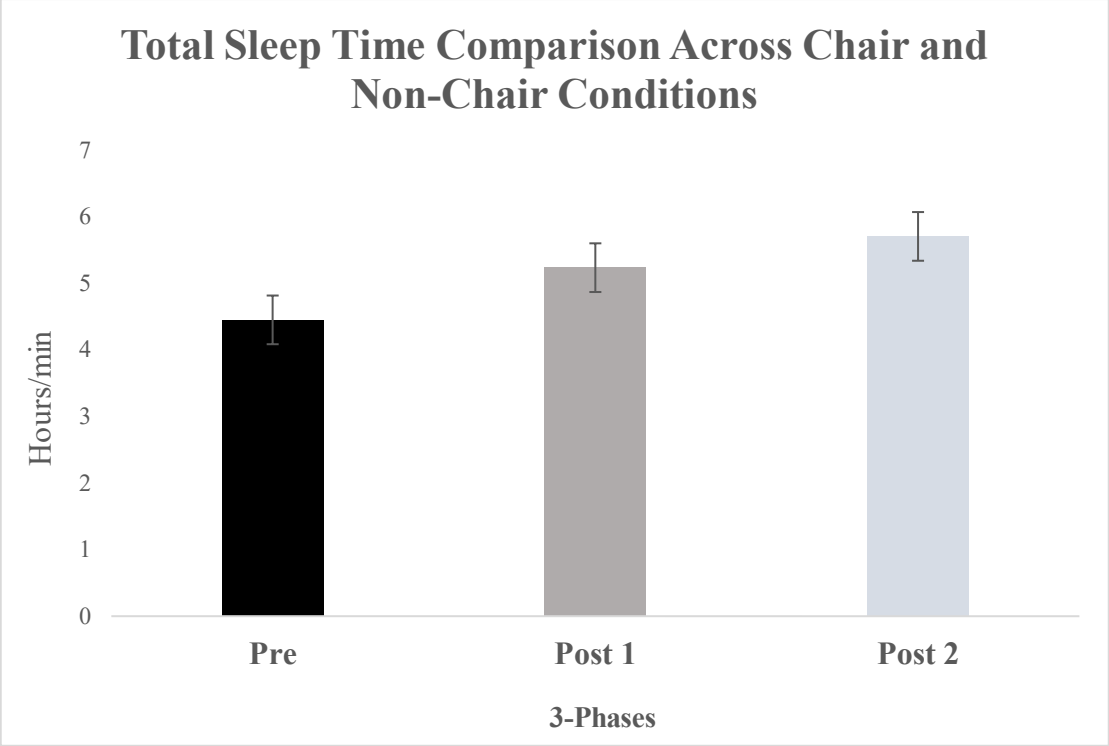


Figure 4. Total Sleep Time comparison across 3 different phases. Note: Statistical differences were found. Pre: Initial assessments without massage chair and usual bedtime routine; Post-1: Measurements after 1 month of massage chair use at home; usage remotely monitored; Post-2: Measurements 1 month after removal of the massage chair.

Discussion

To the best of our knowledge, this is among the first and very few studies to explore the long-term effects of modern automatic massage chairs on sleep quality and overall well-being in individuals with severe insomnia. By combining both objective (polysomnography) and subjective (validated questionnaires) assessments, this study provides valuable insight into an emerging and underexplored field that bridges innovative technology with therapeutic applications in sleep medicine.

The main finding of the present study, is the great improvement that it was observed during the Pre to Post-1 phase when participants actively used the massage chair. Specifically, Pittsburgh Sleep Quality Index (PSQI) scores improved by 18% during this phase, indicating a significant improvement in perceived sleep quality.

A smaller, yet still notable, improvement by 14.8% in PSQI scores was also observed during the Post-2 phase, when the massage chair had already been removed from the participants' homes. The maintenance of this improvement compared to baseline values may be attributed to a chronic relaxation effect on musculoskeletal system in addition to the accumulating improved sleep quality from the previous regular use of the chair during the month of the intervention (Table 2).

Furthermore, objective measurements using PSG-EEG indicated a significant improvement in Total Sleep Time (TST) across the three phases, with the greatest improvement observed during the Post-2 phase. Specifically, TST improved by 30.7% between the Post-1 phase, while an even larger improvement 41% (+10.3%) was observed in the Post-2 phase (Table 3), demonstrating a substantial extension of total sleep duration following the current interventional pattern. These findings suggest that the massage interventions not only improve subjective sleep quality but also promote meaningful physiological changes in sleep architecture, contributing to longer and potentially more restorative sleep.

Additionally, significant improvements were observed in sustained sleep efficiency and sleep latency during the Post-2 phase. It is plausible that the regular use of the massage chair led to lasting enhancements in autonomic nervous system regulation and overall well-being, which contributed to faster sleep onset and more stable, consolidated sleep even beyond the active interventional period. These sustained

effects may be mediated by increased parasympathetic activity and reduced sympathetic arousal, factors known to promote deeper and more restorative sleep.[350]

Moreover, significant improvements were observed in sustained sleep efficiency and sleep latency during the Post-2 phase. Massage therapy has increasingly been recognized as an effective non-pharmacological intervention for addressing sleep disturbances such as insomnia, particularly by improving both subjective and objective sleep indicators including sleep latency, which refers to the time it takes to transition from wakefulness to sleep. In postmenopausal women, where hormonal changes frequently disrupt sleep onset and continuity, massage has shown promise in reducing symptoms and improving sleep quality, with studies suggesting that these benefits may be mediated through anti-inflammatory and neuroendocrine pathways.[351] Our own findings align with this evidence, showing that a single session of relaxation massage not only improved sleep efficiency but also contributed to a reduction in sleep latency, facilitating faster sleep onset in individuals with chronic insomnia.[7] These outcomes are consistent with those reported in fibromyalgia patients, where massage-myofascial release significantly enhanced sleep quality and reduced anxiety factors that are closely linked to shortened latency.[352] Collectively, these results underscore the role of massage in regulating autonomic nervous system activity and enhancing parasympathetic dominance, which is crucial for promoting relaxation and accelerating sleep initiation.

In line with the present findings, evidence from studies evaluating the physiological effects of electric massage also supports its role in regulating autonomic nervous system activity and reducing perceived fatigue.[353] For instance, research comparing massage chairs and proprioceptive neuromuscular facilitation (PNF) stretching demonstrated that both interventions significantly improved heart rate variability (HRV) parameters and reduced subjective fatigue, with the massage chair group showing a more pronounced improvement in HRV indices such as LF/HF and HF components. These effects were attributed to enhanced parasympathetic modulation and faster metabolic recovery post-exercise. While the mechanism of action differs, physical contact and mechanoreceptor stimulation in massage versus isometric contraction and proprioceptive feedback in PNF both methods contribute to autonomic balance and fatigue reduction.[339] Integrating this knowledge with our study's results suggests that the regular use of an automated massage chair may offer similar

autonomic and recovery benefits, potentially extending its application to fatigue management beyond insomnia care.

These results align with previous evidence supporting the beneficial effects of massage chairs on stress reduction and autonomic regulation. For example, Baek et al., showed that long-term use of a massage chair can reduce stress markers and improve mood and cognition in adults, suggesting a potential mechanism for improved sleep quality.[340] Similarly, Zhang et al., demonstrated that massage chair interventions significantly decrease fatigue scores and modulate heart rate variability parameters by reducing sympathetic nervous system excitability and increasing parasympathetic activity, which could underpin the relaxation and sleep improvements observed in our study.[354] Additionally, Lee et al., reported that prolonged massage chair use in children promoted growth and musculoskeletal development, highlighting the potential of massage chairs for positive long-term health outcomes beyond immediate relaxation.[355]

Hormonal pathways also play a role, as massage promotes serotonin release[200], and a study by Ji Yeon Baek et al., reported that long-term use of the AEMC can reduce anxiety in adults, as the intervention resulted in significant decreases in cortisol and serum DHEA-S (dehydroepiandrosterone sulfate) levels, along with improvements in mood and health status.[340]

Beyond hormonal modulation, the beneficial effects of massage therapy on sleep may also be mediated through autonomic nervous system regulation. Regular massage has been shown to shift the sympathovagal balance towards parasympathetic dominance, a state associated with relaxation, decreased arousal, and improved sleep quality.[356] This shift is believed to occur through activation of mechanoreceptors in the skin and deep tissues, which stimulate afferent vagal pathways and reduce hypothalamic-pituitary-adrenal (HPA) axis activity.[357] These neurophysiological mechanisms may explain the observed reductions in stress markers, such as cortisol and norepinephrine levels, and the beneficial effects on autonomic nervous system function following heat and massage applications. The attenuation of sympathetic tone and the promotion of vagal activity not only facilitate sleep onset but also enhance sleep continuity by stabilizing neurophysiological patterns associated with non-REM sleep. Furthermore, mechanistic studies using heart rate variability (HRV) metrics have confirmed that massage can increase high-frequency HRV components, indicative of

enhanced parasympathetic function.[358,359] These neurophysiological changes together with reductions in circulating stress hormones support a multi-layered mechanism through which automated massage chairs may exert chronic and restorative effects on sleep architecture and emotional homeostasis.[360]

Similar to our findings, studies examining the effects of automated massage chairs have shown that techniques such as roll-stretch and shiatsu reduce muscle tension in distant areas and promote neurovegetative relaxation.[361] These results support that the use of automated massage chairs can induce rapid and measurable relaxation, which likely contributes to improved sleep quality and reduced stress, as also confirmed by our study.

Taken together, these findings suggest that modern automated massage chairs can serve as effective, non-pharmacological interventions to improve sleep quality and reduce chronic stress, potentially offering a practical therapeutic tool for individuals suffering from insomnia and related disorders. It is evident therefore, that the use of massage chairs can benefit not only people with increased stress or various health issues, but also in totally healthy individuals for sustaining a healthy lifestyle or promoting a power nap for boosting their cognitive function or improve creativity.

Beyond its clinical usefulness for individuals with insomnia, this intervention could also be applied to individuals as a means of enhancing mental well-being or supporting recovery following intense mental or physical exertion. The potential integration of massage chairs in workplace settings[330], rehabilitation clinics, or geriatric care facilities could offer an affordable and user-friendly tool for maintaining healthy sleep patterns and lifestyle habits, contributing to stress reduction and improved overall functioning.

However, caution is warranted when recommending automated massage chairs, especially for individuals with or at risk of osteoporosis. Recent case reports have highlighted the potential for osteoporotic vertebral compression fractures induced by deep tissue massage delivered via such devices.[362] Therefore, clinical guidance and patient screening should be considered to ensure safety alongside therapeutic benefits.

In addition, studies evaluating the effects of mechanical massage combined with mental training in workplace settings have shown mixed results. While no significant differences were found between intervention groups, individual improvements in

anxiety, stress susceptibility, and detachment suggest potential benefits.[363] These preliminary findings underscore the need for further research to validate mechanical massage as an effective tool to enhance stress recovery in diverse populations.

In the present study, we must acknowledge both some significant strengths and unforeseen limitations. The primary strengths are the combination of both objective and subjective methods used to assess the sleep quality. In addition, the use of a real-time EEG monitoring system provided an objective measurement of the brain activity that is valuable for understanding the immediate effects of massage on the brain activity and analyzing the sleep quality. Furthermore, the daily usage of the chair was remotely monitored via an integrated tracking system coupled with a smart plug (Tapo P100, TP-Link, China) to ensure compliance, adding robustness to the intervention adherence data.

One limitation is the small sample size even though the study had more than 95% power to detect statistically significant differences for the primary outcome. Another important limitation is the menstrual cycle of female participants was not controlled; however, none of the female participants were during the menstrual phase. Additionally, the Athens Insomnia Scale (AIS-8) was only measured at the beginning of the study, whereas measuring it at all phases, similar to the PSQI could have provided an additional valuable subjective indicator of sleep quality throughout the intervention.

The present findings offer a promising foundation for considering automated massage chairs as an accessible, non-pharmacological tool to improve sleep quality, reduce stress, and enhance overall well-being in individuals with insomnia symptoms. With growing interest in integrative and lifestyle-based therapies, such technological interventions may play an increasingly important role in modern sleep medicine and holistic health care.

Future randomized controlled trials with larger sample sizes and longer follow-up periods are warranted to confirm these findings and assess the durability and generalizability of the observed effects.

Conclusion

The use of new generation automatic massage chairs appears to offer benefits and serves as a promising non-pharmacological tool for improving sleep quality and promoting relaxation. The findings of this study suggest that regular use of the massage chair may lead to long-term improvements in sleep duration and efficiency, as well as enhanced feelings of calmness and well-being. These improvements could greatly benefit individuals living in high-stress, fast-paced environments. However, further research is needed to better understand the mechanisms through which massage chairs influence sleep neurophysiology and to evaluate their long-term effectiveness in people with insomnia, stress and anxiety disorders.

General Discussion

The present PhD Thesis sought to evaluate the acute and chronic effects of non-pharmacological, lifestyle-based interventions particularly various massage techniques (e.g., manual sports/activation massage, manual relaxation massage using Swedish techniques, manual sports/activation massage, "sham" massage, mechanical relaxation massage) and sleep hygiene strategies (e.g., limiting daytime napping, maintaining a consistent sleep schedule, minimizing screen exposure before bedtime, avoiding caffeine and alcohol before bedtime) on key health indicators such as sleep quality, fatigue, stress, daytime sleepiness and physical performance. Through five independents but thematically connected experimental clinical trials, the aim was to achieve a holistic understanding of how massage applications can contribute to physical performance or in an improvement in sleep quality and psychosomatic indices . The results of this work confirm the hypothesis that structured manual or mechanical massage, when appropriately timed and administered, can significantly influence sleep parameters, psychological well-being and even athletic performance.

In the context of sports performance (Study 1), the application of sports massage following warm-up, especially when using activation essential oils (AEO), led to significant improvements in 60-meter sprint performance. This suggests that not only timing but also the biochemical composition of the massage medium may amplify performance-enhancing effects possibly through increased muscle perfusion, thermal regulation, or local anti-inflammatory action.[364] This supports the broader literature emphasizing the ergogenic potential of pre-competition massage and the collaborative role of specific essential oils.[365] If not the first, this is one of the few, well-powered, randomized and blinded studies, showing that the application of a post-warm up sport massage using oil (a common approach in field practice) can meaningfully enhance performance. The result gains particular importance because the participants, in contrast to past research reporting no effects or negative effects of massage on sprint performance, our study participants demonstrated good to excellent sprinting ability (on par with European competitive collegiate, national and international level) thereby adding ecological value to our findings. Furthermore, considering there is a burgeoning market on aromatherapy –related products, our finding that essential oils mixtures may confer added benefits opens up a new avenue of research direction to explore the role of skin permeant elements. Last, but not least, a brief, 5-min, sports massage is feasible

and achievable even for a financially constrained, resource deficient club. Thus athletes of all means could access it and benefit.

Across all studies, relaxation massage consistently demonstrated benefits in both subjective and objective sleep parameters. In particular, in Study 3, statistically significant improvements were observed in sleep efficiency and sustained sleep efficiency following a single session of relaxation massage before bedtime in individuals with chronic insomnia symptoms. These outcomes mean that even a single session of relaxation massage can contribute to measurable improvements in sleep quality, highlighting its potential as a complementary, non-pharmacological intervention for individuals experiencing chronic insomnia symptoms.

These findings align with previous literature showing that massage therapy can reduce cortisol levels and increase neurotransmitters such as serotonin and dopamine, contributing to stress relief and improved emotional regulation across various medical and psychological conditions.[366] Although our study did not assess these biological markers directly, the observed improvements in EEG-based sleep outcomes support the hypothesis that relaxation massage may exert its effects through such physiological pathways.[7] This reinforces its potential role as a safe, non-pharmacological intervention for the management of insomnia.[367]

Study 2 extended this line of inquiry by assessing daytime naps, confirming that brief relaxation techniques such as progressive muscle relaxation can enhance nap quality in poor sleepers. The observed increase in slow-wave sleep and improvements in relaxation scores support the notion that relaxation-based interventions can effectively modulate psychophysiological arousal, thereby promoting daytime restorative sleep.[368] These findings are of particular relevance in modern high-stress environments where daytime fatigue and low sleep quality are increasingly prevalent.[369]

[369][370]Moving from manual techniques to mechanical solutions, Studies 4 and 5 indicated that specific pre-programmed AEMC protocols particularly those targeting fatigue recovery improved subjective sleepiness, quality of life, and certain objective sleep parameters (e.g., total sleep time). Importantly, these effects were more pronounced in individuals with insomnia, underscoring the potential of accessible, at-home solutions to complement standard non-pharmacological treatments for sleep disorders.[370]

Still, it is important to note that that more work is needed in that area. Companies do not allow full access on the data they based their massage 'sequences' on nor do they easily allow their equipment to undergo research scrutiny. The present studies indicate a great opportunity for further industry and academia collaboration. Mechanical massage can prove invaluable when high costs of labour and time restrict access of healthy individuals or patients to expert massage services. While a direct comparison of automated mechanical massage protocols to manual massage by experts was not done, it appears that well designed protocols implemented with high quality equipment can provide sufficient benefit. Thus, these results hold promise for millions of potential users who might need but can't afford manual massage.

A unifying theme across studies is the role of massage in shifting autonomic balance from sympathetic to parasympathetic dominance, as demonstrated by improved relaxation scores, better sleep parameters and reduced fatigue.[371] These findings align with existing evidence on the effects of massage on hormonal profiles, notably reduced cortisol and increased serotonin and melatonin levels. Given the biopsychosocial complexity of sleep and fatigue-related disorders, the multimodal action of massage offers an attractive adjunctive strategy in holistic health management.[372]

From a methodological perspective, the strength of this thesis lies in its use of objective sleep assessment tools (i.e. PSG-EEG system), randomized protocols, and blinded data analysis all of which address common limitations in the massage therapy literature.[373] In addition, four out of the five studies were registered as clinical trials at clinicaltrials.gov. The inclusion of both healthy and clinical populations also broadens the generalizability of findings. However, some limitations should be acknowledged: sample sizes were modest even though power analysis revealed that the studies were not underpowered, and most interventions were short-term ranging from one day to one month.

In practical terms, the findings support the integration of massage interventions into clinical and everyday settings as part of a personalized lifestyle medicine approach. Relaxation massage prior to sleep, activation massage in athletic contexts, and the use of automated massage chairs at home or in the workplace could all serve as low-cost, scalable interventions for improving sleep, reducing fatigue, and enhancing well-being.[374] These interventions are particularly important in populations where

pharmacological options may be limited or carry risks (e.g., older adults, individuals with psychiatric comorbidities, or athletes avoiding performance-impairing substances).

In conclusion, this dissertation provides robust scientific evidence supporting the use of massage as an effective, non-pharmacological strategy to improve sleep quality, reduce fatigue, and promote physical and mental recovery, applicable to a sport, and health related pre-clinical and a clinical setting. The integration of these techniques into broader health promotion strategies offers a promising direction for future research and clinical application. Further studies are warranted to explore long-term effects, optimize intervention protocols, and expand the use of objective assessments across diverse populations.

General Conclusions & Future Perspective

This doctoral dissertation demonstrated that lifestyle-based, non-pharmacological interventions such as massage therapy can significantly improve sleep quality, reduce fatigue, enhance psychological well-being, and contribute to physical performance enhancement. The integration of relaxation massage, activation massage and automatic electric massage chairs showed beneficial effects across both healthy and clinical populations, reinforcing the role of complementary therapies in modern health strategies.

The findings support the application of massage techniques not only in clinical rehabilitation and athletic settings but also in everyday health promotion, particularly for individuals suffering from insomnia, stress, or fatigue offering a new type of treatment at the workplace or at home. The consistent improvements observed across objective and subjective measures suggest that these interventions can be effective, scalable, and low-risk alternatives or adjuncts to pharmacological approaches.

Future research should focus on long-term intervention protocols and expanding interdisciplinary collaborations between exercise science, sleep medicine and digital health technologies may open new paths for precision, non-invasive interventions targeting holistic recovery and quality of life.

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Appendix

Appendix 1: Bioethics Approval

Εσωτερική Επιτροπή Δεοντολογίας

Τρίκαλα: 7.2.2024
Αριθμ. Πρωτ.: 2334

Βεβαίωση έγκρισης της πρότασης για διεξαγωγή έρευνας με τίτλο: Η επίδραση της αλλαγής του τρόπου ζωής σε παράγοντες που σχετίζονται με την κόπωση, την ποιότητα ζωής, την υγεία και την ημερήσια υπνηλία / The effect of lifestyle modifications on aspects related to fatigue, quality of life, health and sleepiness

Επιστημονικώς υπεύθυνος-η / επιβλέπων-ουσα: Σακκάς Γεώργιος
Ιδιότητα: Αναπληρωτής Καθηγητής
Ίδρυμα: Πανεπιστήμιο Θεσσαλίας
Τμήμα: ΤΕΦΑΑ

Κύριος ερευνητής-τρια / φοιτητής-τρια: Ντούμας Ηλίας
Πρόγραμμα Σπουδών: Διδακτορικό
Ίδρυμα: Πανεπιστήμιο Θεσσαλίας
Τμήμα: ΤΕΦΑΑ

Η προτεινόμενη έρευνα θα είναι: ερευνητικό πρόγραμμα

Τηλ. επικοινωνίας: 24310-47022
Email επικοινωνίας: gsakkas@uth.gr

Η Εσωτερική Επιτροπή Δεοντολογίας του Τ.Ε.Φ.Α.Α., Πανεπιστημίου Θεσσαλίας μετά την υπ. Αριθμ. 4-2/ 7.2.2024 συνεδρίασή της εγκρίνει τη διεξαγωγή της προτεινόμενης έρευνας.

Ο Πρόεδρος της
Εσωτερικής Επιτροπής Δεοντολογίας
– ΤΕΦΑΑ

Τσιόκανος Αθανάσιος
Καθηγητής

Appendix 2: Consent Form

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ ΚΑΙ ΑΘΛΗΤΙΣΜΟΥ

Υπεύθυνη δήλωση Συναίνεσης Δοκιμαζόμενου σε Ερευνητική Εργασία

Σκοπός της ερευνητικής εργασίας: Σκοπός της έρευνας είναι να αξιολογήσει τη χρονική επίδραση του αθλητικού μασάζ πριν και μετά από την προθέρμανση σε μια ημέρα αγώνα, χρησιμοποιώντας δύο διαφορετικά έλαια μασάζ στην απόδοση των 60μ. δρόμου ταχύτητας σε αθλητές ταχύτητας (sprinters).

Διαδικασία μετρήσεων: Θα χρειαστεί να πραγματοποιηθεί μία συνάντηση, όπου θα συμπληρώσετε ένα ατομικό ιστορικό υγείας, και εφόσον πληροίτε τις προϋποθέσεις, μπορείτε να συμμετέχετε στην έρευνα. Συνολικά θα συμμετάσχετε σε 3 συνεδρίες: Στην 1η συνάντηση δεν θα λάβετε κάποια μορφή μάλαξης και θα γίνει απλή καταγραφή ενός μέγιστου σπριντ 60μ. δρόμου ταχύτητας. Στην 2η συνάντηση θα σας εφαρμοστεί μια συνεδρία αθλητικής μάλαξης με την χρήση αιθέριου ελαίου ενεργοποίησης και στη συνέχεια θα πραγματοποιήσετε ένα μέγιστο σπριντ του δρόμου 60μ ταχύτητας. Στην 3η συνάντηση θα σας πραγματοποιηθεί πάλι μια συνεδρία αθλητικής μάλαξης χρησιμοποιώντας ένα κοινό λάδι μασάζ και στη συνέχεια θα πραγματοποιήσετε ένα μέγιστο σπριντ του δρόμου 60μ ταχύτητας.

Πιθανοί κίνδυνοι: Δεν υπάρχει κίνδυνος τραυματισμού κατά τη διάρκεια των δοκιμασιών.

Προσδοκώμενες ωφέλειες: Από τα αποτελέσματα της παρούσας έρευνας θα προκύψουν τυχόν θετικές επιδράσεις της αθλητικής μάλαξης στην απόδοση στους δρόμους ταχύτητας 60μ. (sprints) και στην αποκατάσταση μετά από έντονη προπόνηση ή αγώνα.

Δημοσίευση δεδομένων-αποτελεσμάτων: Οι πληροφορίες που θα συλλέξουμε από τις απαντήσεις σας με το ατομικό ιστορικό υγείας είναι κωδικοποιημένες και θα μείνουν απόρρητες. Η συμμετοχή σας στην έρευνα συνεπάγεται ότι συμφωνείτε με τη δημοσίευση των δεδομένων και των αποτελεσμάτων της, με την προϋπόθεση ότι θα είναι ανώνυμα και θα χρησιμοποιηθούν μόνο για τις ανάγκες της παρούσας έρευνας.

Πληροφορίες: Σε όλη τη διάρκεια της έρευνας οι ερευνητές (Δρ. Γεώργιος Σακκάς και κος. Ηλίας Ντούμας) θα είναι στη διάθεση των δοκιμαζομένων για να προσφέρουν οποιουδήποτε είδους πληροφορία είτε αυτή αφορά την έρευνα είτε τη συμπλήρωση των ερωτηματολογίων.

Ελευθερία συναίνεσης: Η συμμετοχή σας στη παρούσα έρευνα είναι εθελοντική και έχετε την δυνατότατα να αρνηθείτε την συμμετοχή σας, καθώς επίσης και να αποχωρήσετε από αυτή οποιαδήποτε στιγμή το επιθυμείτε.

Διάβασα το έντυπο αυτό και κατανοώ τις διαδικασίες που θα εκτελέσω. Συναινώ να συμμετέχω στην έρευνα.

Ημερομηνία: …../……/……

Ονοματεπώνυμο και υπογραφή συμμετέχοντος

Υπογραφή ερευνητή

Ηλίας Ντούμας

Ονοματεπώνυμο και υπογραφή παρατηρητή

Appendix 3: Consent Form

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ ΚΑΙ ΑΘΛΗΤΙΣΜΟΥ

Υπεύθυνη δήλωση Συναίνεσης Δοκιμαζόμενου σε Ερευνητική Εργασία

Σκοπός της ερευνητικής εργασίας: Σκοπός της έρευνας είναι να εξετάσει το βαθμό επίδρασης που μπορεί έχει η μάλαξη χαλάρωσης, καθώς και η μάλαξη ενεργοποίησης (αθλητική μάλαξη) στα επίπεδα εγρήγορσης και χαλάρωσης υγειών ατόμων.

Διαδικασία μετρήσεων: Θα χρειαστεί να πραγματοποιηθεί μία συνάντηση, όπου θα συμπληρώσετε ένα ατομικό ιστορικό, και εφόσον πληροίτε τις προϋποθέσεις, μπορείτε να συμμετέχετε στην έρευνα. Συνολικά θα συμμετάσχετε σε 3 συνεδρίες: Στην 1η επίσκεψη δεν θα λάβετε κάποια μορφή μάλαξης. Θα συμπληρώσετε μια σειρά ερωτηματολογίων και στη συνέχεια θα γίνει μια απλή καταγραφή του εγκεφάλου μέσω μηχανήματος καταγραφής εγκεφαλικής δραστηριότητας: Εγκεφαλογράφημα [Home Sleep Test (HST)]. Στην 2η επίσκεψη θα εφαρμοστεί μια συνεδρία 30 λεπτών μάλαξης χαλάρωσης με καταγραφή εγκεφαλικής δραστηριότητας μέσω του HST. Στην 3η επίσκεψη θα εφαρμοστεί μια συνεδρία 30 λεπτών μάλαξης ενεργοποίησης με καταγραφή εγκεφαλικής δραστηριότητας μέσω του HST.

Πιθανοί κίνδυνοι: Δεν υπάρχει κίνδυνος τραυματισμού κατά τη διάρκεια των δοκιμασιών.

Προσδοκώμενες ωφέλειες: Από τα αποτελέσματα της παρούσας έρευνας θα προκύψουν τυχόν θετικές επιδράσεις που μπορούν να προκαλέσουν αυτά τα δύο είδη μάλαξης στο εγκεφαλικό σύστημα υγιών ανθρώπων, καθώς και ως προς την μυϊκή και ψυχική χαλάρωση.

Δημοσίευση δεδομένων-αποτελεσμάτων: Οι πληροφορίες που θα συλλέξουμε από τις απαντήσεις σας με το ατομικό ιστορικό υγείας είναι κωδικοποιημένες και θα μείνουν απόρρητες. Η συμμετοχή σας στην έρευνα συνεπάγεται ότι συμφωνείτε με τη δημοσίευση των δεδομένων και των αποτελεσμάτων της, με την προϋπόθεση ότι θα είναι ανώνυμα και θα χρησιμοποιηθούν μόνο για τις ανάγκες της παρούσας έρευνας.

Πληροφορίες: Σε όλη τη διάρκεια της έρευνας οι ερευνητές (Δρ. Γεώργιος Σακκάς και Ηλίας Ντούμας) θα είναι στη διάθεση των δοκιμαζομένων για να προσφέρουν οποιουδήποτε είδους πληροφορία είτε αυτή αφορά την έρευνα είτε τη συμπλήρωση των ερωτηματολογίων.

Ελευθερία συναίνεσης: Η συμμετοχή σας στη παρούσα έρευνα είναι εθελοντική και έχετε την δυνατότατα να αρνηθείτε την συμμετοχή σας, καθώς επίσης και να αποχωρήσετε από αυτή οποιαδήποτε στιγμή το επιθυμείτε.

Διάβασα το έντυπο αυτό και κατανοώ τις διαδικασίες που θα εκτελέσω. Συναινώ να συμμετέχω στην έρευνα.

Ημερομηνία: …../……/……

Ονοματεπώνυμο και υπογραφή συμμετέχοντος

Υπογραφή ερευνητή

Ηλίας Ντούμας

Ονοματεπώνυμο και υπογραφή παρατηρητή

Appendix 4: Consent Form

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ ΚΑΙ ΑΘΛΗΤΙΣΜΟΥ

Υπεύθυνη δήλωση Συναίνεσης Δοκιμαζόμενου σε Ερευνητική Εργασία

Σκοπός της ερευνητικής εργασίας: Σκοπός της έρευνας είναι να αξιολογήσουμε το αντίκτυπο μιας συνεδρίας μάλαξης χαλάρωσης σε όλο το σώμα σε πτυχές που σχετίζονται με την ποιότητα και την ποσότητα του ύπνου σε ασθενείς που πάσχουν από χρόνια αϋπνία και αν μπορεί αυτό το είδος μάλαξης να επιδράσει θετικά στην αντιμετώπιση της χρόνια αϋπνίας και της ποιότητας ύπνου.

Διαδικασία μετρήσεων: Θα χρειαστεί να πραγματοποιηθεί μία συνάντηση, όπου θα συμπληρώσετε ένα ατομικό ιστορικό, και εφόσον πληροίτε τις προϋποθέσεις, μπορείτε να συμμετέχετε στην έρευνα. Συνολικά θα συμμετάσχετε σε 3 συνεδρίες: Στην 1η επίσκεψη δεν θα λάβετε κάποια μορφή μάλαξης. Θα συμπληρώσετε μια σειρά ερωτηματολογίων και στη συνέχεια θα γίνει μια ολονύχτια καταγραφή ύπνου μέσω φορητής συσκευής καταγραφής ύπνου [Home Sleep Test (HST)]. Στην 2η επίσκεψη θα εφαρμοστεί μια συνεδρία 40 λεπτών μάλαξης χαλάρωσης ακριβώς πριν πέσετε να κοιμηθείτε και στη συνέχεια θα σας τοποθετήσουμε την συσκευή HST για ολονύχτια καταγραφή ύπνου. Στην 3η επίσκεψη θα εφαρμοστεί ξανά μια συνεδρία 40 λεπτών μάλαξης χαλάρωσης ακριβώς πριν πέσετε να κοιμηθείτε και στη συνέχεια θα σας τοποθετήσουμε την συσκευή HST για ολονύχτια καταγραφή ύπνου.

Πιθανοί κίνδυνοι: Δεν υπάρχει κίνδυνος τραυματισμού κατά τη διάρκεια των δοκιμασιών.

Προσδοκώμενες ωφέλειες: Από τα αποτελέσματα της παρούσας έρευνας θα προκύψουν τυχόν θετικές επιδράσεις και βελτιώσεις που μπορεί να προκαλέσει η τεχνική της μάλαξης χαλάρωσης στους ανθρώπους που πάσχουν από χρόνιο πρόβλημα αϋπνίας.

Δημοσίευση δεδομένων-αποτελεσμάτων: Οι πληροφορίες που θα συλλέξουμε από τις απαντήσεις σας με το ατομικό ιστορικό υγείας είναι κωδικοποιημένες και θα μείνουν απόρρητες. Η συμμετοχή σας στην έρευνα συνεπάγεται ότι συμφωνείτε με τη δημοσίευση των δεδομένων και των αποτελεσμάτων της, με την προϋπόθεση ότι θα είναι ανώνυμα και θα χρησιμοποιηθούν μόνο για τις ανάγκες της παρούσας έρευνας.

Πληροφορίες: Σε όλη τη διάρκεια της έρευνας οι ερευνητές (Δρ. Γεώργιος Σακκάς και Ηλίας Ντούμας) θα είναι στη διάθεση των δοκιμαζομένων για να προσφέρουν οποιουδήποτε είδους πληροφορία είτε αυτή αφορά την έρευνα είτε τη συμπλήρωση των ερωτηματολογίων.

Ελευθερία συναίνεσης: Η συμμετοχή σας στη παρούσα έρευνα είναι εθελοντική και έχετε την δυνατότατα να αρνηθείτε την συμμετοχή σας, καθώς επίσης και να αποχωρήσετε από αυτή οποιαδήποτε στιγμή το επιθυμείτε.

Διάβασα το έντυπο αυτό και κατανοώ τις διαδικασίες που θα εκτελέσω. Συναινώ να συμμετέχω στην έρευνα.

Ημερομηνία: …../……/……

Appendix 5: Consent Form

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ ΚΑΙ ΑΘΛΗΤΙΣΜΟΥ

Υπεύθυνη δήλωση Συναίνεσης Δοκιμαζόμενου σε Ερευνητική Εργασία

Σκοπός της ερευνητικής εργασίας: Σκοπός της έρευνας είναι να εξετάσουμε εάν ένα μασάζ στο σπίτι πριν τον ύπνο με χρήση των καρεκλών μασάζ νέας γενιάς μπορεί να συμβάλει θετικά στη θεραπεία της αϋπνίας.

Διαδικασία μετρήσεων: Θα χρειαστεί να πραγματοποιηθεί μία συνάντηση, όπου θα συμπληρώσετε ένα ατομικό ιστορικό, και εφόσον πληροίτε τις προϋποθέσεις, μπορείτε να συμμετέχετε στην έρευνα. Επίσης, θα συμπληρώσετε μια σειρά ερωτηματολογίων. Συνολικά θα συμμετάσχετε στην μελέτη για 3 μήνες. Τον πρώτο μήνα θα χρησιμοποιείτε σε καθημερινή βάση και ιδιαίτερα πριν το ύπνο την καρέκλα μάλαξης ενώ στον δεύτερο μήνα θα παρακολουθήσουμε την ποιότητα του ύπνου σας χωρίς την χρήση της καρέκλας. Επίσης, κατά τη διάρκεια αυτών των 3 μηνών θα σας γίνουν 5 ολονύχτιες καταγραφές ύπνου με τη χρήση ειδικής φορητής συσκευής-Home Sleep Test (HST). Στην 1η μέρα, στην 7η και τη τελευταία μέρα του μήνα χρήσης καρέκλας μασάζ, καθώς και την 7 και τελευταία μέρα του μήνα χωρίς την χρήση της καρέκλας.

Πιθανοί κίνδυνοι: Δεν υπάρχει κίνδυνος τραυματισμού κατά τη διάρκεια των δοκιμασιών.

Προσδοκώμενες ωφέλειες: Από τα αποτελέσματα της παρούσας έρευνας θα προκύψουν τυχόν θετικές επιδράσεις και βελτιώσεις που μπορεί να προκαλέσει η καρέκλα μασάζ (νέας γενιάς) στους ανθρώπους που πάσχουν από χρόνιο πρόβλημα αϋπνίας.

Δημοσίευση δεδομένων-αποτελεσμάτων: Οι πληροφορίες που θα συλλέξουμε από τις απαντήσεις σας με το ατομικό ιστορικό υγείας είναι κωδικοποιημένες και θα μείνουν απόρρητες. Η συμμετοχή σας στην έρευνα συνεπάγεται ότι συμφωνείτε με τη δημοσίευση των δεδομένων και των αποτελεσμάτων της, με την προϋπόθεση ότι θα είναι ανώνυμα και θα χρησιμοποιηθούν μόνο για τις ανάγκες της παρούσας έρευνας.

Πληροφορίες: Σε όλη τη διάρκεια της έρευνας οι ερευνητές (Δρ. Γεώργιος Σακκάς και Ηλίας Ντούμας) θα είναι στη διάθεση σας να προσφέρουν οποιουδήποτε είδους πληροφορία είτε αυτή αφορά την έρευνα είτε τη συμπλήρωση των ερωτηματολογίων.

Ελευθερία συναίνεσης: Η συμμετοχή σας στη παρούσα έρευνα είναι εθελοντική και έχετε την δυνατότατα να αρνηθείτε την συμμετοχή σας, καθώς επίσης και να αποχωρήσετε από αυτή οποιαδήποτε στιγμή το επιθυμείτε.

Διάβασα το έντυπο αυτό και κατανοώ τις διαδικασίες που θα εκτελέσω. Συναινώ να συμμετέχω στην έρευνα.

Ημερομηνία: …../……/……

Ονοματεπώνυμο και υπογραφή συμμετέχοντος

Υπογραφή ερευνητή

Ηλίας Ντούμας

Ονοματεπώνυμο και υπογραφή παρατηρητή

Appendix 6: General Health Questionnaire

ATHENS INSOMNIA SCALE

Αυτή η κλίμακα έχει σκοπό να καταγράψει την δική σας εκτίμηση σχετικά με τις δυσκολίες που μπορεί να αντιμετωπίσατε στον ύπνο. Παρακαλώ, επιλέξτε (κυκλώνοντας τον κατάλληλο αριθμό) τα ερωτήματα που δηλώνουν σύμφωνα με την εκτίμηση σας τον βαθμό δυσκολίας, με την προϋπόθεση ότι συνέβησαν τουλάχιστον τρεις φορές την εβδομάδα κατά τη διάρκεια του περασμένου μήνα.

1. ΕΝΑΡΞΗ ΥΠΝΟΥ *(χρόνος που χρειάζεστε για να αποκοιμηθείτε μετά από το σβήσιμο των φώτων)*

0	**1**	**2**	**3**
Κανένα πρόβλημα	Μικρή καθυστέρηση	Σημαντική καθυστέρηση	Μεγάλη καθυστέρηση η δεν κοιμηθήκατε καθόλου

2. ΞΥΠΝΗΜΑΤΑ ΜΕΣΑ ΣΤΗ ΝΥΧΤΑ

0	**1**	**2**	**3**
Κανένα πρόβλημα	Μικρό πρόβλημα	Σημαντικό πρόβλημα	Σοβαρό πρόβλημα η δεν κοιμηθήκατε καθόλου

3. ΤΕΛΙΚΗ ΑΦΥΠΝΙΣΗ ΝΩΡΙΤΕΡΑ ΑΠΟ ΤΗΝ ΕΠΙΘΥΜΗΤΗ

0	**1**	**2**	**3**
Όχι νωρίτερα	Λίγο νωρίτερα	Σημαντικά νωρίτερα	Πολύ νωρίτερα η δεν κοιμηθήκατε καθόλου

4. ΣΥΝΟΛΙΚΗ ΔΙΑΡΚΕΙΑ ΥΠΝΟΥ

0	**1**	**2**	**3**
Επαρκής	Ελαφρά ανεπαρκής	Σημαντικά ανεπαρκής	Πολύ ανεπαρκής η δεν κοιμηθήκατε καθόλου

5. ΣΥΝΟΛΙΚΗ ΠΟΙΟΤΗΤΑ ΥΠΝΟΥ *(ανεξάρτητα από τη διάρκεια του ύπνου)*

0	**1**	**2**	**3**
Ικανοποιητική	Ελαφρά Μη ικανοποιητική	Σημαντικά Μη ικανοποιητική	πολύ μη ικανοποιητική η δεν κοιμηθήκατε καθόλου

6. ΑΙΣΘΗΣΗ ΕΥΕΞΙΑΣ ΚΑΤΑ ΤΗ ΔΙΑΡΚΕΙΑ ΤΗΣ ΗΜΕΡΑΣ

0	**1**	**2**	**3**
Φυσιολογική	Ελαφρά μειωμένη	Σημαντικά μειωμένη	Πολύ μειωμένη

7. ΛΕΙΤΟΥΡΓΙΚΟΤΗΤΑ(ΣΩΜΑΤΙΚΗ ΚΑΙ ΝΟΗΤΙΚΗ)ΣΤΗ ΔΙΑΡΚΕΙΑ ΤΗΣ ΜΕΡΑΣ

0	**1**	**2**	**3**
Φυσιολογική	Ελαφρά μειωμένη	Σημαντικά μειωμένη	Πολύ μειωμένη

8. ΥΠΝΗΛΙΑ ΣΤΗ ΔΙΑΡΚΕΙΑ ΤΗΣ ΗΜΕΡΑΣ

0	**1**	**2**	**3**
Καθόλου	Ήπια	Αρκετή	Έντονη

Δείκτης Ποιότητας Ύπνου του Pittsburgh (ΔΠΥ)

Οδηγίες: Οι ακόλουθες ερωτήσεις σχετίζονται με τις συνήθειες ύπνου τις οποίες είχατε κατά τη διάρκεια μόνον του περασμένου μήνα. Οι απαντήσεις σας θα πρέπει να είναι ακριβείς για την πλειοψηφία των ημερών και νυχτών του περασμένου μήνα. Παρακαλώ, απαντήστε σε όλες τις ερωτήσεις.

Κατά τη διάρκεια του περασμένου μήνα,

1. Πότε συνήθως πηγαίνατε για ύπνο; _____
2. Πόση ώρα (σε λεπτά) σας έπαιρνε για να κοιμηθείτε, κάθε βράδυ; _____
3. Συνήθως το πρωί τι ώρα ξυπνούσατε; _____
4. Πόσες ώρες κοιμόσασταν πραγματικά κατά τη διάρκεια της νύχτας; (Μη περιλαμβανομένων των ωρών που βρισκόσασταν, άυπνοι στο κρεβάτι; _____

5. Κατά τη διάρκεια του περασμένου μήνα, πόσο συχνά αντιμετωπίσατε προβλήματα ύπνου διότι	Όχι κατά τη διάρκεια του περασμένου μήνα (0)	Λιγότερο από 1 φορά την εβδομάδα (1)	Μία ή δύο φορές την εβδομάδα (2)	Τρεις ή περισσότερες φορές την εβδομάδα (3)
α. δεν μπορούσατε να κοιμηθείτε μέσα σε 30 λεπτά;				
β. ξυπνούσατε κατά τα μεσάνυχτα ή πολύ νωρίς το πρωί;				
γ. έπρεπε να σηκωθείτε για τουαλέτα;				
δ. δεν μπορούσατε να αναπνεύσετε ικανοποιητικά;				
ε. είχατε βήχα ή ροχαλίζατε δυνατά;				
στ. κρυώνατε υπερβολικά;				
ζ. ζεσταινόσασταν υπερβολικά;				
η. βλέπατε άσχημα όνειρα;				
θ. πονούσατε;				
ι. ..... άλλες αιτίες. Παρακαλώ περιγράψτε τις αναφέροντας και πόσο συχνά είχατε δυσκολία στον ύπνο λόγω αυτών των αιτιών:				
6. Κατά τη διάρκεια του περασμένου μήνα πόσο συχνά παίρνατε υπνογόνα φάρμακα;				
7. Κατά τη διάρκεια του περασμένου μήνα πόσο συχνά αντιμετωπίσατε πρόβλημα να μείνετε ξύπνιος/α όταν οδηγούσατε, τρώγατε ή σε κάποια κοινωνική δραστηριότητα;				

Appendix 7: Beck's Depression Inventory

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΚΑΤΑΘΛΙΨΗΣ (Α)

Όνομα..... Ημ/νία.....

Παρακαλούμε να βάλετε μόνο έναν κύκλο μπροστά στην απάντηση που εκφράζει καλύτερα πως αισθάνεστε. Σημειώστε μία απάντηση από κάθε ενότητα.

Α. 0. Δεν αισθάνομαι λυπημένος
1. Αισθάνομαι λυπημένος ή μελαγχολικός
2α. Είμαι λυπημένος ή μελαγχολικός συνεχώς και δεν μπορώ να απαλλαγώ από αυτό.
2β. Είμαι τόσο μελαγχολικός ή δυστυχισμένος ώστε αυτό μου προξενεί πόνο.
3. Είμαι τόσο μελαγχολικός ή δυστυχισμένος ώστε δεν μπορώ να το αντέξω.

Β. 0. Δεν είμαι ιδιαίτερα απαισιόδοξος ή αποθαρρημένος για το μέλλον.
1. Αισθάνομαι χωρίς θάρρος για το μέλλον.
2α. Μου φαίνεται ότι δεν έχω τίποτα καλό να περιμένω από το μέλλον
2β. Μου φαίνεται ότι δεν θα ξεπεράσω τις δυσκολίες μου.
3. Μου φαίνεται ότι το μέλλον είναι χωρίς ελπίδα και ότι τα πράγματα δεν μπορεί να φτιάξουν.

Γ. 0. Δεν αισθάνομαι αποτυχημένος.
1. Μου φαίνεται ότι είμαι αποτυχημένος περισσότερο από τους άλλους ανθρώπους
2α. Αισθάνομαι ότι έχω πετύχει στη ζωή μου πολύ λίγα πράγματα άξια λόγου.
2β. Καθώς σκέφτομαι τη ζωή μου μέχρι τώρα το μόνο που βλέπω είναι πολλές αποτυχίες
3. Αισθάνομαι ότι είμαι τελείως αποτυχημένος σαν άτομο (σύζυγος - πατέρας).

Δ. 0. Δεν αισθάνομαι ιδιαίτερα δυσαρεστημένος
1α. Αισθάνομαι βαριεστημένος σχεδόν όλη την ώρα.
1β. Δεν απολαμβάνω τα πράγματα όπως πρώτα.

2. Δεν με ευχαριστεί πια τίποτα.

3. Αισθάνομαι δυσαρεστημένος με το κάθε τι

Ε. 0. Δεν αισθάνομαι ιδιαίτερα ένοχο τον εαυτό μου.

1. Πολλές φορές αισθάνομαι κακός ή χωρίς αξία.

2α. Αισθάνομαι πολύ ένοχος.

2β. Τον τελευταίο καιρό αισθάνομαι κακός ή χωρίς αξία σχεδόν όλη την ώρα.

3. Αισθάνομαι ότι είμαι πολύ κακός ή ανάξιος

Ζ. 0. Δεν αισθάνομαι ότι τιμωρούμαι.

1. Αισθάνομαι ότι κάτι κακό μπορεί να μου συμβεί.

2. Αισθάνομαι ότι τιμωρούμαι ή ότι θα τιμωρηθώ.

3α. Αισθάνομαι ότι μου αξίζει να τιμωρηθώ.

3β. Θέλω να τιμωρηθώ

Παράρτημα ΙΙ

Η. 0. Δεν αισθάνομαι απογοητευμένος από τον εαυτό μου

1α. Αισθάνομαι απογοητευμένος από τον εαυτό μου.

1β. Δεν μου αρέσει ο εαυτός μου.

2. Σιχαίνομαι τον εαυτό μου.

3. Μισώ τον εαυτό μου.

Θ. 0. Δεν αισθάνομαι ότι είμαι χειρότερος από τους άλλους.

1. Είμαι αυστηρός με τον εαυτό μου για τις αδυναμίες μου.

2α. Κατηγορώ τον εαυτό μου για τα λάθη μου.

2β. Κατηγορώ τον εαυτό μου για κάθε κακό που συμβαίνει.

Ι. 0. Δεν μου έρχονται σκέψεις να κάνω κακό στον εαυτό μου.

1. Μου έρχονται σκέψεις να κάνω κακό στον εαυτό μου αλλά ποτέ δεν θα έκανα κάτι τέτοιο.

2α. Μου φαίνεται ότι θα ήταν καλύτερα να πέθαινα.

2β. Μου φαίνεται ότι η οικογένειά μου θα ήταν καλύτερα αν πέθαινα.

2γ. Έχω συγκεκριμένα σχέδια αυτοκτονίας.

3. Θα αυτοκτονούσα αν μπορούσα.

Κ. 0. Δεν κλαίω περισσότερο από το συνηθισμένο.
1. Κλαίω τώρα περισσότερο από ότι συνήθως.
2. Κλαίω συνεχώς, δεν μπορώ να το σταματήσω
3. Άλλοτε μπορούσα να κλάψω, αλλά τώρα μου είναι αδύνατο να κλάψω αν το θέλω.

Λ. 0. Δεν είμαι περισσότερο εκνευρισμένος από ότι συνήθως.
1. Ενοχλούμαι ή εκνευρίζομαι περισσότερο από ότι συνήθως.
2. Αισθάνομαι διαρκώς εκνευρισμένος
3. Δεν εκνευρίζομαι τώρα για πράγματα που με νευρίαζαν συνήθως.

Μ. 0. Δεν έχω χάσει το ενδιαφέρον μου για άλλους ανθρώπους.
1. Ενδιαφέρομαι τώρα λιγότερο για τους άλλους ανθρώπους από ότι παλιότερα.
2. Έχω χάσει το περισσότερο ενδιαφέρον μου για τους άλλους ανθρώπους και τα αισθήματά μου για αυτούς έχουν λιγοστέψει.
3. Έχω χάσει όλο το ενδιαφέρον μου για τους άλλους ανθρώπους και δεν νοιάζομαι καθόλου γι' αυτούς.

Ν. 0. Είμαι το ίδιο αποφασιστικός όπως πάντα.
1. Τελευταία αναβάλλω το να παίρνω αποφάσεις.
2. Έχω μεγάλη δυσκολία στο να παίρνω αποφάσεις.
3. Δεν μπορώ να πάρω καμιά απόφαση.

Ξ. 0. Δεν μου φαίνεται ότι η εμφάνισή μου είναι χειρότερη από άλλοτε.
1. Ανησυχώ μήπως μοιάζω γερασμένος και αντιπαθητικός
2. Αισθάνομαι ότι έγινε τέτοια αλλαγή επάνω μου, ώστε να φαίνομαι αντιπαθητικός
3. Μου φαίνεται ότι είμαι άσχημος και αποκρουστικός

Ο. 0. Τα καταφέρνω στη δουλειά μου όπως και πρώτα.
1α. Χρειάζεται να κάνω ιδιαίτερη προσπάθεια για να αρχίσω κάποια δουλειά.
1β. Δεν τα καταφέρνω στη δουλειά μου όπως πρώτα.

2. Χρειάζεται να πιέσω πολύ τον εαυτό μου για να κάνω κάτι.
3. Μου είναι αδύνατο να εργαστώ.

Π. 0. Κοιμάμαι τόσο καλά όσο συνήθως.
1. Ξυπνώ το πρωί πιο κουρασμένος από άλλοτε.
2. Ξυπνώ το πρωί 2 - 3 ώρες νωρίτερα από άλλοτε και δυσκολεύομαι να ξανακοιμηθώ.
3. Ξυπνώ νωρίς κάθε μέρα και δεν μπορώ να κοιμηθώ πάνω από 5 ώρες το 24ωρο.

Ρ. 0. Δεν κουράζομαι ευκολότερα από ότι συνήθως.
1. Κουράζομαι τώρα ευκολότερα από πρώτα.
2. Κουράζομαι με το παραμικρό που κάνω.
3. Κουράζομαι τόσο εύκολα ώστε δεν μπορώ να κάνω τίποτε.

Σ. 0. Η όρεξή μου δεν είναι χειρότερη από άλλοτε.
1. Η όρεξή μου δεν είναι τόσο καλή όσο άλλοτε.
2. Η όρεξή μου είναι πολύ χειρότερη τώρα.
3. Δεν έχω πια καθόλου όρεξη.

Τ. 0. Δεν έχω χάσει σχεδόν καθόλου βάρος τον τελευταίο καιρό.
1. Έχω χάσει περισσότερο από 2 κιλά.
2. Έχω χάσει περισσότερο από 4 κιλά.
3. Έχω χάσει περισσότερο από 7 κιλά.

Υ. 0. Δεν με απασχολεί η υγεία μου περισσότερο από άλλοτε.
1. Με απασχολούν πόνοι ή βαρυστομαχιά ή δυσκοιλιότητα.
2. Με απασχολεί τόσο πολύ το πως αισθάνομαι ή το τί αισθάνομαι ώστε μου είναι δύσκολο να σκεφτώ τίποτε άλλο.
3. Είμαι εντελώς απορροφημένος με το τι αισθάνομαι.

Φ. 0. Δεν έχω προσέξει τελευταία καμιά αλλαγή στο ενδιαφέρον μου για το σεξ (για τις γυναίκες).
1. Ενδιαφέρομαι τώρα λιγότερο για το σεξ (για τις γυναίκες) από ότι συνήθως.

2. Ενδιαφέρομαι πολύ λιγότερο τώρα για το σεξ (για τις γυναίκες)

3. Έχω χάσει τελείως το ενδιαφέρον μου για το σεξ (για τις γυναίκες)

Clasification	Total Score	Level of Depression
Low	1-10	These ups and downs are considered normal
	11-16	Mild mood disturbance
Moderate	17-20	Borderline clinical depression
	21-30	Moderate depression
Significant	31-40	Severe depression
	Over 40	Extreme depression

A persistent score of 17 or above indicates you may need professional treatment.

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΚΑΤΑΘΛΙΨΗΣ (Γ)

Όνομα..... Ημ/νία.....

Παρακαλούμε να βάλετε μόνο έναν κύκλο μπροστά στην απάντηση που εκφράζει καλύτερα πως αισθάνεστε. Σημειώστε μία απάντηση από κάθε ενότητα.

Α. 0. Δεν αισθάνομαι λυπημένη.

1. Αισθάνομαι λυπημένη ή μελαγχολική.

2α. Είμαι λυπημένη ή μελαγχολική συνεχώς και δεν μπορώ να απαλλαγώ από αυτό.

2β. Είμαι τόσο μελαγχολική ή δυστυχισμένη ώστε αυτό μου προξενεί πόνο.

3. Είμαι τόσο μελαγχολική ή δυστυχισμένη ώστε δεν μπορώ να το αντέξω.

C. 0. Δεν είμαι ιδιαίτερα απαισιόδοξη ή αποθαρρυμένη για το μέλλον.

1. Αισθάνομαι χωρίς θάρρος για το μέλλον.

2α. Μου φαίνεται ότι δεν έχω τίποτα καλό να περιμένω από το μέλλον

2β. Μου φαίνεται ότι δεν θα ξεπεράσω τις δυσκολίες μου.

3. Μου φαίνεται ότι το μέλλον είναι χωρίς ελπίδα και ότι τα πράγματα
δεν μπορεί να φτιάξουν.

Γ. 0. Δεν αισθάνομαι αποτυχημένη.
1. Μου φαίνεται ότι είμαι αποτυχημένη περισσότερο από τους άλλους ανθρώπους
2α. Αισθάνομαι ότι έχω πετύχει στη ζωή μου πολύ λίγα πράγματα άξια λόγου.
2β. Καθώς σκέφτομαι τη ζωή μου μέχρι τώρα το μόνο που βλέπω είναι
πολλές αποτυχίες
3. Αισθάνομαι ότι είμαι τελείως αποτυχημένο σαν άτομο (σύζυγος - μητέρα).

Δ. 0. Δεν αισθάνομαι ιδιαίτερα δυσαρεστημένη.
1α. Αισθάνομαι βαριεστημένη σχεδόν όλη την ώρα.
1β. Δεν απολαμβάνω τα πράγματα όπως πρώτα.
2. Δεν με ευχαριστεί πια τίποτα.
3. Αισθάνομαι δυσαρεστημένη με το κάθε τι

Ε. 0. Δεν αισθάνομαι ιδιαίτερα ένοχο τον εαυτό μου.
1. Πολλές φορές αισθάνομαι κακή ή χωρίς αξία.
2α. Αισθάνομαι πολύ ένοχη.
2β. Τον τελευταίο καιρό αισθάνομαι κακή ή χωρίς αξία σχεδόν όλη την ώρα.
3. Αισθάνομαι ότι είμαι πολύ κακή ή ανάξια.

Ζ. 0. Δεν αισθάνομαι ότι τιμωρούμαι.
1. Αισθάνομαι ότι κάτι κακό μπορεί να μου συμβεί.
2. Αισθάνομαι ότι τιμωρούμαι ή ότι θα τιμωρηθώ.
3α. Αισθάνομαι ότι μου αξίζει να τιμωρηθώ.
3β. Θέλω να τιμωρηθώ

Η. 0. Δεν αισθάνομαι απογοητευμένη από τον εαυτό μου
1α. Αισθάνομαι απογοητευμένη από τον εαυτό μου.
1β. Δεν μου αρέσει ο εαυτός μου.
2. Σιχαίνομαι τον εαυτό μου.
3. Μισώ τον εαυτό μου.

Θ. 0. Δεν αισθάνομαι ότι είμαι χειρότερη από τους άλλους.
1. Είμαι αυστηρή με τον εαυτό μου για τις αδυναμίες μου.
2α. Κατηγορώ τον εαυτό μου για τα λάθη μου.
2β. Κατηγορώ τον εαυτό μου για κάθε κακό που συμβαίνει.

Ι. 0. Δεν μου έρχονται σκέψεις να κάνω κακό στον εαυτό μου.
1. Μου έρχονται σκέψεις να κάνω κακό στον εαυτό μου αλλά ποτέ
δεν θα έκανα κάτι τέτοιο.
2α. Μου φαίνεται ότι θα ήταν καλύτερα να πέθαινα.
2β. Μου φαίνεται ότι η οικογένειά μου θα ήταν καλύτερα αν πέθαινα.
2γ. Έχω συγκεκριμένα σχέδια αυτοκτονίας.
3. Θα αυτοκτονούσα αν μπορούσα.

Κ. 0. Δεν κλαίω περισσότερο από το συνηθισμένο.
1. Κλαίω τώρα περισσότερο από ότι συνήθως.
2. Κλαίω συνεχώς δεν μπορώ να το σταματήσω
3. Άλλοτε μπορούσα να κλάψω, αλλά τωρα μου είναι αδύνατο
να κλάψω αν το θέλω.

Λ. 0. Δεν είμαι περισσότερο εκνευρισμένη από ότι συνήθως.
1. Ενοχλούμαι ή εκνευρίζομαι περισσότερο από ότι συνήθως.
2. Αισθάνομαι διαρκώς εκνευρισμένη.
3. Δεν εκνευρίζομαι τώρα για πράγματα που με νευρίαζαν συνήθως.

Μ. 0. Δεν έχω χάσει το ενδιαφέρον μου για άλλους ανθρώπους.
1. Ενδιαφέρομαι τώρα λιγότερο για τους άλλους ανθρώπους από ότι παλιότερα.
2. Έχω χάσει το περισσότερο ενδιαφέρον μου για τους άλλους ανθρώπους
και τα αισθήματά μου για αυτούς έχουν λιγοστέψει.
3. Έχω χάσει όλο το ενδιαφέρον μου για τους άλλους ανθρώπους και
δεν νοιάζομαι καθόλου για αυτούς.

Ν. 0. Είμαι το ίδιο αποφασιστική όπως πάντα.
1. Τελευταία αναβάλλω το να παίρνω αποφάσεις.

2. Έχω μεγάλη δυσκολία στο να παίρνω αποφάσεις.
3. Δεν μπορώ να πάρω καμιά απόφαση.

Ξ. 0. Δεν μου φαίνεται ότι η εμφάνισή μου είναι χειρότερη από άλλοτε.
1. Ανησυχώ μήπως μοιάζω γερασμένη και αντιπαθητική.
2. Αισθάνομαι ότι έγινε τέτοια αλλαγή επάνω μου, ώστε
να φαίνομαι αντιπαθητική.
3. Μου φαίνεται ότι είμαι άσχημη και αποκρουστική.

Ο. 0. Τα καταφέρνω στη δουλειά μου όπως και πρώτα.
1α. Χρειάζεται να κάνω ιδιαίτερη προσπάθεια για να αρχίσω κάποια δουλειά.
1β. Δεν τα καταφέρνω στη δουλειά μου όπως πρώτα.
2. Χρειάζεται να πιέσω πολύ τον εαυτό μου για να κάνω κάτι.
3. Μου είναι αδύνατο να εργαστώ.

Π. 0. Κοιμάμαι τόσο καλά όσο συνήθως.
1. Ξυπνώ το πρωί πιο κουρασμένη από άλλοτε.
2. Ξυπνώ το πρωί 2 - 3 ώρες νωρίτερα από άλλοτε και δυσκολεύομαι
να ξανακοιμηθώ.
3. Ξυπνώ νωρίς κάθε μέρα και δεν μπορώ να κοιμηθώ πάνω από 5 ώρες
το 24ωρο.

Ρ. 0. Δεν κουράζομαι ευκολότερα από ότι συνήθως.
1. Κουράζομαι τώρα ευκολότερα από πρώτα.
2. Κουράζομαι με το παραμικρό που κάνω.
3. Κουράζομαι τόσο εύκολα ώστε δεν μπορώ να κάνω τίποτε.

Σ. 0. Η όρεξή μου δεν είναι χειρότερη από άλλοτε.
1. Η όρεξή μου δεν είναι τόσο καλή όσο άλλοτε.
2. Η όρεξή μου είναι πολύ χειρότερη τώρα.
3. Δεν έχω πια καθόλου όρεξη.

Τ. 0. Δεν έχω χάσει σχεδόν καθόλου βάρος τον τελευταίο καιρό.
1. Έχω χάσει περισσότερο από 2 κιλά.

2. Έχω χάσει περισσότερο από 4 κιλά.

3. Έχω χάσει περισσότερο από 7 κιλά.

Υ. 0. Δεν με απασχολεί η υγεία μου περισσότερο από άλλοτε.

1. Με απασχολούν πόνοι ή βαρυστομαχιά ή δυσκοιλιότητα.

2. Με απασχολεί τόσο πολύ το πως αισθάνομαι ή το τί αισθάνομαι
ώστε μου είναι δύσκολο να σκεφτώ τίποτε άλλο.

3. Είμαι εντελώς απορροφημένη με το τι αισθάνομαι.

Φ. 0. Δεν έχω προσέξει τελευταία καμιά αλλαγή στο ενδιαφέρον μου
για το σεξ (για τους άνδρες).

1. Ενδιαφέρομαι τώρα λιγότερο για το σεξ (για τους άνδρες) από ότι συνήθως.

2. Ενδιαφέρομαι πολύ λιγότερο τώρα για το σεξ (για τους άνδρες).

3. Έχω χάσει τελείως το ενδιαφέρον μου για το σεξ (για τους άνδρες).

Appendix 8: Relaxation State Questionnaire

Relaxation State Questionnaire (RSQ) – Ερωτηματολόγιο Αίσθηση Χαλάρωσης

Όνομα _____ Ημερομηνία _____

Ηλικία _____ Φύλο (κυκλώστε): Α Θ Άλλο _____

Παρακάτω υπάρχουν φράσεις που οι άνθρωποι συνηθίζουν να χρησιμοποιούν για να περιγράψουν την κατάσταση που αισθάνονται. Διαβάστε κάθε φράση και μετά σημειώστε το αντίστοιχο κουτί για την φράση που σας εκφράζει για να δείξετε πως αισθάνεστε **τώρα**, δηλαδή αυτή τη στιγμή. Δεν υπάρχουν σωστές ή λανθασμένες απαντήσεις. Μην ξοδεύετε πολύ ώρα για κάθε μία φράση αλλά δώστε την απάντηση που φαίνεται να ταιριάζει πιο καλά σε αυτό που αισθάνεστε **τώρα**.

Ερωτήσεις	Διαφωνώ Απόλυτα	Διαφωνώ	Ούτε Συμφωνώ ούτε Διαφωνώ	Συμφωνώ	Συμφωνώ Απόλυτα
1. Νιώθω ότι αναπνέω γρηγορότερα από ότι συνήθως (Α)					
2. Η καρδιά μου χτυπά πιο γρήγορα από ότι συνήθως (Α)					
3. Αισθάνομαι τους μύες μου σφικτούς και σε ένταση (σφιγμένες γροθιές ή τάση στην γνάθο ή συνοφρυωμένο μέτωπο) (Α)					
4. Αισθάνομαι τους μύες μου ανακουφισμένους					
5. Αισθάνομαι τους μύες μου χαλαρούς					
6. Αισθάνομαι πολύ χαλαρά					
7. Αυτή την στιγμή νιώθω εντελώς ήρεμος/η					
8. Νιώθω υπνηλία και κούραση.					
9. Είμαι έτοιμος/η να κοιμηθώ.					
10. Νιώθω αναζωογονημένος/η και ξύπνιος/α (Α)					

Ευχαριστούμε πολύ για τον χρόνο σας

Βαθμολόγηση Ερωτηματολογίου

Ερωτήσεις	Διαφωνώ Απόλυτα	Διαφωνώ	Ούτε Συμφωνώ ούτε Διαφωνώ	Συμφωνώ	Συμφωνώ Απόλυτα
1. Νιώθω ότι αναπνέω γρηγορότερα από ότι συνήθως (A)	5	4	3	2	1
2. Η καρδιά μου χτυπά πιο γρήγορα από ότι συνήθως (A)	5	4	3	2	1
3. Αισθάνομαι τους μύες μου σφικτούς και σε ένταση (σφιγμένη γροθιά ή τάση στην γνάθο ή συνοφρυωμένος) (A)	5	4	3	2	1
4. Αισθάνομαι τους μύες μου ανακουφισμένους	1	2	3	4	5
5. Αισθάνομαι τους μύες μου χαλαρούς	1	2	3	4	5
6. Αισθάνομαι πολύ χαλαρά	1	2	3	4	5
7. Αυτή την στιγμή νιώθω εντελώς ήρεμος/η	1	2	3	4	5
8. Νιώθω υπνηλία και κούραση.	1	2	3	4	5
9. Είμαι έτοιμος/η να κοιμηθώ.	1	2	3	4	5
10. Νιώθω αναζωογονημένος/η και ξύπνιος/α (A)	5	4	3	2	1

- Muscle Score (Items 3, 4, and 5)
- Cardiovascular Score (Items 1 & 2)
- Generell Relaxation Score (Items 6 & 7)
- Sleepiness Score (Items 8, 9, and 10)

Higher means are equal to more relaxed muscles and more relaxation. For the sleepiness score, higher scores mean more sleepiness.

Appendix 9: 36-Item Short Form Survey (SF-36)

SF-36 ΕΡΕΥΝΑ ΥΓΕΙΑΣ

ΗΜΕΡΟΜΗΝΙΑ _____ **ΚΩΔΙΚΟΣ** _____

ΟΔΗΓΙΕΣ: Το ερωτηματολόγιο αυτό ζητά τις δικές σας απόψεις για την υγεία σας. Οι πληροφορίες σας θα μας βοηθήσουν να εξακριβώσουμε πώς αισθάνεστε από πλευράς υγείας και πόσο καλά μπορείτε να ασχοληθείτε με τις συνηθισμένες δραστηριότητές σας. Απαντήστε στις ερωτήσεις, βαθμολογώντας κάθε απάντηση με τον τρόπο που σας δείχνουμε. Αν δεν είστε απόλυτα βέβαιος/βέβαιη για την απάντησή σας, παρακαλούμε να δώσετε την απάντηση που νομίζετε ότι ταιριάζει καλύτερα στην περίπτωσή σας.

1. Γενικά, θα λέγατε ότι η υγεία σας είναι:

(βάλτε έναν κύκλο)

Εξαιρετική 1
Πολύ καλή 2
Καλή 3
Μέτρια 4
Κακή 5

2. Σε σύγκριση με ένα χρόνο πριν, πώς θα αξιολογούσατε την υγεία σας τώρα;

(βάλτε έναν κύκλο)

Πολύ καλύτερη τώρα απ' ότι ένα χρόνο πριν 1
Κάπως καλύτερη τώρα απ' ότι ένα χρόνο πριν 2
Περίπου η ίδια όπως ένα χρόνο πριν 3
Κάπως χειρότερη τώρα απ' ότι ένα χρόνο πριν 4
Πολύ χειρότερη τώρα απ' ότι ένα χρόνο πριν 5

3. Οι παρακάτω προτάσεις περιέχουν δραστηριότητες που πιθανώς να κάνετε κατά τη διάρκεια μιας συνηθισμένης ημέρας. Η τωρινή κατάσταση της υγείας σας, σας περιορίζει σε αυτές τις δραστηριότητες; Εάν ναι, πόσο;

(κυκλώστε έναν αριθμό σε κάθε σειρά)

ΔΡΑΣΤΗΡΙΟΤΗΤΕΣ	**Ναι, με περιορίζει Πολύ**	**Ναι, με περιορίζει Λίγο**	**Οχι, δεν με περιορίζει Καθόλου**
α. **Σε κουραστικές δραστηριότητες**, όπως το τρέξιμο, το σήκωμα βαριών αντικειμένων, η συμμετοχή σε δυναμικά σπόρ	1	2	3
β. **Σε μέτριας έντασης δραστηριότητες,** όπως η μετακίνηση ενός τραπεζιού, το σπρώξιμο μιας ηλεκτρικής σκούπας, ο περίπατος στην εξοχή ή όταν παίζετε ρακέτες στην παραλία	1	2	3
γ. Οταν σηκώνετε ή μεταφέρετε ψώνια από την αγορά	1	2	3
δ. Οταν ανεβαίνετε **μερικές** σκάλες	1	2	3
ε. Οταν ανεβαίνετε **μία** σκάλα	1	2	3
στ. Στο λύγισμα του σώματος, στο γονάτισμα ή στο σκύψιμο	1	2	3

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ζ. Οταν περπατάτε περίπου **ένα χιλιόμετρο**	1	2	3
η. Οταν περπατάτε **μερικές εκατοντάδες μέτρα**	1	2	3
θ. Οταν περπατάτε περίπου **εκατό μέτρα**	1	2	3
ι. Οταν κάνετε μπάνιο ή όταν ντύνεστε	1	2	3

1. Τις τελευταίες 4 εβδομάδες, σας παρουσιάστηκαν - είτε στη δουλειά σας είτε σε κάποια άλλη συνηθισμένη καθημερινή σας δραστηριότητα - κάποια από τα παρακάτω προβλήματα, εξαιτίας της κατάστασης της σωματικής σας υγείας;

(κυκλώστε έναν αριθμό σε κάθε σειρά)

	ΝΑΙ	**ΟΧΙ**
α. Μειώσατε **το χρόνο** που συνήθως ξοδεύετε στη δουλειά ή σε άλλες δραστηριότητες	1	2
β. **Επιτελέσατε λιγότερα** από όσα θα θέλατε	1	2
γ. Περιορίσατε **τα είδη** της δουλειάς ή τα είδη άλλων δραστηριοτήτων σας	1	2
δ. **Δυσκολευτήκατε** να εκτελέσετε τη δουλειά ή άλλες δραστηριότητές σας (για παράδειγμα, καταβάλατε μεγαλύτερη προσπάθεια)	1	2

1. Τις τελευταίες 4 εβδομάδες, σας παρουσιάστηκαν - είτε στη δουλειά σας είτε σε κάποια άλλη συνηθισμένη καθημερινή δραστηριότητα - κάποια από τα παρακάτω προβλήματα εξαιτίας οποιουδήποτε συναισθηματικού προβλήματος (λ.χ., επειδή νιώσατε μελαγχολία ή άγχος);

(κυκλώστε έναν αριθμό σε κάθε σειρά)

	ΝΑΙ	**ΟΧΙ**
α. Μειώσατε **το χρόνο** που συνήθως ξοδεύετε στη δουλειά ή σε άλλες δραστηριότητες	1	2
β. **Επιτελέσατε λιγότερα** από όσα θα θέλατε	1	2
γ. Κάνατε τη δουλειά σας ή και άλλες δραστηριότητες λιγότερο προσεκτικά απ' ότι συνήθως	1	2

2. Τις τελευταίες 4 εβδομάδες, σε ποιο βαθμό επηρέασε η κατάσταση της σωματικής σας υγείας ή κάποια συναισθηματικά προβλήματα τις συνηθισμένες κοινωνικές σας δραστηριότητες με την οικογένεια, τους φίλους, τους γείτονές σας ή με άλλες κοινωνικές ομάδες;

(βάλτε έναν κύκλο)

Καθόλου 1
Ελάχιστα 2
Μέτρια 3
Αρκετά 4
Πάρα πολύ 5

3. Πόσο σωματικό πόνο νιώσατε τις τελευταίες 4 εβδομάδες;

(βάλτε έναν κύκλο)

Καθόλου 1
Πολύ ήπιο 2
Ηπιο 3
Μέτριο 4
Εντονο 5
Πολύ έντονο 6

8. Τις τελευταίες 4 εβδομάδες, πόσο επηρέασε ο πόνος τη συνηθισμένη εργασία σας (τόσο την εργασία έξω από το σπίτι όσο και μέσα σε αυτό);

(βάλτε έναν κύκλο)

Καθόλου 1
Λίγο 2
Μέτρια 3
Αρκετά 4
Πάρα πολύ 5

9. Οι παρακάτω ερωτήσεις αναφέρονται στο πώς αισθανόσαστε και στο πώς ήταν γενικά η διάθεσή σας τις τελευταίες 4 εβδομάδες. Για κάθε ερώτηση, παρακαλείστε να δώσετε εκείνη την απάντηση που πλησιάζει περισσότερο σε ό,τι αισθανθήκατε. Τις τελευταίες 4 εβδομάδες, για πόσο χρονικό διάστημα -

(κυκλώστε ένα αριθμό σε κάθε σειρά)

	Συνεχώς	Το μεγαλύτερο διάστημα	Σημαντικό διάστημα	Μερικές φορές	Μικρό διάστημα	Καθόλου
α. Αισθανόσαστε γεμάτος/γεμάτη ζωντάνια;	1	2	3	4	5	6
β. Είχατε πολύ εκνευρισμό;	1	2	3	4	5	6
γ. Αισθανόσαστε τόσο πολύ πεσμένος/πεσμένη ψυχολογικά, που τίποτε δεν μπορούσε να σας φτιάξει το κέφι;	1	2	3	4	5	6
δ. Αισθανόσαστε ηρεμία και γαλήνη;	1	2	3	4	5	6
ε. Είχατε πολλή ενεργήτικότητα;	1	2	3	4	5	6
στ. Αισθανόσαστε απελπισία και μελαγχολία;	1	2	3	4	5	6
ζ. Αισθανόσαστε εξάντληση;	1	2	3	4	5	6
η. Ησαστε ευτυχισμένος/ ευτυχισμένη;	1	2	3	4	5	6

8. Τις τελευταίες 4 εβδομάδες, για πόσο χρονικό διάστημα επηρέασαν τις κοινωνικές σας δραστηριότητες (π.χ. επισκέψεις σε φίλους, συγγενείς, κλπ.) η κατάσταση της σωματικής σας υγείας ή κάποια συναισθηματικά προβλήματα;

(βάλτε έναν κύκλο)

Συνεχώς.....1
Το μεγαλύτερο διάστημα.....2

Μερικές φορές.....3
Μικρό διάστημα.....4
Καθόλου.....5

9. Πόσο ΑΛΗΘΙΝΕΣ ή ΨΕΥΔΕΙΣ είναι οι παρακάτω προτάσεις στη δική σας περίπτωση;

(κυκλώστε ένα αριθμό σε κάθε σειρά)

	Εντελώς Αλήθεια	**Μάλλον Αλήθεια**	**Δεν ξέρω**	**Μάλλον Ψέμα**	**Εντελώς Ψέμα**
α. Μου φαίνεται ότι αρρωσταίνω λίγο ευκολότερα από άλλους ανθρώπους	1	2	3	4	5
β. Είμαι τόσο υγιής όσο όλοι οι γνωστοί μου	1	2	3	4	5
γ. Περιμένω ότι η υγεία μου θα χειροτερεύσει	1	2	3	4	5
δ. Η υγεία μου είναι εξαιρετική	1	2	3	4	5

Appendix 10: Perceived Stress Scale (PSS-10)

Κλίμακα αντίληψης του άγχους

Οι ερωτήσεις σε αυτή την κλίμακα σας ρωτούν για τα συναισθήματα και τις σκέψεις σας **κατά τη διάρκεια του τελευταίου μήνα**. Σε κάθε περίπτωση, θα σας ζητηθεί να υποδείξτε κυκλώνοντας *πόσο συχνά* αισθανθήκατε ή σκεφτήκατε κατά έναν ορισμένο τρόπο.

Όνομα _____Ημερομηνία _____

Ηλικία _____Φύλο (κυκλώστε): **Α Θ** Άλλο _____

0 = ποτέ 1 = σχεδόν ποτέ 2 = μερικές φορές 3 = αρκετά συχνά 4 = πολύ συχνά

1.	Τον τελευταίο μήνα πόσο συχνά αναστατωθήκατε για κάτι που συνέβη απροσδόκητα;.....	**0**	**1**	**2**	**3**	**4**
2.	Τον τελευταίο μήνα πόσο συχνά αισθανθήκατε ότι δεν ήσασταν σε θέση να ελέγξετε τα σημαντικά πράγματα στη ζωή σας;.....	**0**	**1**	**2**	**3**	**4**
3.	Τον τελευταίο μήνα πόσο συχνά νιώσατε νευρικός και αγχωμένος;.....	**0**	**1**	**2**	**3**	**4**
4.	Τον τελευταίο μήνα πόσο συχνά νιώσατε πεπεισμένος για την ικανότητά σας να διαχειριστείτε τα προσωπικά σας προβλήματα;...	**0**	**1**	**2**	**3**	**4**
5.	Τον τελευταίο μήνα πόσο συχνά αισθανθήκατε ότι τα πράγματα πήγαιναν όπως εσείς θέλατε;.....	**0**	**1**	**2**	**3**	**4**
6.	Τον τελευταίο μήνα πόσο συχνά διαπιστώσατε ότι δεν μπορέσατε να αντεπεξέλθετε σε όλα τα πράγματα που είχατε να κάνετε;.....	**0**	**1**	**2**	**3**	**4**
7.	Τον τελευταίο μήνα πόσο συχνά μπορέσατε να ελέγχετε τον εκνευρισμό σας;.....	**0**	**1**	**2**	**3**	**4**
8.	Τον τελευταίο μήνα πόσο συχνά νιώσατε ότι είχατε τον έλεγχο των πραγμάτων;.....	**0**	**1**	**2**	**3**	**4**
9.	Τον τελευταίο μήνα πόσο συχνά έχετε οργιστεί για πράγματα που ήταν πέρα από τον έλεγχό σας;.....	**0**	**1**	**2**	**3**	**4**
10.	Τον τελευταίο μήνα πόσο συχνά νιώσατε ότι δυσκολίες συσσωρεύτηκαν σε τέτοιο σημείο, ώστε να μην μπορείτε να τις ξεπεράσετε;.....	**0**	**1**	**2**	**3**	**4**

Appendix 11: Published paper related to the Study 1

Dear Ilias Ntoumas, Prof. Karatzaferi, Dr. Christoforos Giannaki, Vasileios Nousios, Konstantina Siarava, Aliki Mpakatselou, Fotini Papanikolaou, Aggelos Pappas, Charalampos Krommidas, Efthimios Dardiotis, Eleftherios Lavdas, Prof. Sakkas:¶

We have reached a decision regarding your submission to International Journal of Therapeutic Massage & Bodywork Research Education & Practice, "The Effect of Timing of Sports Massage on 60-m Sprint¶
Performance in Competitive Athletes: Post-warm
up sports massage". We are pleased to accept
your article for publication in the IJTMB.¶
The author guidelines provide the information you need to prepare your final
version for copyediting. The relevant section is "Copyediting" near the end of the
Author Guidelines at¶
http://www.ijtmb.org/index.php/ijtmb/about/submissions.¶

Please note that while a final read-through of the article is requested at his point, substantial changes should not be made. If any further changes in data, meaning, or conclusions are desired, please contact your Editor immediately.¶

I will continue to assist you as needed during the
copyediting process. Best regards,¶

International Journal of Therapeutic Massage & Bodywork: Research, Education &
Practice www.ijtmb.org¶

Appendix 12: Published paper related to the Study 2

---------- Forwarded message ---------
From: **BMC Complementary Medicine and Therapies** <anitha.nivas@springernature.com>
Date: Wed, May 28, 2025 at 4:50 PM
Subject: BMC Complementary Medicine and Therapies: Decision on your manuscript
To: <gsakkas@uth.gr>

Ref: Submission ID 32f811c4-1751-49d9-a933-3d5e1c5c9554

Dear Dr Sakkas,

Your manuscript, "Massage Positively Contributes to Daytime Napping and Alters Brain Activity by Reducing Arousal State in Poor Sleepers: A randomized control trial", has now been assessed and I am pleased to inform you that your manuscript is potentially acceptable for publication. However, before we can proceed with acceptance please address the remaining points below:

---
1. Please ensure the statement in the 'Data Availability' section on the submission system matches the 'Availability of Data and Materials' in your manuscript.

This should be: "original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author."

2. Research conducted on humans and/or human data, or material must be in compliance with the Helsinki Declaration (https://www.wma.net/policies-post/wma-declaration-of-helsinki/). Please include a statement clarifying whether your study adhered to the Declaration of Helsinki to this effect in the 'Ethics approval and consent to participate' section of the Declarations.

We recommend submitting all revisions within 14 days of the corresponding author receiving a revision request email.

If you need more time, please contact us and include your submission ID.

Kind regards,

Sarah Gray
Editor
BMC Complementary Medicine and Therapies

Appendix 13: Published paper related to the Study 3

healthcare

MDPI

Article

The Impact of Relaxation Massage Prior to Bedtime on Sleep Quality and Quantity in People with Symptoms of Chronic Insomnia: A Home-Based Sleep Study

Ilias Ntoumas [1], Christina Karatzaferi [1], Christoforos D. Giannaki [2,3], Fotini Papanikolaou [1], Aggelos Pappas [1], Efthimios Dardiotis [4] and Giorgos K. Sakkas [1,*]

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[3] Research Centre for Exercise and Nutrition (RECEN), 2417 Nicosia, Cyprus
[4] Department of Neurology, School of Medicine, University of Thessaly, 41110 Larisa, Greece; edar@med.uth.gr
* Correspondence: gsakkas@uth.gr

Abstract: Background/Objectives: Manual massage is an effective treatment approach for reducing general stress and promoting an overall sense of well-being. Relaxation massage aims to alleviate psychophysiological tension, enhance both blood and lymphatic circulation, and promote mental and physical relaxation. It is particularly beneficial for those with anxiety-related symptoms (such as generalized anxiety disorder and social anxiety) and sleep disorders, aiming to improve calmness and promote sleepiness. **Aims:** The purpose of the present study was to assess the effectiveness of a single session of relaxation massage prior to bedtime on sleep quality and quantity indices in individuals with symptoms of chronic insomnia. **Methods**: In total, 20 (N = 20) healthy individuals (aged 25.5 ± 12.0 years; 6F/14M) with a score on the Athens Insomnia Scale of ≥16 participated under three different conditions over one week apart: (1) a 45 min relaxation massage condition (REL), (2) a 45 min sham massage condition (PLA), and (3) a control condition with no massage. Sleep activity was monitored using a portable polysomnographic system. **Results**: A statistically significant effect was observed between sleep efficiency across the three sessions ($p = 0.034$), with a notable effect in the relaxation massage (REL) session ($p = 0.045$). Additionally, sustained sleep efficiency showed a statistically significant difference among the sessions ($p = 0.005$). **Conclusions**: Relaxation massage prior to bedtime could be used as an effective and safe non-pharmacological approach for improving sleep efficiency and potentially restoring the fragmented sleep of individuals with symptoms of insomnia. Trial registration number: The trial was registered at clinicaltrials.gov as NCT06781866.

Keywords: sleep; well-being; health; EEG; efficiency; sleepiness; lifestyle

check for updates

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1. Introduction

Sleep is a naturally occurring state for both the mind and body, marked by changes in consciousness, decreased sensory responsiveness, lowered muscle activity, and the suppression of almost all voluntary muscles [1]. There is no fixed amount of hours of sleep per night; however, it is recommended that for a healthy adult, the minimum hours of uninterrupted sleep should be approximately 6–8 h [2]. In modern Western societies, sleep

Appendix 14: The manual of the mechanical massage equipment used in Study 4 and Study 5.

Appendix 15: Copyright Statement

Υπεύθυνη Δήλωση

Η κάτωθι υπογεγραμμένη Name μεταπτυχιακή/ος φοιτήτρια φοιτητής του Προγράμματος Μεταπτυχιακών Σπουδών <<Άσκηση ΚΑΙ ΥΓΕΙΑ>> του Τμήματος Επιστήμης Φυσικής Αγωγής και Αθλητισμού του Πανεπιστημίου Θεσσαλίας

Δηλώνω υπεύθυνα ότι αποδέχομαι τους παρακάτω που αφορούν

α. Στα πνευματικά δικαιώματα της Διδακτορικής Διπλωματικής Εργασίας μου με τίτλο <<"Η επίδραση της αλλαγής του τρόπου ζωής σε παράγοντες που σχετίζονται με την κόπωση, την ποιότητα ζωής, την υγεία και την ημερήσια υπνηλία>>

β. Στη διαχείριση των ερευνητικών δεδομένων που θα συλλέξω στην πορεία εκπόνησης της:

1. Τα πνευματικά δικαιώματα του τόμου της διδακτορικής διατριβής που θα προκύψει θα ανήκουν σε μένα. Θα ακολουθήσω τις οδηγίες συγγραφής, εκτύπωσης και κατάθεσης αντίτυπων της διατριβής στα ανάλογα αποθετήρια (σε έντυπη ή/και σε ηλεκτρονική μορφή).
2. Η διαχείριση των δεδομένων της διατριβής ανήκει από κοινού σε εμένα και στον/στην πρώτο επιβλέποντα-ουσα καθηγητή – τριας.
3. Οποιαδήποτε επιστημονική δημοσίευση ή ανακοίνωση (αναρτημένη ή προφορική), ή αναφορά που προέρχεται από το υλικό/δεδομένα της εργασίας αυτής θα γίνεται με συγγράφεις εμένα τον ίδιο, τον/την κύριο-α επιβλέποντα – ουσα ή και άλλους ερευνητές (όπως πχ μέλους -ων της τριμελούς συμβουλευτικής επιτροπής), ανάλογα με τη συμβολή τους στην έρευνα ή στη συγγραφή των ερευνητικών εργασιών.
4. Η σειρά των ονομάτων στις επιστημονικές δημοσιεύσεις ή επιστημονικές ανακοινώσεις θα αποφασίζεται από κοινού από εμένα και τον/την κύριο -α επιβλέποντα – ουσα της εργασίας, πριν αρχίσει η εκπόνησή της. Η απόφαση αυτή θα πιστοποιηθεί εγγράφως μεταξύ εμού και του/της κ. επιβλέποτνα -ουσας.

Τέλος, δηλώνω ότι γνωρίζω τους κανόνες περί λογοκλοπής και πνευματικής ιδιοκτησίας και ότι θα τους τηρώ απαρέγκλιτα καθ' όλη τη διάρκεια της φοίτησης και κάλυψης των εκπαιδευτικών υποχρεώσεων που προκύπτουν από το

ΠΜΣ/τμήμα, αλλά και των διαδικασιών δημοσίευσης που θα προκύψουν μετά την ολοκλήρωση των σπουδών μου.

Ημερομηνία

Ο δηλών: Ηλίας Ντούμας