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EXERCISE & HEALTH

THE EFFECT OF MUSCLE FATIGUE IN NEUROMUSCULAR ACTIVITY DURING SLEEP

by

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Περίληψη

Εισαγωγή: Η συστηματική άσκηση επιδρά ευεργετικά στην υγεία των ασθενών που πάσχουν από κάποιο χρόνιο νόσημα. Οι ασθενείς με νευρολογικές διαταραχές όπως το Σύνδρομο Ανήσυχων Ποδιών (ΣΑΠ) και το Σύνδρομο Περιοδικών Κινήσεων των Άκρων (ΣΠΚΑ) παραπονούνται συχνά ότι τα συμπτώματα της νόσου επαυξάνονται ύστερα από έντονη σωματική δραστηριότητα ή ύστερα από μια σωματικά κουραστική ημέρα.

Σκοπός: Σκοπός της παρούσας έρευνας ήταν να εξεταστεί αν η ασκησιογενής μυϊκή κόπωση θα μπορούσε να επηρεάσει την νευρομυϊκή δραστηριότητα κατά τη διάρκεια του ύπνου (ανησυχία) σε υγιείς εθελοντές.

Μεθοδολογία: 21 υγιείς ενήλικες (N=21, 12Α/9Γ, 24±3,7 ετών), συμμετείχαν σε ένα τρίωρο πρόγραμμα άσκησης μικρής έντασης και μεγάλης διάρκειας (περπάτημα με ταχύτητα 5km/h, 0% κλίση). Η πτώση της δύναμης ως αποτέλεσμα του πρωτοκόλλου άσκησης εκτιμήθηκε μέσω της μέτρησης της μέγιστης ισομετρικής ροπής (Cybex), πριν και μετά από το πρωτόκολλο άσκησης καθώς και την πέμπτη ημέρα των μετρήσεων (ημέρα 5). Η νευρομυϊκή δραστηριότητα κατά την διάρκεια του ύπνου καταγράφηκε μέσω ακτιγραφίας ύπνου (Somnowatch) ένα βράδυ πριν το πρωτόκολλο άσκησης καθώς και τα τρία ακόλουθα βράδια. Πραγματοποιήθηκε επίσης αιμοληψία πριν το πρωτόκολλο άσκησης καθώς και την πέμπτη ημέρα των μετρήσεων ώστε να πραγματοποιηθεί ένας βιοχημικός έλεγχος των συμμετεχόντων καθώς επίσης και να αποκλειστεί η πιθανότητα μυϊκής βλάβης. Τέλος, οι δοκιμαζόμενοι συμπλήρωσαν τα παρακάτω ερωτηματολόγια για την αξιολόγηση της: γενικής υγείας, ποιότητας ύπνου-Pittsburgh (ημέρα 1), ποιότητας ζωής-SF36, εβδομαδιαίας ποιότητας ύπνου, κλίμακας υπνηλίας-Epworth, κλίμακας κόπωσης (ημέρα 1 και ημέρα 5). Οι συμμετέχοντες, συμπλήρωναν επίσης ημερολόγιο ύπνου, διαγνωστικά κριτήρια ΣΑΠ και ερωτηματολόγιο πόνου McGill (καθημερινά, 5 φορές).

Αποτελέσματα: Παρόλο που το σκορ του μυϊκού πόνου κορυφώθηκε το βράδυ μετά το πρωτόκολλο άσκησης ($p<0,05$), επιστρέφοντας στο αρχικό σκορ την πέμπτη ημέρα των μετρήσεων, δεν παρατηρήθηκαν στατιστικά σημαντικές διαφορές πριν και μετά το πρωτόκολλο σε κανέναν από τους υπόλοιπους εξεταζόμενους παράγοντες, ούτε και στην νευρομυϊκή δραστηριότητα κατά την διάρκεια του ύπνου.

Συμπεράσματα: Μαρτυρίες ασθενών με ανησυχία κατά τη διάρκεια του ύπνου, όπως ασθενών με ΣΑΠ, υποστηρίζουν ότι η ασκησιογενής μυική κόπωση θα μπορούσε να επηρεάσει την νευρομυϊκή δραστηριότητα κατά τη διάρκεια του ύπνου και αυτό θα μπορούσε να οδηγήσει σε πρόσθετη ανησυχία και διαταραχές ύπνου. Τα αποτελέσματά μας έδειξαν πως ένα τρίωρο πρωτόκολλο ήπιας άσκησης, δεν επηρέασε σημαντικά την ποιότητα ύπνου ούτε επαύξησε την νευρομυϊκή δραστηριότητα. Αυτό είναι θετικό εφόσον όπως φαίνεται οι ασθενείς με νευρολογικές διαταραχές όπως το ΣΑΠ μπορούν αν το επιθυμούν να συμμετέχουν σε προγράμματα άσκησης χωρίς να χειροτερεύουν τα συμπτώματά τους. Μελλοντική έρευνα πρέπει να αξιολογήσει αν τα αποτελέσματά μας ισχύουν εξίσου σε ασθενείς που υποφέρουν από ανησυχία κατά την διάρκεια του ύπνου, καθώς και σε υγιή άτομα που πάσχουν από διαταραχές ύπνου λόγω εργασίας σε βάρδιες.

Abstract

Exercise is beneficial for many chronic diseases. Patients with movement disorders like Restless Leg Syndrome (RLS) and Periodic Leg Movement Syndrome (PLMS) complain of restlessness during sleep especially after intense exercise or “a very long day”.

Aim: The purpose of the study was to examine whether exercise-induced muscle fatigue could affect neuromuscular activity during sleep (restlessness) in healthy volunteers with no sleep or movement disorders.

Methods: 21 healthy adults (N=21), participated in a 3–hour mild intensity exercise protocol (walking at 5 km/hr, 0% inclination). Maximal isometric torque (Cybex) was assessed before and after the exercise protocol and at the fifth day of measurements (day 5). Neuromuscular activity during sleep was recorded by an actigraphy system (Somnowatch), the night before the exercise protocol and for the three following nights. Blood samples taken at baseline and at day 5, were subsequently analyzed for standard biochemical indices. Participants completed the following questionnaires for assessing: general health, sleep quality-Pittsburgh (at baseline), quality of life-SF36, 7-day sleep quality, Epworth’s Sleepiness Scale, Fatigue Severity scale (at baseline and at day 5) and daily sleep diary, RLS diagnostic criteria and McGill pain (every day, i.e. 5 times).

Results: Even though the score of muscle pain peaked the night after the exercise protocol ($p<0.05$), returning to baseline values on the last day, no statistical differences were found before and after the exercise protocol in any of the other examined parameters, nor in the neuromuscular activity during sleep.

Conclusion: It has been reported from patients with restlessness during sleep like RLS patients, that exercise-induced muscle fatigue could affect neuromuscular activity during sleep and this could lead to added restlessness and disturbed sleep. Our results showed that a

3-hour bout of mild intensity exercise, did not significantly affect sleep quality. This is promising if patients with neurological symptoms such as RLS wish to engage in exercise programme without worsening their symptoms. Future research should evaluate whether our findings are applicable to clinical population who suffer from restlessness during sleep, and to healthy individuals with shift-work sleep disorders.

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List of abbreviations

ALB: Albumin

BMI: Body Mass Index

CHO: Cholesterol

CPK: Creatine Phosphokinase

Cr: Creatinine

CRP: C - reactive protein

EPP: Extremities Pattern Pain questionnaire

ESS: Epworth Sleepiness Scale

Fe: Iron

FER: Ferritin

Fit: 3 or more days per week of physical activity

HDL: High Density Lipoprotein

LDL: Low Density Lipoprotein

HR: Heart Rate

LE: maximum left extension

LF: maximum left flexion

QoL: Quality of Life

PLMS: Periodic Leg Movement

RE: maximum right extension

RF: maximum right flexion

RLS: Restless Legs Syndrome

TG: Triglycerides

Introduction

Exercise is beneficial on many aspects of health including cardiovascular system, musculoskeletal system, mental health and sleep quality. In addition, exercise can be used as a mean of prevention or treatment of many chronic diseases such as cardiovascular diseases, musculoskeletal diseases, diabetes mellitus, depression, movement and sleep disorders such as Restless Leg Syndrome (RLS) and Periodic Leg Movements Syndrome (PLMS)(Esteves, de Mello, Pradella-Hallinan, & Tufik, 2009; Giannaki et al., 2010; *Office of the U.S. Surgeon General: Physical, Activity, and Health: A report of the Surgeon General, US.* , 1996).

Sleep disorders and poor sleep quality affect many people all over the world (Parish, 2009). The severity of sleep disorders vary from patient to patient and very often depends on the daily life functioning, the level of comorbidity and on their fitness status (Mota & Vale, 2010).

It is well known that poor sleep quality is related to other conditions like heart disease and diabetes (Hoevenaar-Blom, Spijkerman, Kromhout, van den Berg, & Verschuren, 2011) as well as various mental disorders (Salo et al., 2010). In addition, poor sleep quality may cause daytime fatigue (Goldman et al., 2008) and sleepiness which also could lead to car and other type of accidents (Smolensky, Di Milia, Ohayon, & Philip, 2011). Poor sleep quality is highly related to mental problems (Manocchia, Keller, & Ware, 2001) and low levels of quality of life (Krishnan et al., 2008).

There have been many studies examining the effect of exercise training in sleep quality and it has been observed that acute or chronic exercise could induce significant improvements in sleep quality (Chen, Liu, Huang, & Chiou, 2012; Kline et al., 2011). Even though exercise has been shown to effectively reduce the RLS and PLMS symptoms in patients (Esteves, et al., 2009; Giannaki, et al., 2010), many patients complain for increased restlessness during sleep after intense muscle work or a very long day and they use this as an excuse to avoid any exercise activity. So far there are no studies investigating the effect of intense muscle work or "a very long day" in sleep quality and particularly in neuromuscular activity during sleep.

Thus, the aim of the current study was to examine the effect of an exercise-induced fatigue protocol in the neuromuscular activity during sleep (restlessness) in healthy adults before we could proceed further into a patient's population.

Aims – Significance

According to patient anecdotal reports, "physical fatigue and intense muscle work make the neuromuscular activity during sleep harder and worsen the sleep affecting thus their quality and quantity of sleep". Using this as an excuse, patients "are afraid" to participate in any exercise training program and therefore they don't receive any of the numerous benefits of exercise. To the best of our knowledge, there are no studies examined whether "a very long day" could indeed increase restlessness during sleep and worsen the sleep quality in healthy volunteers.

The Aim of the study was to examine whether exercise-induced fatigue, can affect neuromuscular activity during sleep in healthy individuals.

Literature Review

Exercise Training and Endurance

Benefits of Exercise training in health

It is well known that exercise training may affect positively physical and mental health in humans of all ages and both genders. Exercise may be beneficial for many clinical situations, chronic diseases and for several problems related with sedentary life style of the modern society. Specifically, exercise is significantly beneficial for weight control, for musculoskeletal health, for the regulation of triglycerides, of cholesterol and of LDL cholesterol and therefore is beneficial for several diseases like hypertension, cardiovascular disease, diabetes mellitus, osteoporosis and sarcopenia (*Office of the U.S. Surgeon General: Physical, Activity, and Health: A report of the Surgeon General, US.* , 1996). In addition, exercise causes significant improvements in mental health not only in healthy people but in clinical population too (Siddiqui, Nessa, & Hossain, 2010; Warburton, Nicol, & Bredin, 2006). Furthermore, exercise improves health status of patients with medical complex illnesses like Parkinson’s disease and End Stage Renal Disease treated with hemodialysis who suffer from multiple physical, neurological and mental problems (Goldberg et al., 1983; Smith, Kennedy, Smith, Orent, & Fleshner, 2006). Although all the types of exercise (aerobic, resistance or combination) cause improvements in health, the type of exercise or the combination of exercise types is an important factor which affects the health improvements accordingly on the clinical situation and the needs of each individual.

Aerobic

Aerobic exercise training is considered as any activity which activates large muscle groups continuously and rhythmically (e.g. walking, cycling). This type of exercise causes improvements mainly in cardiovascular health and in metabolic regulation. Particularly, causes beneficial alterations in systolic blood pressure, in resting Heart Rate, in triglyceride levels, in HDL cholesterol, in total cholesterol, in body fat and in body weight. As a result, aerobic training is beneficial not only for the prevention of metabolic and heart diseases in healthy people but also for the treatment of metabolic and heart diseases and for other complex diseases that metabolic and heart problems are presented like End stage renal disease and obesity (Braun, 1991).

According to ACSM prescription about quality and quantity of exercise ("American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults," 1998) the duration of an aerobic exercise training program should be 20-60 minutes in order to be efficient. The intensity of training should be at 55%-90% of individual’s maximum Heart Rate (HRmax) while 55%-64% of HRmax is suggested as the appropriate intensity for unfit individuals. However, exercise training is still efficient with shorter durations when intensity is decreased or conversely.

Resistance

Resistance exercise is considered as any voluntary activation of muscles against a weight or resistance (e.g. body weight, dumbbells, and elastic bands). This type of exercise training causes improvements in musculoskeletal system, and therefore improves musculoskeletal functioning, prevents osteoporosis, sarcopenia and other problems associated with musculoskeletal problems. Additionally, resistance training induces the resting metabolic rate and improves lipidic profile included the regulation of insulin sensitivity and glucose metabolism, body fat and blood pressure (Winett & Carpinelli, 2001).

According to ACSM prescription ("American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults," 1998), a resistance exercise program should be progressive and should activate major muscle groups. A set of 8-12 repetitions for each exercise is required in order to be efficient a training program. A set of 8-10 repetitions for each exercise is enough for the maintenance of muscle strength and more sets or more repetitions could be done for greater benefits. The frequency of the training sessions should be about 2-3 days per week. Lastly, resistance exercise should be accompanied by flexibility exercises in order to maintain or improve range of motion (ROM).

Aerobic-resistance combination

In the last years there have been many studies which examine the influence of combined aerobic-resistance exercise training programs in several factors of health and in chronic diseases and it seems that this type of training causes greater improvements in health. For example, Sanal et al. (Sanal, Ardic, & Kirac, 2012) who examined the influence of an aerobic training program compared to a combined aerobic-resistance program in body composition of obese and overweight participants, observed that the combined program caused greater reduction of body fat and greater increase of free fat free mass after 12 weeks of combined training compared to aerobic training. These findings were consistent with the study of Brennan et al. who also observed that a combined aerobic-resistance training caused greater benefits in body composition, in strength and in cardiovascular fitness compared to the aerobic training (Brennan, 2012).

What is Fatigue?

Terminology

Fatigue is the inability to maintain the expected force (Edwards, 1981). Muscle fatigue is usually observed after an exercise session but is also presented in clinical population as secondary fatigue mainly because people with chronic diseases adopt a sedentary life style which leads to the reduction of muscle mass and thus in the reduction of muscle strength and the increase of fatigue (Rimmer, Schiller, & Chen, 2012).

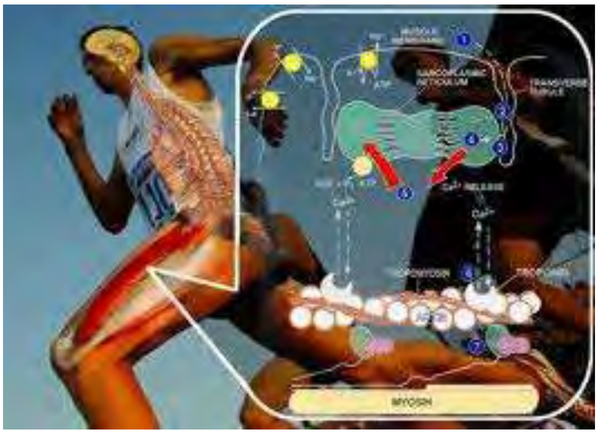
Causes of Fatigue

In one third of people who declare that they feel fatigued there is no etiology. Cancer, anemia, lung disease, chronic obstructive pulmonary disease, chronic renal failure, chronic heart failure, HIV, multiple sclerosis, aging, sarcopenia, medications, depression and chronic fatigue syndrome are the most common clinical situations that are accompanied by fatigue (Evans & Lambert, 2007; Rosenthal, Majeroni, Pretorius, & Malik, 2008). It must be noticed here that chronic fatigue syndrome is most severe compared to chronic fatigue. Additionally the half patients suffered of chronic fatigue syndrome believe that their illness caused by their psychological status (Darbishire, Ridsdale, & Seed, 2003). It has been also supposed that in healthy people, the main cause of fatigue is the sedentary life style and inactivity which lead to reduced muscle mass and strength and thus to fatigue. Individuals who withdraw from their daily physical activities due to injuries also feel fatigued and depressed (Berlin, Kop, & Deuster, 2006).

The causes of fatigue in clinical population vary from disease to disease. For example in multiple sclerosis the cause of fatigue is probably that most of patients can't activate their muscles up to 60% of the expected activation (Rice, Vollmer, & Bigland-Ritchie, 1992) and their reduced muscle fiber size which has reported to be 26% smaller compared to healthy people (Kent-Braun et al., 1997). Thus, muscle strength of these patients is limited and they experience fatigue.

In addition, an exhausting exercise training program is also able to cause fatigue. The appearance and progress of muscle fatigue induced by exercise depends on the type of muscle fibers that are used during exercise, the intensity of exercise and the duration of exercise (Vander, 2001).

Picture 1. Muscle Fatigue (alssymptoms.net)



The cause of fatigue induced by long term and mild intensity exercise (cycle periods of muscle contraction and relaxation) is not yet well known but lactic acid may be the main cause probably because of muscle oxidation (caused of the release of lactic acid in blood). Muscle oxidation, affects the 3D muscle structure and as a result the muscle is not able to be as active as it was before the activity. In addition, the reduction of ATP during a long term and low intensity exercise, leads to muscle glycogen use. Thus, muscle cannot be as strong as it was before the exercise. This kind of fatigue (low frequency fatigue) may be recovered after 24 hours of rest (via protein-synthesis) but depends on the accurate intensity and duration of the activity (Vander, 2001).

In short duration and high intensity exercise, ATP-Pcr energy system (Pcr provides the phosphate for the phosphorylation of ADP to ATP) is the main energy source. In muscle fatigue caused by this kind of exercise, a significant reduction of PCr (Phosphocreatine) is observed (Wilmore, 2006). The reduction of PCr could mean a loss of ATP that could cause serious problems in muscle relaxation while without ATP, actin filaments cannot be detached from the myosin cross bridges (Koopman et al., 2003).

However, ATP isn't reduced as fast as Pcr due to its production from other sources after depletion of Pcr. Thus, ATP reduction cannot be considered as a cause of fatigue but (this reduction of ATP) may cause a prolongation in muscle relaxation of a fatigued muscle compared to a non-fatigued muscle. Thus, while the reduction of Pcr and ATP after a short duration and high intensity muscle cannot be considered as the causes of fatigue, the increase of Pi (inorganic phosphate) due to the splitting of Pcr has been considered as a possible cause of fatigue after short duration and high intensity exercise (Wilmore, 2006) while it is well known that when the concentration of Pi is high, the force is reduced (Westerblad, Lee, Lannergren, & Allen, 1991).

Means of reducing fatigue

Exercise

Several studies have examined the effect of exercise as a non pharmacological treatment of fatigue. Fatigue may be reduced after exercise training due to the increase of muscle size, to the alterations of muscle fibers type, to the changes of muscle activation and to the development of muscle pH regulation (Bogdanis, 2012). In addition, exercise may cause improvements not only to physical health but in mental health (Penedo & Dahn, 2005) which is also an important factor related with fatigue (Williamson et al., 2005).

Puetz et al. (Puetz, Flowers, & O'Connor, 2008) examined the impact of a 6 week aerobic training program in fatigue and energy feelings. In this study, the participants were sedentary healthy adults and they only had feelings of fatigue. After the end of the intervention program there was observed a reduction of fatigue feeling mainly by low intensity aerobic exercise compared to moderate intensity exercise.

In clinical population suffered from secondary fatigue, exercise training programs are very helpful for ameliorating fatigue. Schwartz et al. examined the impact of a low intensity and short duration home-based aerobic exercise program in women with breast cancer receiving chemotherapy and they observed a significant reduction in fatigue. However the reduction of fatigue was more when the duration of the program was increased. Additionally, the reduction of fatigue was maintained only for the day of exercise session (Schwartz, Mori, Gao, Nail, & King, 2001). Furthermore, the study of Weert et al. (van Weert et al., 2006) examined the effect of a complex intervention program in cancer patients with different diagnosis. The intervention program consisted of 15 sessions of combined aerobic and strengthening exercise training, 17 sessions of physical activity (sports), 9 sessions of psycho education and 10 sessions of information about the illness. The results of this study showed a significant decline of fatigue.

Hemodialysis patients are another group of patients who suffer from muscle weakness and fatigue. Exercise programs may improve muscle structure and functional capacity and especially during hemodialysis may also cause significant improvements in fatigability (Kouidi, 2001; Storer, Casaburi, Sawelson, & Kopple, 2005).

Medication

In chronic diseases related with fatigue have been tried a lot of medications in order to reduce fatigue mainly be reducing depression. Thus, the drugs that have been most studied, are psychotropic medications. In cancer-related fatigue the most common medications include antidepressants drugs, psychostimulants and wakefulness-promoting agents.

According to Breitbart and Alici-Evcimen review (Breitbart & Alici-Evcimen, 2007) Paroxetine is an effective drug for the reduction of fatigue mainly when fatigue is accompanied by clinical depression. In addition, bupropion has been supposed that probably has psychostimulant-like effect and it seems to be beneficial to fatigue while methylphenidate has been reported as the most efficient and well tolerated drug in cancer related fatigue. Modafinil and paroxetine are efficient drugs but they are not well tolerated as methylphenidate.

In chronic fatigue syndrome the most common treatment that is used by patients (subscribed or not) include vitamins and pain relievers. Jones et. al (Jones, Nisenbaum, & Reeves, 2003) in their study used a telephone survey in order to ask patients with CFS and non fatigued individuals about what medications use in order to reduce the symptoms of fatigue. The authors suggested that CFS patients reported 316 different drugs and non fatigued controls reported 157 different drugs. However, in this patient group and in healthy controls the most common agents for reducing muscle fatigue were pain relievers and vitamins. CFS patients also reported consumption of hormones, antidepressants, central nervous system medications benzodiazepines and gastrointestinal medications. However, as it was suggested by authors the need of CFS patients is focused on the fatigue symptoms relief.

Psychology

Since fatigue has a strong relationship with mental health (Williamson, et al., 2005) there have been many studies focusing on the improvement of mental health in order to cause reduction in fatigue. Cognitive behavior therapy (CBT) has been suggested as an important intervention for the reduction of fatigue in clinical population. For example, Van Kessel et al. (van Kessel et al., 2008) examined the impact of 8 months of CBT in patients with multiple sclerosis and the results showed an important reduction of fatigue which lasted even six months after the end of the intervention program. Furthermore, there is a large body of literature about the effect of CBT in chronic fatigue syndrome and in cancer related fatigue which also reports significant reduction of fatigue via this kind of intervention (Cella, Stahl, Reme, & Chalder, 2011; Deale, Chalder, Marks, & Wessely, 1997; Kwekkeboom, Abbott-Anderson, & Wanta, 2010; Prins & Bleijenberg, 1999). However, there have been studies which have applied interventions with combination of CBT and exercise training in order to reduce fatigue in several clinical situations. For example, the study of Van-Weert et al. (van Weert et al., 2010) examined the impact of a combined intervention program (CBT and physical training) compared to only physical training in fatigue of cancer survivors. According to the results, the reduction of fatigue only via physical training was similar to the reduction of fatigue via the combined intervention program. Thus physical training may be most beneficial alternative treatment for the reduction of the fatigue compared to CBT due to the ability of exercise to improve both mental health and physical health (Peluso & Guerra de Andrade, 2005; Penedo & Dahn, 2005).

Fatigue Effects

In quality of life

Quality of life, in diseases related with fatigue has been well established. Hardt et al. (Hardt et al., 2001) suggested that patients with CFS patients of 3 countries had similarly low health related quality of life (HRQoL). In addition, in the study of Schweitzer et al. (Schweitzer, Kelly, Foran, Terry, & Whiting, 1995) was observed a poor quality of life (QoL), especially focused in social functioning aspects. Dickson et al. (Dickson, Toft, & O'Carroll, 2009) also observed a decline in physical and psychological aspects of QoL compared to healthy individuals and in thyroid disease patients.

In sleep and daytime sleepiness

Disturbed sleep is presented in chronic ill people and in healthy people too for various causes. Sleep disruption may be due to sleep disorders like RLS and PLMS or it may be sedentary to other chronic diseases (Reynolds & Banks, 2010). Furthermore, it has been well established that sleep disorders may occur due to work load, to shift work, to the long duration of work and important predisposing factors are also the gender and age (Ribet & Derriennic, 1999). Sleep disruption causes sleep loss and therefore daytime sleepiness (Reynolds & Banks, 2010).

“The complaint of excessive daytime sleepiness includes inappropriate and undesirable sleep during waking hours; reduced motor and cognitive performance; unavoidable napping; sometimes-but not always-an increase in total 24 hour sleep time; and occasionally states of incomplete arousal with automatic behaviour and sleep drunkenness, slufted speech, impaired motor control, and difficulty in focusing” (Parkes, 1993). It has been reported from several studies that daytime sleepiness leads to accidents too often and it should be noticed that (daytime sleepiness) is often be confused with fatigue and tiredness (Parkes, 1993).

It is well known that sleep disorders-poor sleep quality cause daytime fatigue (Lichstein, Means, Noe, & Aguillard, 1997). However, few investigations have explored the effect of fatigue in sleep. Kunert et al. (Kunert, King, & Kolkhorst, 2007) compared sleep quality between night shift nurses with day shift nurses. As it was self reported by questionnaires, night shift nurses experienced more fatigue and poorer sleep quality compared to day shift nurses. Akerstedt et al. (Akerstedt, Fredlund, Gillberg, & Jansson, 2002) interviewed 58.115 individuals with questions related to health and work. As it was observed, the individuals with more physical strenuous work, shift work stress -which were in association with fatigue -had high levels of disturbed sleep. Other factors that caused sleep disruption were the gender (female), the age (above 49 years) and the presence of other diseases. However, in the study of Jacquinet-Salord et al. (Jacquinet-Salord, Lang, Fouriaud, Nicoulet, & Bingham, 1993), physical working conditions of physicians didn't affect the sleep quality. In the current study, the factors which had a negative impact in sleep quality were the age (above 55), the gender (females), the drug consumption, the bad work conditions and the bad work atmosphere.

In RLS and PLMS

Restless Leg Syndrome (RLS)

Restless legs syndrome (RLS) is a sensorimotor neurological disorder which is mainly characterized by a discomfort sensation at legs and an unconquerable desire of leg movements. Restlessness in these patients is more intense during rest time and during night and is relieved only by moving their legs. The pathophysiology of the disorder is not well known yet but according to the most studies, the problem is detected in iron deficiency and in dopaminergic system (Clark, 2001). The prevalence of the syndrome is 3-10% in general population mainly because of family history and is also presented in clinical population. The syndrome is presented mostly in the older population and is most severe in patients with low Ferritin levels (Curgunlu et al., 2012).

There have been tried a lot of medication in order to reduce RLS symptoms and the most efficient and common used medications are levodopa, ropinirole, pramipexole, capergoline, pergolide, and gabapentin (Trenkwalder et al., 2008).

RLS is highly associated with fatigue and daytime sleepiness. Gerhard et al. (Gerhard, Bosse, Uzun, Orth, & Kotterba, 2005) observed that between 28 RLS patients, 17 patients reported high levels of fatigue and 17 patients reported daytime sleepiness but fatigue and daytime sleepiness were not correlated. However, there was observed that high levels of shelf reported fatigue caused low levels of physical health (of SF36) while daytime sleepiness caused low levels of mental health. The authors suggested that fatigue and daytime sleepiness affect negatively RLS patients.

Periodic Leg Movements during Sleep (PLMS)

PLMS is a neurological sensory-motor disorder that takes place during sleep. It is characterized by repetitive movements of lower limbs during sleep (Yang & Winkelman, 2010), it affects the continuity of sleep and as a result it disrupts the sleep quality and quantity (Ekbom & Ulfberg, 2009). The symptoms cannot be recognized from patients but most times they complain for day time sleepiness and insomnia (Pigeon & Yurcheshen, 2009). A polysomnography system or actigraphy during sleep is used to support the clinical diagnosis (Yang & Winkelman, 2010). The pathophysiology of the syndrome is not well known but most studies have found a defect in brain biochemistry (dopaminergic dysfunction within CNS) (Avidan, 2009). PLMS is estimated to be appeared in 4-11% of general population (Hornyak, Feige, Riemann, & Voderholzer, 2006), in 80% of patients with

Restless Legs Syndrome (RLS) (Montplaisir et al., 1997) and in 25% of patients with end-stage renal disease (Burmann-Urbanek et al., 1995). In the long run, the syndrome may cause cardiovascular diseases (hypertension, heart disease) cerebral diseases (stroke) and sleep disorders (Yang & Winkelman, 2010). Dopaminergic agonists are considered as the first line treatment (ropinirole, capergoline, pramipexole) (Karatas, 2007) but acute and chronic exercise could also be an effective alternative treatment (Giannaki, et al., 2010).

Methodology

Participants

Twenty one (N=21) young adults (12 males/9 females), agreed to voluntarily participate in the present study. Our participants were asked to read and sign the consent form of the research and they had the right to withdraw from the study at any moment they would wish to. The present study was approved by the Ethical committee of the University of Thessaly.

Table 1. Participant's characteristics

Variables	**Participants**
N	21
Males (6 fit, 6 unfit)/ Females (6 fit, 3 unfit)	12/9
Age (years)	24 ± 3.7
BMI (kg/m²)	22.4 ± 2.4
Fit/Unfit	12/9
Physical Health (SF36)	81,7 ± 14,4
Mental Health (SF36)	75,6 ± 15,0
Total Score (SF36)	80,3 ± 14,1
Pittsburgh	7,4 ± 5,5
Fatigue	3,2 ± 1,2
RLS	Negative

All data are mean ± SD. Abbreviations: BMI, Body Mass Index; Fit, 3 or more days per week of physical activity, RLS, Restless Legs Syndrome.

Inclusion criteria

In order to participate, volunteers had to be healthy and aged between 18-30 years old. In addition, the participants had not to do any activity which would cause muscle damage the week before the start of the study and the week during the study too.

Exclusion criteria

From the study was been excluded any prospective participant suffering from orthopedic problems, cardiovascular problems, from Periodic Leg Movement Syndrome (PLMS), from any other sleep disturbance (checked by health questionnaire) and anybody who was under treatment for several health problems and especially anybody who had to use inflammatory drugs. In addition, anybody who used to work during night at the time of the study's carrying out was also been excluded from the study.

Study design

The study design which was been followed, was the following (Table 2): The duration of the measurements was 5 days for each participant. The first day the participants had first to read and sign the consent form of the study, to fill in the health questionnaire and they were also asked to fill in several questionnaires and diaries every day. Their neuromuscular activity during sleep was recorded at the first night of the study (pre exercise protocol) and at the next 3 consecutive nights (after exercise protocol) by an actigraphy system (Somnowatch-Northmed). The second day of the study the blood sampling, the measurement of their weight and high, the maximum isokinetic torque test and the exercise protocol took place and after that the maximum isokinetic torque test was repeated. At the end of the protocol, the participant’s weight was measured again. This day was followed by the overnight recording of neuromuscular activity. The next days the participants had only to fill in the pain questionnaire, the daily Restless Leg Syndrome (RLS) questionnaire, the sleep diary and to wear the Somnowatch during their sleep. At the fifth day of the study (72 hours after the exercise protocol), volunteers were asked to come for last time to the laboratory just for a blood sampling and a maximum isometric torque test. Then they had to give as all the questionnaires and that was the end of the study for each participant.

Table 2. Brief description of study design

	Day 1	Day 2	Day 3	Day 4	Day 5
Consent form	●				
Health questionnaire	●				
Exercise protocol		●			
Maximum isometric torque test		●●			●
Blood sampling		●			●
Sf36 questionnaire	●				●
Weekly sleep diary	●				●
Levels of sleepiness questionnaire	●				●
Sleep quality indices questionnaire	●				
Daily diary of sleep	●	●	●	●	●
Daily RLS questionnaire	●	●	●	●	●
Pain questionnaire	●	●	●	●	●
Fatigue questionnaire	●				●
Neuromuscular activity during sleep study	●	●	●	●	

Abbreviations: RLS, Restless Leg Syndrome.

Exercise Protocol

The exercise protocol was consisted by three hours of continuous walking on a treadmill with a low speed of 5 km/h with zero incline. This speed was applied while there is evidence that is the mean speed of human walking (Hoxie & Rubenstein, 1994) and our purpose was to cause fatigue by applying in the protocol a normal daily activity with an extreme duration. Before starting the exercise protocol, participants had to warm up for 5 minutes. At the first 15 minutes of the protocol heart rate was recorded every 5 minutes using heart rate monitoring (polar) and for the next 2 hours and 45 minutes, heart rate was recorded every 15 minutes.

Picture 2. Treadmill (mohamedshahin.com)

During the protocol, participants were able to watch television or films, or to listen to music in order to spend their time more pleasantly. At the end of the 3 hour exercise, participants had to cool down for 5 minutes.

Maximal isometric torque test

This test was been applied three times as an indicator of muscle fatigue on an isokinetic dynamometer (Cybex Norm Lumex, Ronkonkoma, NY, USA). For the first time the test took place before the start of the exercise protocol and then at the end of the exercise protocol. It was also been applied 72 hours after the 3 hour walking on the treadmill. The test was been consisted of 1 set of five maximum leg extensions and flexions for each leg.

Picture 3. Cybex (Biomechanics Lab-DPESS)

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Biochemical blood test

Routine biochemical blood test including C - Reactive Protein (CRP), Urea, Creatinine (Cr), Albumin (ALB), Creatine Phosphokinase (CPK), Total Cholesterol, Triglycerides (TG), High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Iron (Fe) and Ferritin (FER) took place in the second day (before the exercise protocol) and in the fifth day of the study. The blood sampling was done by qualified personnel and the quantity of the blood sample which was taken from each participant was 10 ml in the second and 10 ml in the fifth day of the study.

Picture 4. Blood Samples (topnews.in)

Questionnaires

Participants were asked to fill in the following standardized and validated questionnaires:

Health questionnaire, SF36 Quality of Life questionnaire (Kalantar-Zadeh, Kopple, Block, & Humphreys, 2001), Weekly Sleep Questionnaire (Sakkas et al., 2008), Epworth sleepiness scale (Johns, 1991), Pittsburgh sleep quality questionnaire (Mystakidou et al., 2007), Daily sleep diary, RLS diagnostic criteria questionnaire (Allen et al., 2003), McGill pain questionnaire (Melzack, 1975) and Fatigue Severity Scale questionnaire (Κατσαρού Ζ., 2007)

Picture 5. Questionnaires (phillj.wordpress.com)

Day 1

Health questionnaire, SF36 Quality of Life questionnaire, Weekly Sleep Questionnaire, Epworth sleepiness scale, Pittsburgh sleep quality questionnaire, Daily diary of sleep, RLS diagnostic criteria questionnaire, McGill pain questionnaire, Fatigue Severity Scale questionnaire.

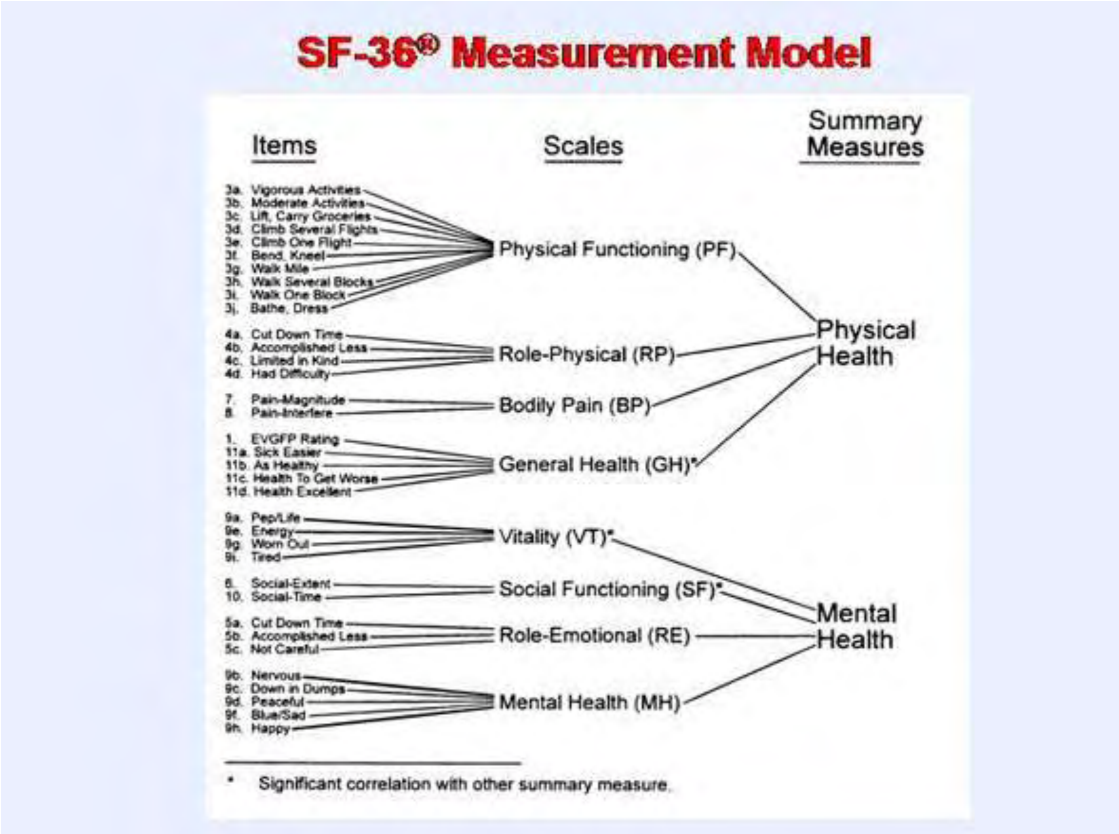
Day 2, day 3, day 4

Daily diary of sleep, RLS diagnostic criteria questionnaire, McGill pain questionnaire,

Day 5

SF36 Quality of Life questionnaire, Weekly Sleep Questionnaire, Epworth sleepiness scale, Pittsburgh sleep quality questionnaire, Daily diary of sleep, RLS diagnostic criteria questionnaire, McGill pain questionnaire and Fatigue Severity Scale questionnaire.

Picture 6. SF-36 Measurement Model (sf-36.org)



Neuromuscular activity during sleep

Neuromuscular activity during sleep was been recorded by an actigraphy system (Somnowatch-Northmed) on the first 4 nights of the study. Somnowatch is similar to a watch but it is applied on the ankle. Three pads are placed along the anterior tibialis muscle and three electrodes are applied on them. A cable connects the electrodes with the device which is worn to the opposite leg. Somnowatch records the movements of tibialis anterior muscle and the duration of the movements. In addition, it recognizes the body position (by 3D accelerometer) and the appearance of light or dark (by photo sensor). The use of the device is noninvasive, bloodless and it doesn't affect the sleep quality of the participant. In order to make it easier for our participants, every night we met them at their home to give them the device. Data were been transshipped every day and were analyzed in Northmed's specific software.

Picture 7. SomnoWatch (s-med.co.uk)

Statistics

The baseline characteristics between males and females as well as between fit and unfit were compared using an unpaired t-test. The changes from baseline to day 2, 3, 4 and 5 were evaluated using General Linear Model Repeated Measures while chi-square was used for categorical variables. Finally, Spearman rank correlation test was used to assess the relation between the examined variables. All statistical analyses were performed using the SPSS version 15.0 (SPSS Inc. Chicago, Illinois). Data in the text are presented as mean ± SD and the level for statistical significance was set at $P \leq 0.05$.

Results

All data and results about the changes in the study's variables between the 5 days of the study are being presented. In some cases, differences between males and females and between fit and unfit participants are also being presented while there were some significant differences between the genders and between participants with different fitness status. Furthermore, the Heart rate of our participants during exercise protocol is also being presented.

Heart rate during exercise protocol

The progress of HR during exercise protocol is presented in figure 1. In addition, in table 3 are presented the average and the differences in HR of participants at rest, during protocol and at the end of the protocol. There were found significant differences between resting HR and HR during protocol (p=0,000) and between resting HR and HR at the end of the protocol (p=0,000). (Table 3a and Table 3b respectively)

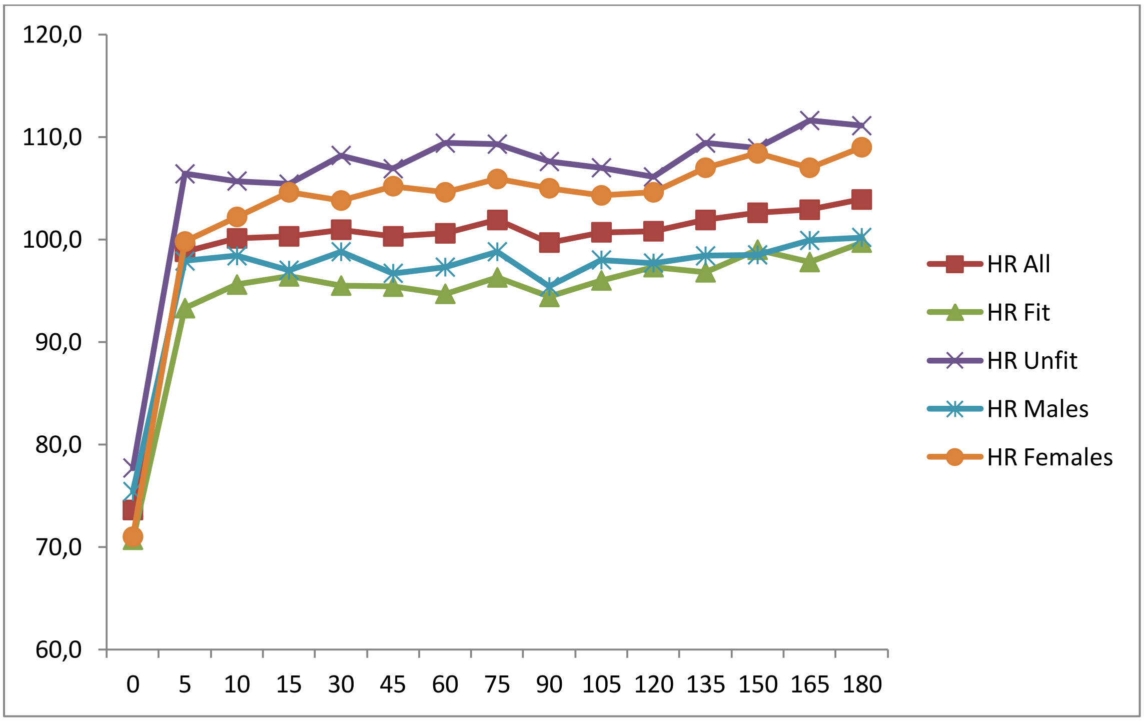


Figure1. Progress of HR during the exercise protocol.

HR was increased gradually during the protocol.

Table 3. Heart rate at rest, during exercise and at the end of the protocol

HR rest	HR during exercise	HR at the end of exercise	p values
73,8 ± 2,4	99,6 ± 2,3	101,1 ± 2,8	**0,000**

All data are mean ± SD. Abbreviations: HR, Heart Rate

There were observed significant changes between resting HR, HR during exercise protocol and HR at the end of the exercise protocol.

Table 3a. Differences between resting HR and HR during exercise

HR rest	HR during	p values
73,8 ± 2,4	99,6 ± 2,3	**0,000**

HR during protocol was significantly higher compared to resting HR (p=0,000).

Table 3b. Differences between resting HR and HR at the end of the protocol

HR rest	HR at the end of exercise	p values
73,8 ± 2,4	101,1 ± 2,8	**0,000**

HR at the end of exercise was significantly higher compared to resting HR (p=0,000).

Maximum isometric torque test

There was no any significant change between the three measurements (one measurement before the exercise protocol, one measurement after the protocol and a measurement 72 hours after the protocol) of maximum isometric torque of our participants. (Table 4) However, it was obvious that total score of maximum isometric torque was significantly greater in males than in females. (Table 4a) Thus, in table 4b and table 4c the data of maximum isometric torque of males and females are respectively being presented. However, there was no any significant difference between the measurements of maximum isometric torque in males (Table 4b) neither in females (Table 4c).

Table 4. Maximum isometric torque measurements before and after the exercise protocol and after 72 hours

Variables	**Day 2** *pre exercise*	**Day 2** *post exercise*	**Day 5** *72 hours post exercise*	**p values**
RE (N)	284,9 ± 253,5	283,4 ± 255,4	274,1 ± 250,9	0,989
RF (N)	174,2 ± 158,1	176,6 ± 156,4	189,5 ± 179,0	0,949
LE (N)	277,2 ± 243,8	258,3 ± 209,7	278,9 ± 238,8	0,951
LF (N)	181,6 ± 161,5	175,9 ± 156,5	197,2 ± 174,3	0,912

All data are mean ± SD. Abbreviations: RE, maximum right extension; RF, maximum right flexion; LE, maximum left extension; LF, maximum left flexion.

There was not observed any significant change between the three measurements of maximum isometric torque.

Table 4a. Differences in maximum isometric torque between males and females

Variables	**Males**	**Females**	**p values**
RE (N)	354,6 ± 295,0	182,4 ± 115,4	**0,006**
RF (N)	227,3 ± 195,7	117,2 ± 63,4	**0,007**
LE (N)	343,1 ± 269,3	172,0 ± 84,0	**0,003**
LF (N)	229,9 ± 193,4	122,2 ± 65,9	**0,008**

All data are mean ± SD. Abbreviations: RE, maximum right extension; RF, maximum right flexion; LE, maximum left extension; LF, maximum left flexion.

The differences between males and females in total maximum isometric force were statistically significant. Maximum right extension was significantly greater in males compared to females (p=0,006) similarly to maximum right flexion which was also significantly greater (p=0,007). In addition, maximum left extension was significantly greater in males compared to females (p=0,003) and maximum left flexion greater too (p=0,008). (Table 4a)

<u>Males</u>

Table 4b. Differences in maximum isometric force of males between measurements data

Variables	Day 2 *pre exercise*	Day 2 *post exercise*	Day 5 *72 hours post exercise*	p values
RE (N)	355,8 ± 300,3	358,7 ± 306,3	349,3 ± 304,9	0,997
RF (N)	217,9 ± 194,6	225,0 ± 189,3	239,0±218,9	0,967
LE (N)	353,4 ± 294,5	330,0 ± 249,6	346,0 ± 285,1	0,978
LF (N)	227,9±196,4	222,0±191,4	240,0 ± 208,9	0,976

All data are mean ± SD. Abbreviations: RE, maximum right extension; RF, maximum right flexion; LE, maximum left extension; LF, maximum left flexion.

No significant differences were observed in males between the three measurements of maximum isometric force.

<u>Females</u>

Table 4c. Differences in maximum isometric force of females between measurements data

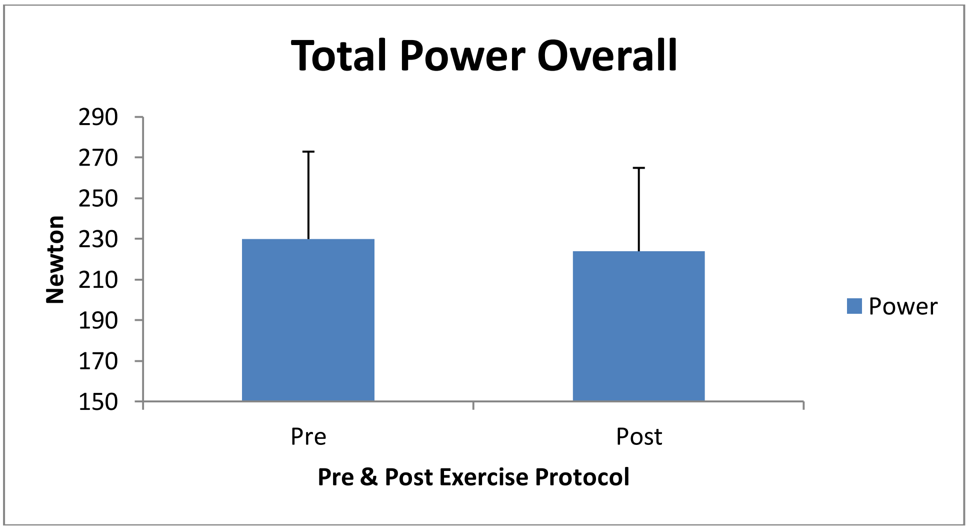
Variables	Day 2 *pre exercise*	Day 2 *post exercise*	Day 5 *72 hours post exercise*	p values
RE (N)	190,4 ± 138,0	183,0 ± 119,5	173,8 ± 99,0	0,957
RF (N)	115,9 ± 60,8	112,1 ± 60,3	123,6 ± 75,3	0,932
LE (N)	175,7 ± 95,0	162,8 ± 79,1	178,1 ± 87,6	0,925
LF (N)	119,9 ± 68,0	114,4 ± 58,3	133,4 ± 78,2	0,844

All data are mean ± SD. Abbreviations: RE, maximum right extension; RF, maximum right flexion; LE, maximum left extension; LF, maximum left flexion.

No significant differences were observed in females between the three measurements of maximum isometric force.

<u>Differences between pre and post exercise protocol in total power of all participants</u>

Total power of all participants after protocol was lower compared to total power before exercise protocol but the difference was not significant (p=0,078) (Shape 1).

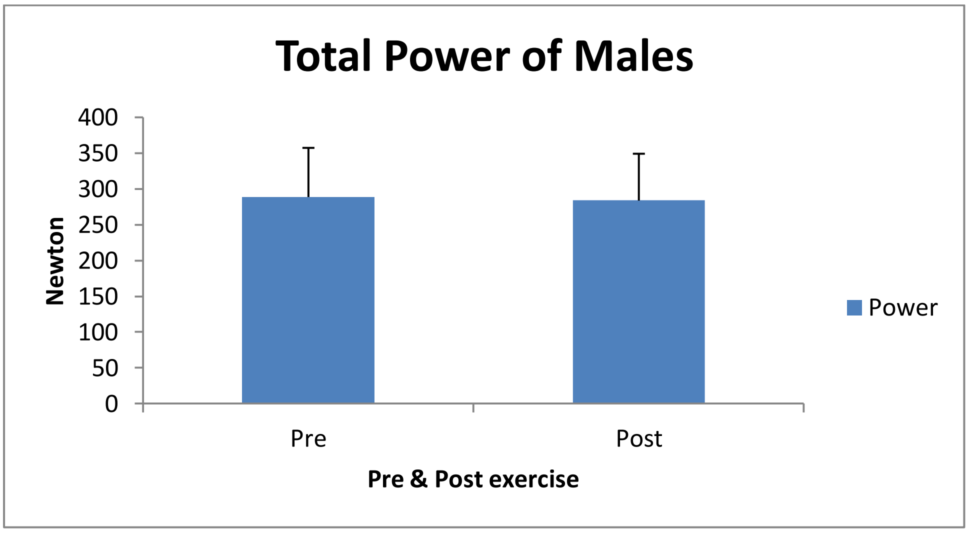


Shape 1. Total power of all participants before and after exercise protocol

Total power of all participants was reduced after the exercise protocol (p=0,078).

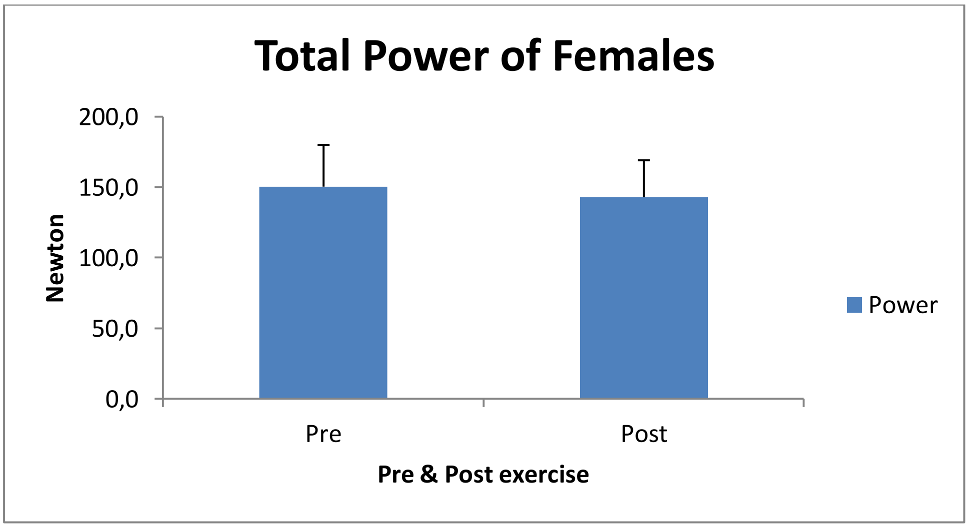
Differences between pre and post exercise protocol in total power of males and females

Total power of males (Shape 2a) and females (Shape 2b) was reduced after the exercise protocol but not significantly (p=0,302 and p=0,155 respectively).



Shape 2a. Total power of males before and after exercise protocol

Total power of males was reduced after the exercise protocol (p=0,302).

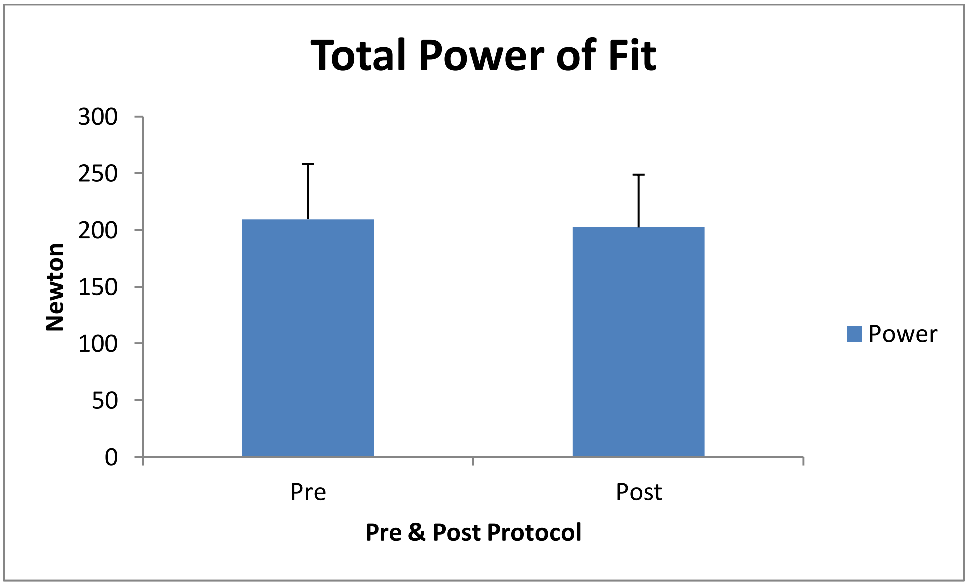


Shape 2b. Total power of females before and after exercise protocol

Total power of females was reduced after the exercise protocol (p=0,155).

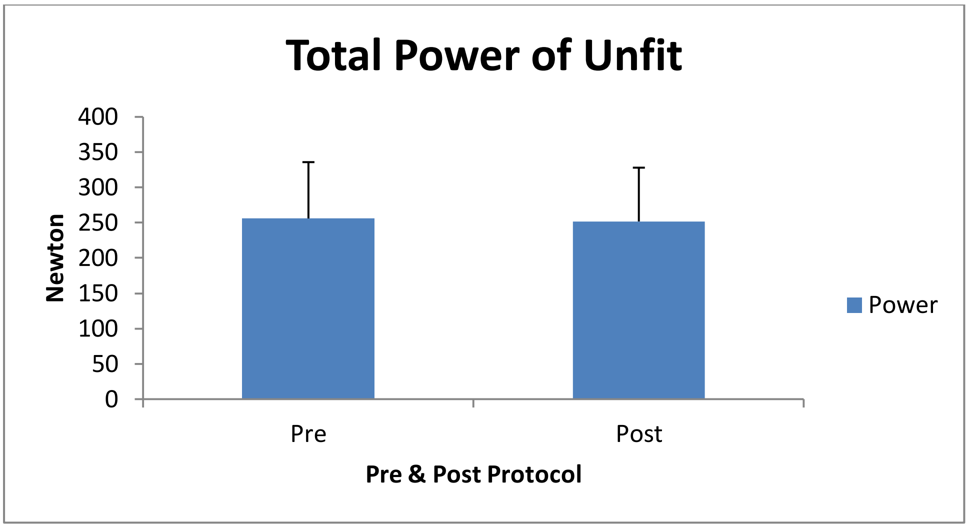
Differences between pre and post exercise protocol in total power of fit and unfit participants

Total power of fit (Shape 3a) and unfit participants (Shape 3b) was reduced after the exercise protocol but not significantly (p=0,069 and p=0,495 respectively).



Shape 3a. Total power of fit participants before and after exercise protocol

Total power of fit participants was reduced after the exercise protocol (p=0,069).



Shape 3b. Total power of unfit participants before and after exercise protocol

Total power of unfit participants was reduced after the exercise protocol (p=0,495).

Biochemical blood test

There were not observed any differences in biochemical blood test results between the second day of the study (pre exercise protocol) and 72 hours after the exercise protocol. (Table 5) However, it was observed a significant difference between fit and unfit participants in UREA levels but only for day 5 (72 hours after the exercise protocol) (p=0,044). (Table 5a)

Table 5. Biochemical blood test data and normal ranges

Variables	**Day 2**	**Day 5**	**p values**	**Normal Ranges**
CRP (mg/L)	0,4 ± 0,3	0,5 ± 0,2	0,608	≤10
Urea (mg/dl)	26,2 ± 7,0	25,7 ± 5,4	0,836	10-50
Cr (mg/dl)	0,8 ± 0,1	0,8 ± 0,1	0,611	0,8-1,2
ALB (g/dl)	3,5 ± 0,5	3,3 ± 0,7	0,405	3,4-5,5
CPK (IU/L)	107,9 ± 179,5	88,5 ± 100,9	0,731	≤173
Total CHO(mg/dl)	124,1 ± 24,6	111,7 ± 29,2	0,226	≤250
TG (mg/dl)	75,4 ± 24,0	59,9 ± 24,2	0,094	<150
HDL (mg/dl)	37,9 ± 10,8	37,0 ± 12,0	0,827	45-65
LDL (mg/dl)	70,9 ± 17,1	62,7 ± 17,6	0,213	<160
HDL/LDL (mg/dl)	0,55 ± 0,18	0,61 ± 0,19	0,437	≥0,3
Total	3,48 ± 1,0	3,12 ± 0,55	0,281	≤5

CHO/HDL ratio (mg/dl)				
Fe (ug/dl)	61,9 ± 30,4	79,0 ± 26,6	0,123	37-145
FER (ng/dl)	66,1 ± 37,8	60,7 ± 30,5	0,679	9-120

All data are mean ± SD. Abbreviations: CRP, C - Reactive Protein; Cr, Creatinine; ALB, Albumin; CPK, Creatine Phosphokinase; CHO, Cholesterol; TG, Triglycerides; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; Fe, Iron and FER, Ferritin.

There was not observed any change in biochemical blood test results between day 2 and day 5.

Table 5a. Differences in UREA levels between fit and unfit participants

Urea	**Fit**	**Unfit**	**p values**
Day 5	28,0 ± 5,5	22,0 ± 2,6	**0,044**

All data are mean ± SD. Abbreviations: Fit, 3 or more days per week of physical activity.

Urea levels of day 5 were significantly greater in fit participants compared to unfit participants (p=0,044).

Questionnaires

a. Quality of life

No changes were observed in quality of life parameters of SF36 questionnaire between day 1 and day 5. (Table 6)

Table 6. SF36 quality of life data

SF36	Day 1	Day 5	p values
Physical Function	97,4 ± 6,8	96,3 ± 7,6	0,618
Role Physical	88,1 ± 28,1	83,8 ± 33,7	0,656
Body Pain	78,2 ± 27,9	73,0 ± 22,7	0,515
General Health	72,2 ± 18,7	73,7 ± 17,4	0,797
Vitality	72,6 ± 15,9	68,3 ± 15,8	0,383
Social Functioning	85,2 ± 16,6	85,1 ± 18,3	0,990
Role Emotional	74,6 ± 37,9	75,0 ± 41,7	0,976
Mental Health	73,3 ± 17,4	68,6 ± 17,9	0,395
Physical Health	81,7 ± 14,4	78,9 ± 12,3	0,515
Mental Health	75,6 ± 15,0	74,1 ± 15,9	0,754
Total Score	80,3 ± 14,1	77,9 ± 14,4	0,600

All data are mean ± SD. Abbreviations: Physical function, Role Physical, Body Pain and General Health refer to the PHYSICAL HEALTH component summary; Vitality, Social Functioning, Role Emotional and Mental Health refer to the MENTAL HEALTH component summary.

b. Sleep Quality

No changes were observed in sleep quality assessed by Weekly Sleep Diary and Epworth Sleepiness Scale (ESS) between day 1 and day 5. The Pittsburgh sleep quality questionnaire was asked only the first day of the study. (Table 7)

Table 7. Sleep quality data

Questionnaires	Day 1	Day 5	p values
Sleep Diary	5,0 ± 3,6	6,0 ± 3,6	0,408
ESS	6,7 ± 3,7	5,2 ± 3,5	0,187
Pittsburgh	7,4 ± 5,5	-	-

All data are mean ± SD. Abbreviations: Sleep Diary, Weekly Sleep Diary; ESS, Epworth Sleepiness Scale; Pittsburgh, Pittsburgh sleep quality questionnaire.

No changes were observed in sleep quality between day 1 and day 5.

c. Body pain

Differences in pain score and EPP were observed between days

The score of pain and EPP was changed significantly between the 5 days of the participation (p=0,004 and p=0,003 respectively). (Table 8) More specifically, in the score of body pain there was found significant difference between day 1 and day 2 (p=0,047) and between day 2 and day 5 (p=0,029). (Table 8a) Furthermore, EPP showed a significant difference between day 1 and day 2 (p=0,021) and between day 2 and day 5 (p=0,005). (Table 8b)

Table 8. Body pain data

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**p values**
PAIN						
Pain	0,8 ± 1,8	3,5 ± 3,6	3,1 ± 4,5	1,4 ± 2,0	0,7 ± 1,2	**0,004#**
EPP	0,4 ± 0,8	1,1 ± 0,9	0,9 ± 0,9	0,6 ± 0,6	0,3 ± 0,6	**0,003#**
Pain Line (cm)	0,8 ± 0,2	0,2 ± 0,2	0,2 ± 0,2	0,1 ± 0,1	0,1 ± 0,1	0,072

All data are mean ± SD. Abbreviations: PAIN, McGill pain questionnaire; Pain, EPP, Pain line are the three parameters of the questionnaire. # refer to Table 8a

Table 8a. Differences in pain score between days

Pairs of days	p values
Day 1 - Day 2	**0,047**
Day1 - Day 3	0,158
Day 1 - Day 4	1,000
Day 1 - Day 5	1,000
Day 2 - Day 3	1,000
Day 2 - Day 4	0,240
Day 2 - Day 5	**0,029**
Day 3 - Day 4	0,664
Day 3 - Day 5	0,102
Day 4 - Day 5	1,000

There were found significant differences in body pain between day 1- day 2 and between day 2 and day 5.

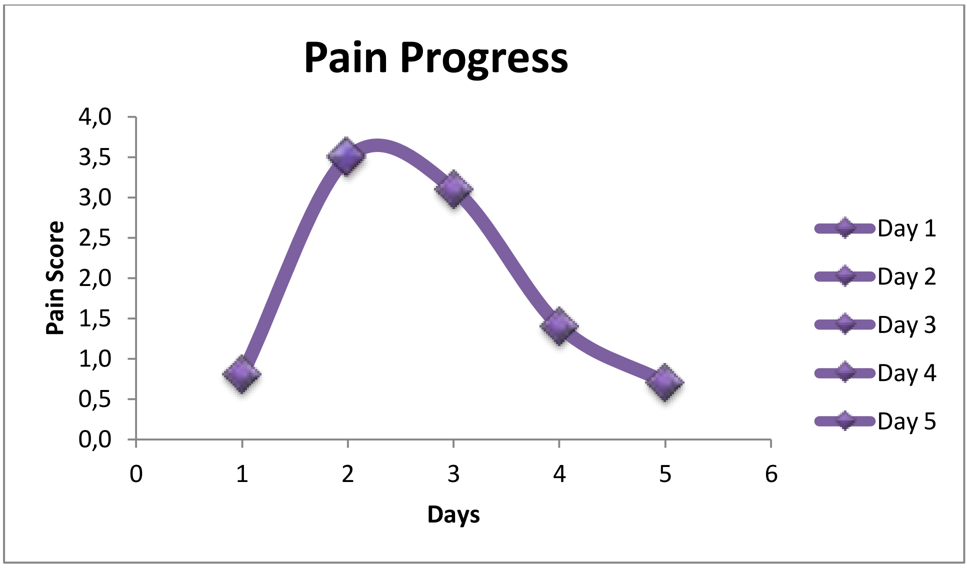


Figure 2. The progress of pain score

In day 2 there was a significant increase in pain score compared to day 1 (p=0,047) and in day 5 there was a significant reduction in pain score compared to day 2 (p=0,029)

Table 8b. Differences in EPP between days

Pairs of days	p values
Day 1 - Day 2	**0,021**
Day1 - Day 3	0,379
Day 1 - Day 4	1,000
Day 1 - Day 5	1,000
Day 2 - Day 3	1,000
Day 2 - Day 4	0,227
Day 2 - Day 5	**0,005**
Day 3 - Day 4	1,000
Day 3 - Day 5	0,132

Day 4 - Day 5	1,000

There were found significant differences in body pain between day 1- day 2 and between day 2 and day 5.

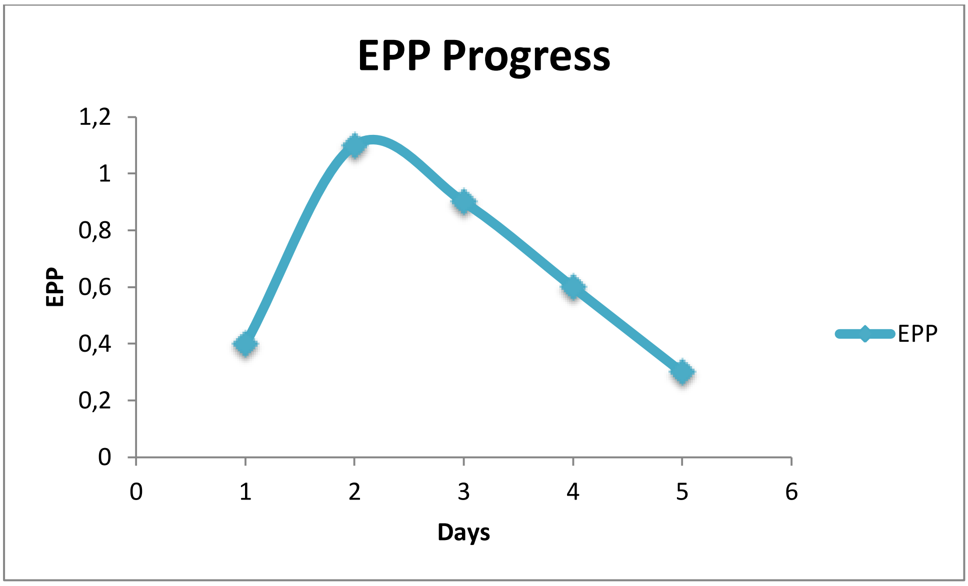


Figure 3. The progress of EPP

In day 2 there was a significant increase in EPP compared to day 1 (p=0,021) and in day 5 there was a significant reduction in EPP compared to day 2 (p=0,005).

<u>Differences in pain score, in EPP and in pain line between males and females were also observed</u>

There were also observed significant differences in pain score, in EPP and in pain line caused by the different gender. All the parameters of pain questionnaire were significantly greater in females compared to males.

Table 8c. Differences in pain score between males and females

PAIN	Males	Females	p values
Day 1	0,09 ± 0,3	1, 7 ± 2,4	0,048
Day 2	1,6 ± 2,4	5,7 ± 3,8	0,010
Day 3	0,9 ± 1,6	5,7 ± 5,5	0,014
Day 4	0,7 ± 1,8	2,1 ± 2,0	0,117
Day 5	0,3 ± 0,9	1,1 ± 1,4	0,117

All data are mean ± SD.

Pain score was significantly greater in females compared to males for day 1 (p=0,048), day 2 (p=0,010) and day 3 (p=0,014). (Table 8c)

Table 8d. Differences in EPP between males and females

EPP	Males	Females	p values
Day1	0,09 ± 0,3	0,67 ± 1,1	0,117
Day 2	0,7 ± 0,8	1,6 ± 0,7	0,026
Day 3	0,4 ± 0,5	1,4 ± 0,9	0,003
Day 4	0,3 ± 0,5	1,0 ± 0,5	0,006
Day 5	0,09 ± 0,3	0,4 ± 0,7	0,158

EPP was significantly greater in females compared to males for day 2 (p=0,026), day 3 (p=0,003) and day 4 (p=0,006). (Table 8d)

Table 8e. Differences in pain line between males and females

PAIN LINE	Males	Females	p values
Day1	0,01 ± 0,03	0,17 ± 0,27	0,068
Day 2	0,12 ± 0,15	0,25 ± 0,12	0,051
Day 3	0,07 ± 0,13	0,27 ± 0,19	0,016
Day 4	0,04 ± 0,09	0,19 ± 0,17	0,023
Day 5	0,01 ± 0,04	0,09 ± 0,14	0,080

All data are mean ± SD.

Pain line was significantly greater in females compared to males for day 3 (p=0,016) and day 4 (p=0,023). (Table 8e)

Differences in pain between fit and unfit participants

Differences in EPP were also observed between fit and unfit participants. EPP was significantly greater in fit participants.

Table 8f. Differences in EPP between fit and unfit participants

EPP	Fit	Unfit	p values
Day1	0,4 ± 0,7	0,3 ± 1,0	0,937
Day2	1,5 ± 0,7	0,7 ± 0,9	**0,036**
Day3	1,2 ± 1,0	0,4 ± 0,5	0,058
Day4	0,8 ± 0,6	0,3 ± 0,5	**0,040**
Day5	0,3 ± 0,6	0,2 ± 0,4	0,844

All data are mean ± SD. Abbreviations: Fit, 3 or more days per week of physical activity.

EPP was significantly greater in fit compared to unfit participants for day 2 (p=0,036) and 4 (p=0,040). (Table 8f)

d. Fatigue

There was no any difference between day 1 and day 5 in fatigue score (Table 9). However, there was observed a significant difference in day 1 and day 5 only between fit and unfit participants (p=0,028). (Table 9a)

Table 9. Fatigue data

	Day 1	Day 5	p values
Fatigue	3,2 ± 1,2	3,2 ± 1,0	0,992

All data are mean ± SD. Abbreviations: FATIGUE, Fatigue Severity Scale questionnaire score.

No changes were observed in fatigue score between day 1 and day 5.

Table 9a. Differences in fatigue score between fit and unfit participants

Total Fatigue	Fit	Unfit	p values
Day 1, Day 5	2,8 ± 1,0	3,6 ± 1,1	0,028

All data are mean ± SD. Abbreviations: Fit, 3 or more days per week of physical activity.

In day 1 and day 5, fatigue score was significantly greater in unfit participants compared to fit participants.

e. RLS diagnostic criteria questionnaire

The RLS diagnostic criteria questionnaire was negative for all participants.

Sleep neuromuscular activity and duration

There were no any significant differences between the four nights that neuromuscular activity during sleep was been recorded (Table 10). However, there was observed a significant difference in PLMS duration between day 1 and day 4 but only between fit and unfit participants (p=0,038). (Table 10a)

Table 10. Sleep neuromuscular activity and duration data

	Day 1	Day 2	Day 3	Day 4	p values
TIB (in minutes)	423,1 ± 74,8	456,6 ± 65,9	427,3 ± 70,4	441,1 ± 91,2	0,479
ILMS	75,0 ± 39,7	87,7 ± 34,7	84,6 ± 32,4	88,3 ± 44,2	0,649
ILMS index (per hour)	10,6 ± 5,1	11,5 ± 4,1	11,8 ± 4,2	11,7 ± 4,8	0,833
PLMS	14,9 ± 12,3	17,4 ± 12,8	20,9 ± 26,1	14,7 ± 11,8	0,694
PLMS index (per hour)	2,0 ± 1,4	2,3 ± 1,7	3,1 ± 4,3	1,9 ± 1,7	0,553
PLMS power (dB)	22,8 ± 3,5	21,9 ± 2,0	23,7 ± 3,5	21,7 ± 3,4	0,262
PLMS amplitude (dB*s)	70,4 ± 43,5	52,1 ± 21,5	62,8 ± 24,7	55,5 ± 28,1	0,332
PLMS duration (s)	2,9 ± 1,6	2,3 ± 0,9	2,5 ± 0,9	2,4 ± 1,0	0,480
Position changes	15,8 ± 8,2	18,4 ± 9,2	21,1 ± 9,7	19,6 ± 11,4	0,354
Position changes index (per hour)	2,2 ± 1,0	2,4 ± 1,0	2,9 ± 1,4	2,6 ± 1,4	0,280

All data are mean ± SD. Abbreviations: TIB, Time In Bed; ILMS, Isolated Limb Movements in Sleep; PLMS, Periodic Limb Movements in Sleep.

No changes were observed in neuromuscular activity during sleep neither in sleep duration between days.

Table 10a. Differences in PLMS duration between fit and unfit participants

PLMS duration	Fit	Unfit	p values
Day 1 - Day 4	2,8 ± 1,3	2,2 ± 0,9	0,038

All data are mean ± SD. Abbreviations: PLMS, Periodic Limb Movements in Sleep; Fit, 3 or more days per week of physical activity.

PLMS duration was significantly greater in fit compared to unfit participants.

Discussion

According to our findings a 3-hour single bout mild intensity exercise doesn't affect neuromuscular activity during sleep in healthy volunteers. The exercise protocol was able to cause exhaustion and to increase levels of shelf reported pain especially the night after the exercise protocol without inducing muscle fatigue or muscle damage to the healthy volunteers, simulating successfully the conditions of a "very long day".

This is the first study to examine whether a 3-hour of mild intensity and long duration walking on treadmill, could affect neuromuscular activity during sleep. So far studies have investigated the effect of working in shifts in sleep quality and the effect of exercise training in patients with sleep disorders.

Patients who suffer from movement disorders such as RLS or PLMS have reported that intense muscle work or "a very long day" increases the neuromuscular activity during sleep and worsen their sleep quality.

In our study, we used an exercise protocol in order to cause fatigue simulating the sensation of a very long day. The average of HR during the 3-hour bout of exercise was 100 beats per minute (50% of HRmax), very similar the HR recorded on other various daily activities taking place during the day (housekeeping activities 95 beats per minute) (Grieve, 1972). As a result of our protocol, the self-reported pain score was significantly increased the day after the test (Day 2, P=0,047 vs Day 1) and return to the baseline levels after 72 hours (Day 3, P=0.988 vs Day 1).

Even though, this exercise protocol caused an increase in HR and in pain scores, did not induced any muscle fatigue nor muscle damage, since such changes would have affected performance (maximal isometric torque) and biochemical indices. Our protocol was strong enough to create a sensation of muscle soreness but this feeling lasted less than 72hour implying that a delayed onset of muscle soreness (DOMS) was avoided (Howatson & Milak, 2009).

In addition, the maximal isometric torque was reduced only by 2,6% (p=0,078) after the exercise protocol applied in contrast to other fatigue protocols used in the literature where the maximal isometric torque could fall up to 65% (Hassanlouei, Arendt-Nielsen, Kersting, & Falla, 2012). No differences were found in maximal isometric torque between baseline and 72hour verifying our previous assumption that this particular exercise protocol did not induce any muscle damage (Paschalis et al., 2007). On the same line, no differences in any of the biochemical indices of muscle damage were found between baseline and the 72 hours after the protocol time point.

The sensation of muscle fatigue induced by our protocol is possibly due to glycogen depletion of the slow twitch fibers which are most activated during low intensity exercise while the fast twitch fibers that mainly used during the maximal contraction remain almost intact (Gollnick, Piehl, & Saltin, 1974). This is our explanation why subjects fatigued after 3 hours of walking but did not lose their maximal strength.

In addition, fat was probably the main energy substrate of our participants during the exercise protocol since it is well known that long duration exercise causes increased fat oxidation (Phillips et al., 1996). There is also evidence that increased levels of plasma fatty acids (due to the increased fat oxidation) leads to increased plasma concentrations of tryptophan causing increase of the 5-hydroxytryptamine (serotonin) brain level (Newsholme, Blomstrand, & Ekblom, 1992). It is well known that serotonin levels play an important role in the presence of mental fatigue and sleepiness in humans (Huffman, Altena, Mawhinney, & Thomas, 2004; Newsholme, et al., 1992). It is possible therefore, that our exercise protocol could have increased serotonin levels inducing mental fatigue and sleepiness, something that was evidenced by the sleep duration of our participants where increased (not significantly) by about 7,4% the night of the protocol (Day 2).

Based on our findings, this kind of fatigue didn't cause any significant changes in neuromuscular activity during sleep even though the Isolated Leg Movements (ILMS), Periodic Leg Movements (PLMS) and Position Changes indices during sleep were increased by 10-15% ($P>0.05$) after the exercise protocol and remained increased for the 3 consecutive nights.

Since healthy volunteers are prone to neuromuscular changes during sleep after a "very long day" it is reasonable to assume that in patients with RLS or PLMS, the same exercise protocol could lead to a larger increase in neuromuscular activity during sleep and therefore this restlessness is able to affect sleep duration and quality. However, this assumption remains to be seen with further experiments.

In this study, all participants were healthy young adults, with normal BMI, normal fatigue and pain scores and normal Quality of Life Scores. In addition, all participants reported neither sleep problems nor daytime restlessness with no abnormal biochemical indices.

In the current study, there are many limitations that need to be acknowledged. In the current study, the biochemical blood test took place only before the exercise protocol and 72 hours after the protocol missing thus the acute and gradual changes in inflammatory indices related to muscle fatigue and damage. In addition, mental fatigue was not assessed nor during exercise neither post exercise to see whether the exercise protocol induced mental fatigue. In addition during the exercise protocol, the level of substrate utilized was not assessed to verify our serotonin hypothesis. Finally, the restlessness during sleep and the quality and quantity of sleep was not assessed by a full night Polysomnography which considered the gold standard technique.

This is the first study to show that a mild intensity long duration exercise protocol that simulates the sensation of a “very long day”, doesn’t affect neuromuscular activity during sleep in healthy volunteers nor induce any muscle damage or fatigue. Even though the indices of neuromuscular activity during sleep did change, the difference were not statistical significant in healthy individuals. It remains to be seen whether a similar protocol will affect restlessness in patients with movement disorders like RLS and PLMS and whether an exercise training program will improve their restlessness during sleep overall.

Conclusions

Even though, it is well known that exercise is beneficial for patients who suffer from restlessness during sleep, patients have reported that intense muscle work or “a very long day”, increases neuromuscular activity during sleep and worsens their sleep quality. Thus, in our study the main purpose was to cause fatigue by a way that it could happen in daily life and then to observe whether fatigue could affect neuromuscular activity during sleep. Our findings showed that after this particular exercise protocol, there were not any significant changes in muscle fatigue indices, while shelf reported pain and exhaustion score was increased significantly as it could happened in real life conditions. According to our results, this kind of fatigue doesn’t induce intense restlessness during sleep in healthy individuals; however it remains unknown whether our results are applicable in clinical population with RLS and PLMS disorders.

Future studies need to clarify whether a “very long day” in patients with movement disorders could induce restlessness during sleep and how this sensation could be avoided.

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Supplement

Appendix 1: Bioethics Approval

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ ΚΑΙ ΑΘΛΗΤΙΣΜΟΥ

Εσωτερική Επιτροπή Δεοντολογίας

Τρίκαλα: 6/05/2011
Αριθμ. Πρωτ.: 289

Αίτηση Εξέτασης της πρότασης για διεξαγωγή Έρευνας με τίτλο:
Η επίδραση της ασκησιογενούς μυϊκής βλάβης στη περιοδική κίνηση των κάτω άκρων κατά τη διάρκεια του ύπνου.

Επιστημονικώς υπεύθυνος – επιβλέπων: Σακκάς Γεώργιος Ερευνητής, Ινστιτούτο Σωματικής Άσκησης και Αποκατάστασης (ΙΣΑΑ), ΚΕΤΕΑΘ, Χριστίνα Καρατζαφέρη Επίκουρη Καθηγήτρια Τμήμα Επιστήμης Φυσικής Αγωγής και Αθλητισμού (ΤΕΦΑΑ), ΠΘ.

Κύρια ερευνήτρια - φοιτήτρια: Μήτρου Γεωργία, μεταπτυχιακή φοιτήτρια του ΠΜΣ «Άσκηση και Υγεία», ΤΕΦΑΑ, ΠΘ

Ίδρυμα & Τμήμα:
Πανεπιστήμιο Θεσσαλίας, ΤΕΦΑΑ
ΚΕΤΑΘ, ΙΣΑΑ

Η προτεινόμενη έρευνα θα είναι:

Ερευνητικό πρόγραμμα ☐ Μεταπτυχιακή διατριβή X Διπλωματική εργασία ☐ Ανεξάρτητη έρευνα ☐

Τηλ. επικοινωνίας: 6948 176 157
Email επικοινωνίας: geomi_@hotmail.com

Η Εσωτερική Επιτροπή Δεοντολογίας του Τ.Ε.Φ.Α.Α., Πανεπιστημίου Θεσσαλίας μετά την υπ. Αριθμ. 2-6/13-4-2011 συνεδρίαση της εγκρίνει τη διεξαγωγή της προτεινόμενης έρευνας.

Η Πρόεδρος της
Εσωτερικής Επιτροπής
Δεοντολογίας - ΤΕΦΑΑ

Χριστίνα Καρατζαφέρη
Επίκουρη Καθηγήτρια

Appendix 2: Consent Form

<u>Έντυπο συναίνεσης δοκιμαζόμενου σε ερευνητική εργασία</u>

<u>Τίτλος:</u> Η επίδραση της ασκησιογενούς μυϊκής βλάβης στην περιοδική κίνηση των κάτω άκρων κατά την διάρκεια του ύπνου.

Υπεύθυνοι Ερευνητές: Μήτρου Γεωργία, Επ. Καθηγήτρια Καρατζαφέρη Χριστίνα, Καθηγητής Κουτεντάκης Ιωάννης, Αν. Καθηγητής Στεφανίδης Ιωάννης, ερευνητής Σακκάς Γεώργιος.

1. Σκοπός της ερευνητικής εργασίας

Η μελέτη έχει στόχο να διερευνήσει κατά πόσο η μυϊκή κάκωση συμβάλλει στην εμφάνιση συμπτωμάτων που ίσως σχετίζονται με το σύνδρομο περιοδικής κίνησης ποδιών.

2. Διαδικασία μετρήσεων

Θα χρειαστεί

- Να απαντήσετε στα ερωτηματολόγια που ακολουθούν.
- Να συμμετάσχετε στη διαδικασία μέτρησης του ύψους και του βάρους σας.
- Να εκτελέσετε με τυχαία επιλογή την δοκιμασία άσκησης στο δαπεδοεργόμετρο **ή** στο ισοκινητικό δυναμόμετρο.
- Να δώσετε δείγμα αίματος για βιοχημική ανάλυση (πριν την άσκηση και 72 ώρες μετά).
- Να απέχετε από προπόνηση ή άλλη σωματική δραστηριότητα ή χειρισμό (πχ μασάζ) που μπορεί να αλλοιώσει τα αποτελέσματα της μελέτης.
- Να μην πάρετε παυσίπονο ή αντιφλεγμονώδες και ας νιώσετε «πιάσιμο» μετά την άσκηση.
- Να ακολουθήσετε για 4 βράδια το ίδιο πρόγραμμα κατάκλισης και να κοιμηθείτε για τουλάχιστον 7 ώρες κάθε βράδυ.

3. Κίνδυνοι και ενοχλήσεις

Δεν υπάρχουν κίνδυνοι για την υγεία σας αφού οι μέθοδοι συλλογής των στοιχείων είναι αβλαβείς. Υπάρχει περίπτωση για μικρό «μελάνιασμα» λόγω της δειγματοληψίας αίματος. Θα νιώσετε «πιάσιμο» και κόπωση λόγω της διαδικασίας άσκησης. Μην πάρετε παυσίπονο ή αντιφλεγμονώδες γιατί θα επηρεαστεί αρνητικά η έκβαση της μελέτης.

4. Προσδοκώμενες ωφέλειες

Το σύνδρομο περιοδικής κίνησης ποδιών δεν έχει ακόμα προσδιορισμένη αιτιολογία και η συμβολή της άσκησης στην εμφάνιση ή και επιδείνωση του συνδρόμου δεν είναι γνωστή. Τα ευρήματα από την εργασία θα σας δώσουν την δυνατότητα να μάθετε πώς είναι η ποιότητα του ύπνου σας και να καταλάβετε εάν η μυϊκή κάκωση επηρεάζει την ποιότητά του. Επίσης θα συμβάλλετε στην προαγωγή της γνώσης και θα βοηθήσετε έτσι τους συνανθρώπους σας που πάσχουν από νευρολογικά σύνδρομα (πχ σύνδρομο περιοδικής κίνησης ποδιών ή σύνδρομο ανήσυχων ποδιών).

5. Δημοσίευση δεδομένων – αποτελεσμάτων

Η συμμετοχή σας στην έρευνα συνεπάγεται ότι συμφωνείτε με τη δημοσίευση των δεδομένων και των αποτελεσμάτων της, με την προϋπόθεση ότι οι πληροφορίες θα είναι ανώνυμες και δε θα αποκαλυφθούν τα ονόματα των συμμετεχόντων. Τα δεδομένα που θα συγκεντρωθούν θα κωδικοποιηθούν με αριθμό, ώστε το όνομα σας δε θα εμφανίζεται πουθενά.

6. Πληροφορίες

Μη διστάσετε να κάνετε ερωτήσεις γύρω από το σκοπό, τον τρόπο πραγματοποίησης της εργασίας ή τον υπολογισμό της ποιότητας του ύπνου σας. Αν έχετε κάποιες αμφιβολίες ή ερωτήσεις, ζητήστε μας να σας δώσουμε πρόσθετες εξηγήσεις.

7. Ελευθερία συναίνεσης

Η άδειά σας να συμμετάσχετε στην εργασία είναι εθελοντική. Είστε ελεύθερος-η να μην συναινέσετε ή να διακόψετε τη συμμετοχή σας όποτε επιθυμείτε.

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

Ημερομηνία: __/__/__

Ονοματεπώνυμο και υπογραφή συμμετέχοντος

Υπογραφή ερευνητή

Ονοματεπώνυμο και υπογραφή παρατηρητή

Appendix 3: General Health Questionnaire

Ημερομηνία

I.D.

Συμπτωματολογία		**Ημερομηνία**
(Είχες πρόσφατα;)		
Πόνο στο στήθος	( )	
Λαχάνιασμα	( )	
Αίσθηση παλμών	( )	
Βήχα στην εξάντληση	( )	
Αιμόπτυση	( )	
Πόνο στη μέση	( )	
Πρήξιμο, δυσκαμψία ή πόνο στις αρθρώσεις	( )	
Ξυπνάς το βράδυ για τουαλέτα;	( )	

Παράγοντες επικινδυνότητας

Κάπνισμα	Ναι	Όχι		
Καπνίζεις;	( )	( )		
Τσιγάρα	( )	( )	Πόσα;	Πόσα χρόνια;

Πούρα ( ) ( ) Πόσα; Πόσα χρόνια;

Πίπα ( ) ( ) Πόσες φορές τη μέρα; Πόσα χρόνια;

Πόσων ετών ήσουν όταν ξεκίνησες;

Σε περίπτωση που σταμάτησες, πότε;

Γιατί;

Δίαιτα

Πόσο είναι το τρέχων βάρος σου;

1 χρόνο πριν;

Στα 21 σου;

Κάνεις δίαιτα;

Γιατί;

1. **<u>Άσκηση</u>**

Συμμετέχεις σε δραστηριότητες αναψυχής;

Σε ποιες;

Πόσο συχνά;

Πόση απόσταση νομίζεις ότι περπατάς κάθε μέρα;

Η εργασία σου είναι: Καθιστική ( )

Αδρανής ( )

Δραστήρια ( )

Βαριά ( )

Έχεις δυσφορία, λαχάνιασμα ή πόνο σε υπομέγιστη άσκηση;

Appendix 4: SF-36 Quality of Life Questionnaire

SF-36 ΕΡΕΥΝΑ ΠΟΙΟΤΗΤΑΣ ΖΩΗΣ

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
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

4. 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

5. 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)

	NAI	OXI
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

6. 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

7. 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 ενεργητικότητα;	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
θ. Αισθανόσαστε κούραση;	1	2	3	4	5	6

10. 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

11. 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 5: Weekly Sleep Diary

Εβδομαδιαίο Ημερολόγιο Ύπνου				
Ημερομηνία (ημέρα / μήνας / έτος) ________/________/_________ Patient's ID:________________	Παρακαλώ κυκλώστε την απάντηση που σας αντιπροσωπεύει.			
Κατά την διάρκεια της <u>προηγούμενης εβδομάδας,</u> πόσο συχνά είχατε…	Όχι, Καθόλου	1-2 φορές	3-5 φορές	6-7 φορές
1. Πρόβλημα να σας πάρει ο ύπνος;	0	1	2	3
2. Ξυπνήσει κατά την διάρκεια της νύχτας;	0	1	2	3
3. Πρόβλημα στο να μείνετε κοιμισμένοι; (ξυπνάγατε νωρίτερα απ'ότι συνήθως;)	0	1	2	3
4. Την αίσθηση ότι ξυπνάγατε κουρασμένοι και ταλαιπωρημένοι;	0	1	2	3
5. Ένταση & στρες κατά την διάρκεια της ημέρας;	0	1	2	3
6. Την αίσθηση ότι ξυπνήσατε ξεκούραστοι;	0	1	2	3

Υπογραφή
____

Appendix 6: Epworth Sleepiness Scale

Κλίμακα Υπνηλίας Epworth (Epworth Sleepiness Scale)				
Ημερομηνία (ημέρα / μήνας / έτος) ________/________/_________ Patient's ID:________________	Παρακαλώ κυκλώστε ένα από τα νούμερα που βρίσκονται κάτω από την απάντηση που σας αντιπροσωπεύει.			
Πόσο συχνά νιώθετε υπνηλία (γλαρώνετε) ή σας παίρνει ο ύπνος κατά την διάρκεια των παρακάτω καταστάσεων;	Ποτέ	Μικρή πιθανότητα	Πιθανόν να συμβεί	Σχεδόν πάντα
1. Όταν διαβάζετε ένα βιβλίο ή κάποιο περιοδικό καθισμένος/η	0	1	2	3
2. Όταν βλέπετε τηλεόραση	0	1	2	3
3. Όταν παρακολουθείτε μία συζήτηση σε δημόσιο χώρο ή βλέπετε μια ταινία στον κινηματογράφο	0	1	2	3
4. Όταν ταξιδεύετε σαν συνεπιβάτης σε ένα ΙΧ αυτοκίνητο και δεν έχετε κάνει διάλειμμα για τουλάχιστον μία ώρα	0	1	2	3
5. Όταν ξαπλώνετε το μεσημέρι μετά ρούχα σε έναν καναπέ για να ξεκουρασθείτε	0	1	2	3
6. Όταν κουβεντιάζετε καθιστός	0	1	2	3
7. Όταν μετά το μεσημεριανό σας γεύμα (δεν έχετε καταναλώσει αλκοόλ) καθίσετε και περιμένετε για λίγο	0	1	2	3
8. Όταν οδηγάτε το αυτοκίνητό σας και είστε σταματημένος/η στην κίνηση	0	1	2	3

Υπογραφή

____

Appendix 7: Pittsburgh Sleep Quality Questionnaire

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;				
8. Κατά τη διάρκεια του περασμένου μήνα πόσο δύσκολο σας ήταν να διατηρήσετε τη διάθεσή σας να κάνετε διάφορα πράγματα;				
	Πολύ καλή (0)	Σχεδόν καλή (1)	Σχεδόν κακή (2)	Κακή
9. Κατά τη διάρκεια του περασμένου μήνα πως θα βαθμολογούσατε την συνολική ποιότητα του ύπνου σας;				

K. Mystakidou, E. Parpa, E. Tsilika, M. Pathiaki, E. Patiraki, A. Galanos, L. Vlahos. Sleep quality in advanced cancer patients. J Psychosom Res 62 (2007) 527-533

Appendix 8: Daily Sleep Diary (morning)

<u>ΚΑΘΗΜΕΡΙΝΟ ΗΜΕΡΟΛΟΓΙΟ ΎΠΝΟΥ</u>

<u>ΣΥΜΠΛΗΡΩΣΤΕ ΤΟ ΠΡΩΙ</u>

	Πήγα για ύπνο χθες βράδυ στις :	*Ξύπνησα το πρωί στις :*	*Χθες βράδυ έμεινα άυπνος για:*	*Ξύπνησα κατά τη διάρκεια της νύχτας(πόσες φορές)*	*όταν ξύπνησα το πρωί ένιωθα:*	*Χθες βράδυ κοιμήθηκα συνολικά(αριθμός ωρών) :*	*Ο ύπνος μου διακόπηκε από (ψυχικούς, περιβαλλοντολογικούς, συναισθηματικούς παράγοντες π.χ. stress, ροχαλητό* *Θερμοκρασία :*
Ημέρα 1 *Ημερ/ία*	______ *πμ/μμ*	______ *πμ/μμ*	--------- *λεπτά*	-------- *φορές*	□ *ξεκούραστος* □ *κάπως ξεκούραστος* □ *κουρασμένος*	------- *ώρες*	______ ______ ______
Ημέρα 2 *Ημερ/ία*	______ *πμ/μμ*	______ *πμ/μμ*	--------- *λεπτά*	-------- *φορές*	□ *ξεκούραστος* □ *κάπως ξεκούραστος* □ *κουρασμένος*	------- *ώρες*	______ ______ ______
Ημέρα 3 *Ημερ/ία*	______ *πμ/μμ*	______ *πμ/μμ*	--------- *λεπτά*	-------- *φορές*	□ *ξεκούραστος* □ *κάπως ξεκούραστος* □ *κουρασμένος*	------- *ώρες*	______ ______ ______
Ημέρα 4 *Ημερ/ία*	______ *πμ/μμ*	______ *πμ/μμ*	--------- *λεπτά*	-------- *φορές*	□ *ξεκούραστος* □ *κάπως ξεκούραστος* □ *κουρασμένος*	------- *ώρες*	______ ______ ______
Ημέρα 5 *Ημερ/ία*	______ *πμ/μμ*	______ *πμ/μμ*	--------- *λεπτά*	-------- *φορές*	□ *ξεκούραστος* □ *κάπως ξεκούραστος* □ *κουρασμένος*	------- *ώρες*	______ ______ ______

Ημέρα 6 ***Ημερ/ία***	______ ***πμ/μμ***	______ ***πμ/μμ***	--------- ***λεπτά***	-------- ***φορές***	□ ***ξεκούραστος*** □ ***κάπως ξεκούραστος*** □ ***κουρασμένος***	------- ***ώρες***	______ ______ ______
Ημέρα 7 ***Ημερ/ία***	______ ***πμ/μμ***	______ ***πμ/μμ***	--------- ***λεπτά***	-------- ***φορές***	□ ***ξεκούραστος*** □ ***κάπως ξεκούραστος*** □ ***κουρασμένος***	------- ***ώρες***	______ ______ ______

Appendix 9: Daily Sleep Diary (night)

<u>ΚΑΘΗΜΕΡΙΝΟ ΗΜΕΡΟΛΟΓΙΟ ΎΠΝΟΥ</u>

<u>ΣΥΜΠΛΗΡΩΣΤΕ ΤΟ ΒΡΑΔΥ</u>

	Κατανάλωσα καφεϊνούχα ποτά (καφέ, τσάι,coca-cola)	***Ασκήθηκα το λιγότερο 20 λεπτά***	***Περίπου 2-3 ώρες πριν κοιμηθώ κατανάλωσα :***	***Παίρνω κάποια φαρμακευτική αγωγή κατά την διάρκεια της ημέρας(ονομασία)***	***Περίπου 1ώρα πριν πάω για ύπνο έκανα την ακόλουθη δραστηριότητα :***
Ημέρα 1 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	____ ____ ____	____ ____ ____
Ημέρα 2 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	____ ____ ____	____ ____ ____
Ημέρα 3 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	____ ____ ____	____ ____ ____
Ημέρα 4 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	____ ____ ____	____ ____ ____
Ημέρα 5 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα***	***□ αλκοόλ*** ***□ βαρύ γεύμα***	____ ____ ____	____ ____ ____

	παραπάνω	***παραπάνω***	***□ τίποτα από τα παραπάνω***		
Ημέρα 6 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	__________ __________ __________	__________ __________ __________
Ημέρα 7 ***Ημερ/ία***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ πρωί*** ***□ απόγευμα*** ***□ λίγες ώρες κοιμηθείς*** ***□ τίποτα από τα παραπάνω***	***□ αλκοόλ*** ***□ βαρύ γεύμα*** ***□ τίποτα από τα παραπάνω***	__________ __________ __________	__________ __________ __________

Appendix 10: RLS Diagnostic Criteria Questionnaire

ΔΙΑΓΝΩΣΤΙΚΑ ΚΡΙΤΗΡΙΑ ΣΥΝΔΡΟΜΟΥ ΑΝΗΣΥΧΩΝ ΠΟΔΙΩΝ

Ημερομηνία (ημέρα / μήνας / έτος)

________/________/_________

ID:_________________

	Ημέρα 1		Ημέρα 2		Ημέρα 3		Ημέρα 4		Ημέρα 5	
	Ναι	Όχι	Ναι	Όχι	Ναι	Όχι	Ναι	Όχι	Ναι	Όχι
1. Έχετε μια ακαταμάχητη επιθυμία να κουνήσετε τα πόδια σας, η οποία συνοδεύεται από ένα δυσάρεστο συναίσθημα στα κάτω άκρα;										
2.Η επιθυμία να κουνήσετε τα πόδια σας ή το δυσάρεστο συναίσθημα στα κάτω άκρα ξεκινάνε ή χειροτερεύουν όταν αναπαύεστε ή ξεκουράζεστε;										
3.Η επιθυμία να κουνήσετε τα πόδια σας ή το δυσάρεστο συναίσθημα στα κάτω άκρα μειώνεται ή εξαφανίζεται όταν κουνάτε τα κάτω άκρα σας (περπατάτε, τεντώνεστε κτλ);										
4.Η επιθυμία να κουνήσετε τα πόδια σας ή το δυσάρεστο συναίσθημα στα κάτω άκρα είναι χειρότερα:										
Το απόγευμα;										
Το βράδυ;										
Εμφανίζονται μόνο το βράδυ σε σχέση με την ημέρα;										

Appendix 11: McGill Pain Questionnaire

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΑΞΙΟΛΟΓΗΣΗΣ ΠΟΝΟΥ

ΟΝΟΜΑΤΕΠΩΝΥΜΟ:

	Καθόλου Πόνος	Ήπιος	Μέτριος	Έντονος
παλμικός-ρυθμικός	**0)**______	**1)**______	**2)**______	**3)**______
σαν να ‘περπατάει’	**0)**______	**1)**______	**2)**______	**3)**______
σαν ‘μαχαιριά’	**0)**______	**1)**______	**2)**______	**3)**______
οξύς	**0)**______	**1)**______	**2)**______	**3)**______
σαν ‘κράμπα’	**0)**______	**1)**______	**2)**______	**3)**______
σαν να ‘δαγκώνει’	**0)**______	**1)**______	**2)**______	**3)**______
καυστικός - ζεστός	**0)**______	**1)**______	**2)**______	**3)**______
γενικός - διαρκής	**0)**______	**1)**______	**2)**______	**3)**______
αίσθημα βάρους	**0)**______	**1)**______	**2)**______	**3)**______
ευαίσθητος	**0)**______	**1)**______	**2)**______	**3)**______
διαμελιστικός-σαν να σε ‘σκίζει’	**0)**______	**1)**______	**2)**______	**3)**______
κουραστικός	**0)**______	**1)**______	**2)**______	**3)**______
αηδιαστικός - νοσηρός	**0)**______	**1)**______	**2)**______	**3)**______
τρομακτικός	**0)**______	**1)**______	**2)**______	**3)**______
βασανιστικός - σκληρός	**0)**______	**1)**______	**2)**______	**3)**______

ΗΜΕΡΟΜΗΝΙΑ:
Ημέρα : ____(1 έως 5)

ΚΑΘΟΛΟΥ ΠΟΝΟΣ ———————————————— **Ο ΧΕΙΡΟΤΕΡΟΣ ΠΟΝΟΣ ΠΟΥ ΕΧΕΤΕ ΝΙΩΣΕΙ ΠΟΤΕ**

Ε.Π.Π.

0. Καθόλου Πόνος __________
1. Ήπιος __________
2. Ενοχλητικός __________
3. Οδυνηρός __________
4. Φρικτός __________
5. Αφόρητος __________

Appendix 12: Fatigue Severity Scale

1

FATIGUE SEVERITY SCALE
[FSS]

Διαβάστε τις παρακάτω δηλώσεις προσεκτικά. Μπορεί να συμφωνείτε ή να διαφωνείτε λίγο ή πολύ με κάθε μία από αυτές.
Σημαδέψτε στην κάθε δήλωση,πάνω στην κλίμακα αξιολόγησης,το σημείο που συμφωνείτε ή διαφωνείτε.
Α)Στο σημείο 1,όταν δεν συμφωνείτε καθόλου με την δήλωση.
Β)Στο σημείο 2 ή 3, άν διαφωνείτε κάπως, αλλά όχι ριζικά.
Γ)Στο σημείο 4, αν δεν μπορείτε ούτε να συμφωνήσετε ούτε να διαφωνήσετε.
Δ)Στο σημείο 5 ή 6 ,αν συμφωνείτε κάπως με τη δήλωση.
Ε)στο σημείο 7,αν συμφωνείτε πλήρως με τη δήλωση

ΔΗΛΩΣΗ	ΚΛΙΜΑΚΑ ΑΞΙΟΛΟΓΗΣΗΣ
1.Η ενεργητικότητα μου μειώνεται όταν είμαι κουρασμένος/η	1 2 3 4 5 6 7 *διαφωνώ πλήρως* — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*
2.Η σωματική άσκηση μου φέρνει κούραση	1 2 3 4 5 6 7 *διαφωνώ πλήρως* — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*
3.Κουράζομαι εύκολα	1 2 3 4 5 6 7 *διαφωνώ πλήρως* — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*
4.Η κούραση παρεμποδίζει τις δραστηριότητές μου	1 2 3 4 5 6 7 *διαφωνώ πλήρως* — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

5. Η κούραση μου προκαλεί συχνά προβλήματα

1 2 3 4 5 6 7

διαφωνώ πλήρως — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

6.Η κούραση δεν μου επιτρέπει παρατεταμένη σωματική δραστηριότητα

1 2 3 4 5 6 7

διαφωνώ πλήρως — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

7.Η κούραση με εμποδίζει να εκτελέσω ορισμένα καθήκοντά μου ή να φέρω σε πέρας μερικές υποχρεώσεις μου

1 2 3 4 5 6 7

διαφωνώ πλήρως — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

8.Η κούραση είναι ένα από τα τρία πιο σοβαρά μου συμπτώματα

1 2 3 4 5 6 7

διαφωνώ πλήρως — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

9.Η κούραση παρεμποδίζει τη δουλειά μου, την οικογενειακή ή την κοινωνική μου ζωή

1 2 3 4 5 6 7

διαφωνώ πλήρως — *ούτε συμφωνώ ούτε διαφωνώ* — *συμφωνώ απόλυτα*

ΟΝΟΜΑ…………………………………… ΗΛΙΚΙΑ………. ΗΜΕΡ: / /….

ΒΑΘΜΟΛΟΓΙΑ:……………………..

FSS ©.Προσαρμογή και στάθμιση στα Ελληνικά:
Ζ.Κατσαρού,Σ.Μποσταντζοπούλου και συν., Εγκέφαλος 2007;44:150-157.

Appendix13: Copyright Statement

Υπεύθυνη Δήλωση

Η κάτωθι υπογεγραμμένη Γεωργία Μήτρου (ΑΕΜ) 06/10), μεταπτυχιακή φοιτήτρια του Προγράμματος Μεταπτυχιακών Σπουδών «ΑΣΚΗΣΗ ΚΑΙ ΥΓΕΙΑ» του Τμήματος Επιστήμης Φυσικής Αγωγής και Αθλητισμού του Πανεπιστημίου Θεσσαλίας

δηλώνω υπεύθυνα ότι αποδέχομαι τους παρακάτω όρους που αφορούν

(α) στα πνευματικά δικαιώματα της Μεταπτυχιακής Διπλωματικής Εργασίας (ΜΔΕ) μου με τίτλο «Η επίδραση της μυικής κόπωσης στην νευρομυική δραστηριότητα κατά τη διάρκεια του ύπνου»

(β) στη διαχείριση των ερευνητικών δεδομένων που θα συλλέξω στην πορεία εκπόνησής της:

1. Τα πνευματικά δικαιώματα του τόμου της μεταπτυχιακής διατριβής που θα προκύψει θα ανήκουν σε μένα. Θα ακολουθήσω τις οδηγίες συγγραφής, εκτύπωσης και κατάθεσης αντιτύπων 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 συγγραφείς εμένα τον ίδιο, τον/την κύριο-α επιβλέποντα -ουσα ή και άλλους ερευνητές (όπως πχ μέλους –ών 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. επιβλέποντα -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.

05/07/2012

Η δηλούσα

Γεωργία Μήτρου