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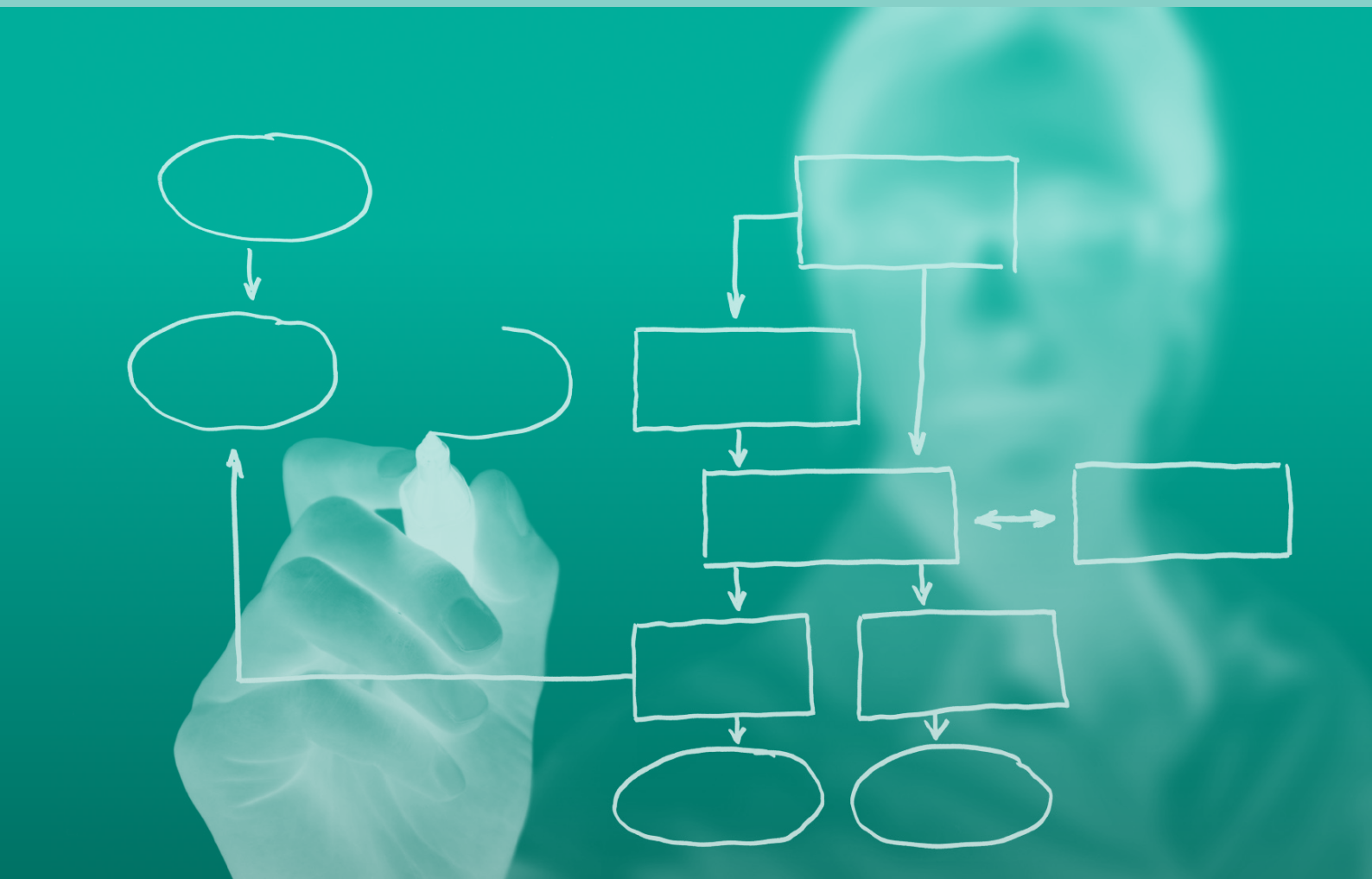
# PHYSIOTHERAPY UPDATES



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**Main office**
C/Segle XX, 78. 08032 Barcelona
Tel. 93 207 50 29 Fax. 93 207 70 22
www.fisioterapeutes.cat
cfc@fisioterapeutes.cat

**Manuscripts sent to:**
Col·legi de Fisioterapeutes de Catalunya. Revista Científica.
C/Segle XX, 78. 08032 Barcelona
revistacientifica@fisioterapeutes.cat

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## TABLE OF CONTENTS



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Col·legi
de Fisioterapeutes
de Catalunya

PHYSIOTHERAPY UPDATES

EDITORIAL

## SHARING KNOWLEDGE

**Ramon Aiguadé**
Dean and responsible for the Scientific Journal

If you are reading this, it means we have done it again: we have published another issue of the Scientific Journal of the Chartered Society of Physiotherapists of Catalonia (CFC) and this is issue number sixteen. You will find original articles, translations, abstracts, experts advising how to do research, reviews of congresses and end-of-degree projects.

The last time I reached you from these pages, please allow me this personal comment, I did it as the person in charge of the journal and also as treasurer of the CFC. Now, after the elections last November, I do it as chair of CFC, and as such, I can tell you that the intention of the new council is to continue offering contents that are useful and interesting for our profession.

This time I find two original articles particularly interesting: "Assessing the level of empathic ability and burnout syndrome in professionals of domiciliary functional rehabilitation" and "Effectiveness of a Nordic walking programme to improve functional capacity in adult patients (40-80 years) with Parkinson's disease. A systematic review". Read them, I'm sure you will enjoy them. You can also find texts on pelvic floor, multimodal physiotherapy, inflammatory process, motor learning or the conundrum that is the shoulder.

As I usually say: go through the index and I'm sure you will find something that will arouse your curiosity and will increase your knowledge. Ours is a profession that is constantly growing and research, and sharing its results, is the best way to keep updated.

This is why we are determined to continue committed to this Scientific Journal. I hope you enjoy it.

Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

ORIGINAL ARTICLE

# ASSESSING THE LEVEL OF EMPATHIC ABILITY AND BURNOUT SYNDROME IN PROFESSIONALS OF DOMICILIARY FUNCTIONAL REHABILITATION

Jordi Pujol-Puig[a,*], Vanesa Bayo-Tallón[b], Jordi Esquirol-Caussa[b], Maider Sánchez-Padilla[b], Carme Olivera-Noguerola[a], Carles Pujol-Puig[a]

[a] Corporación Fisiogestión domiciliary rehabilitation service. C/Casp 79, 3a pl. 08012 Barcelona.
[b] Physiotherapy Research Centre (S.U.R.F.), Escoles Universitàries Gimbernat (affiliated with Autonomous University of Barcelona). Av. de la Generalitat 202-206, 08174 Sant Cugat del Vallès (Barcelona).
[*] First author: Jordi Pujol-Puig. C/Casp 79, 3a pl. 08012 Barcelona. jpujol@fisiogestion.com. Tel.: 625553460

## ABSTRACT

**State of the art.** Empathy is an essential characteristic of clinical competence. There are not many studies on empathy related to functional rehabilitation. The scientific evidence shows a high prevalence of burnout syndrome in the field of healthcare, which has negative consequences both for sufferers themselves and the organization they work for.

**Aims**. Assess the level of empathy and burnout in functional rehabilitation professionals and examine its relationship with sociodemographic variables.

Analyse the relationship between empathy and burnout (subscales: professional efficacy, exhaustion, cynicism).

**Design/Methodology.** Observational analytical transversal study. Variables: sociodemographic; Empathy (Jefferson Scale of Physician Empathy, JSPE); Burnout (MBI-GS questionnaire, Maslach Burnout Inventory, general-Survey: exhaustion, cynicism, professional efficacy subscales). Univariate and bivariate descriptive analysis. Software package SPSS v.17.0; (CI 95% CI, statistical significance p <0.05).

**Results.** Descriptive: 77 participants (68.8% females, 31.2% males), mean age 33.45 (min. 22, max. 64 years; SD 10.10); 88.3% of them were physiotherapists and 11.7%, occupational therapists. Univariate analysis: mean JSPE: 38.44/60. MBI-GS: 58/112 (exhaustion 16.73/35, cynicism 14.45/42, efficacy 26.82/35). Bivariate analysis: significant linear relationship between empathy and professional efficacy (r=0.275; p=0.015).

**Conclusions.** The results show that the level of empathy (JSPE) does not correspond to our individual perception of empathy. A clearer, more universal definition of the term should be agreed.

Burnout shows a low level of exhaustion and cynicism and a high level of efficacy. Significant relationship between empathy and professional efficacy; no relationship with sociodemographic variables.

Further research on empathy and communication skills in the field of functional rehabilitation is needed in order to improve this clinical competence.

**Conflict of interests.** This study has not been funded by any external organization and it presents no conflicts of interest.

## ACKNOWLEDGMENTS

We would like to acknowledge all those people and institutions in the field of domiciliary functional rehabilitation that have voluntarily participated in this research project. We would also like to thank the management and research team of Escoles Universitàries Gimbernat (UAB) and the management of Corporación Fisiogestión.

**KEY WORDS:** Empathy. *Burnout.* Rehabilitation. Physiotherapy. Occupational therapy.

## STATE OF THE ART

The World Health Organization recommends the use of a biopsychosocial model when treating patients (1). They take into account the physical, cognitive, social, psychological, emotional, economic and spiritual aspects of the individual and also how these aspects interact with each other. It is therefore important to consider all these characteristics so that they can be part of the rehabilitation process and any therapeutic outcomes as well as the patient's level of satisfaction can improve (2). Within this framework, the concept of clinical competence comprises technical knowledge and therapist-patient communication and relationship skills for an efficient intervention (3).

When healthcare providers get in contact with their patients, it becomes clear that medicine means having scientific and humanistic knowledge and consequently it is necessary to acquire and develop sensitivity, communicative and social skills (4).

Empathy is an essential characteristic in the therapist-patient relationship but it is becoming more and more precarious due to different factors like medical scientific and technological advances, the mass media, culture, individual aspects of the doctor, the patient or his/her family, or the formal academic training of healthcare professions (5,6). Empathy is considered to be the core of the healthcare provider-patient relationship since medical practice is part of the human relations system that is why healthcare professionals should be trained in empathic interactions in order to help restore, maintain or improve the patient's quality of life and their physical, biological, psychological and social wellbeing (5, 6).

Although the term empathy is often used in the field of healthcare, its understanding by both the healthcare provider and the patient tends to be ambiguous (1), which brings about the undervaluing of its use as a therapeutic tool in clinical competence (2, 7). Empathy is the practical ability of emotional intelligence that makes us be aware of the other person's feelings, needs and concerns (8) or, colloquially speaking "to be in somebody's shoes" (2). Dr Edward R. Melnick defines empathy in healthcare as "the cognitive attribute that involves an understanding of patients' experiences, concerns, and perspectives combined with a capacity to communicate this understanding" (9). In short, empathy is a cognitive attribute that allows you to understand the patient's internal perspectives and experiences and the ability to communicate you do understand (3). The concept of empathy can be understood as the ability to imagine yourself "in somebody else's shoes", that is to say, to be aware of their feelings, emotions, concerns, needs, wishes, intentions and expectations, and the patient must feel this. Empathy does not only imply a commitment by the healthcare professional but it also includes the active participation and self-responsibility of patients and their environment (10).

In the last few years, many studies have been published on empathy within the healthcare field that emphasise the fact that good communication strengthens the care process. Most of these studies have been done within the field of medicine, odontology and nursing and there are just a few within the field of physical rehabilitation (4).

There are some instruments that measure empathy. The Interpersonal Reactivity Index (IRI) developed by Davis consists of 28 items distributed into four subscales that measure four dimensions of the global concept of empathy: perspective taking, fantasy, empathic concern and personal distress (11). Another of these instruments that can measure empathic behaviour is the Affective and Cognitive Empathy Test (Test d'Empatia Cognitiva i Afectiva, TECA). It is a global measure of empathy that provides information about cognitive and affective aspects through four subscales: perspective taking, emotional understanding, personal distress and empathic joy (12). The Jefferson Scale of Physician Empathy (JSPE) (9) is an instrument that has been widely used in clinical studies and its validity and reliability have been widely demonstrated in several countries. In 2005 it was validated in Spanish by Alcorta-Garza *et al.* (13). This scale has wide published evidence that supports the construct validity and internal consistency (psychometric indicators) of the English and Spanish versions. It consists of 20 questions including variables such as age, sex, year at medical school and empathic orientation (13) and 20 7-point Likert-type items (7). Half of these items are positive coded and give a directly proportional result (1 = strongly disagree and 7 = strongly agree) and the other half are reverse coded yielding a reverse score (1 = strongly agree and 7 = strongly disagree) (7.14). Evidence shows that the JSPE is the only instrument that can measure empathic orientation in all its dimensions with factors that are relevant in situations that involve treating people (15) after comparing it with other instruments such as Davis' IRI (11).

Research done with students of healthcare sciences indicates that empathic aptitude can be significantly improved by offering a humanistic point of view at medical school, particularly if the professor is involved in the students' experiences with patients (16). In 2007 Gonzáles (17), in his article "The Expert Nurse and Inter-Personal Relations", aimed to develop elements of knowledge and skill that foster inter-personal relations. Gonzáles stressed that having little experience in clinical practice often makes the application of efficient methods in therapeutic relationships difficult.

A study carried out at Boston University School of Medicine examined the importance of empathy in the doctor-patient relationship and concluded that doctor empathy could decline with clinical training (18). Their aim was to measure student empathy across medical school years. The results indicate that in the preclinical years, the level of empathy was higher than in the clinical years so

they suggested doing further research to confirm whether clinical training impacts negatively on empathy and, if so, whether interventions can be designed to reduce this impact (18).

Although in the last few years, clinical practice has become more sophisticated and progressively more specialised, communication skills continue to be key in the treatment of patients in order to achieve a clinical improvement and a higher level of subjective satisfaction, together with the family and the healthcare professionals involved in the treatment (2,4,7,19,20,21), making teamwork easier and reducing the level of burnout (2,22).

Burnout syndrome was first described in 1974 by the American psychiatrist Herbert Freudenberger, who defined it as "overcome by fatigue and frustration which are usually brought about when a job, a cause, a way of life, or relationship fails to produce the expected reward" (24). According to Freudenberger, those people who are more devoted and committed to work are more prone to developing burnout, particularly those who have professions that provide help to others (therapeutic communities, voluntary services, etc.) (24). In 1981 Pines, Aronson and Kafry defined burnout syndrome as a state of physical, emotional and mental exhaustion caused by long term involvement in emotionally demanding situations (24).

Later on, Maslach *et al* defined burnout as a psychological syndrome that appears as a response to chronic work stressors. They state that the three dimensions of this response are emotional exhaustion, which is the basic dimension of burnout and refers to the sufferer's lack of physical and emotional resources; depersonalization or feelings of cynicism, which represent the interpersonal context dimension of the syndrome; and low personal accomplishment or feeling of incompetence, which represents the self-evaluation dimension and refers to the feelings of lack of productivity at work (23,24,25). After the appearance of this phenomenon, Schaufeli, Leiter, Maslach and Jackson developed the MBI-GS (Maslach Burnout Inventory, general Survey) (23), designed to assess three components of a possible crisis of a person with his/her habitual environment, how this person relates to this context, and the effects on his/her health and wellbeing; reflecting not only the impact of work pressure but also the subject's personal environment. The survey consists of 16 items distributed among three subscales: professional efficacy (six items about social and non-social aspects at work focusing on the person's expectations of success), exhaustion (five items about physical and emotional fatigue) and cynicism (five items about distant attitudes toward work, as a way of trying to stay away from work so as not to face its tiring demands, reducing the energy of the person to do a good job and develop creative solutions to work problems) (13).

The latest changes in our socioeconomic environment and labour market have significantly contributed to the spreading of burnout, which does not only have an impact on the health of healthcare providers but also on healthcare quality, damaging the doctor-patient relationship and involving a very high social and economic cost. Burnout syndrome is a public health problem that has become central in the last few years. Scientific evidence demonstrates the high prevalence of this syndrome in the medical world with negative consequences for workers and also for the institutions they work for. A review done in the States and Canada between 1984 and 2001 (25) on burnout syndrome in doctors found high percentages in the three dimensions of burnout among medical professionals. They presented moderate to high levels of emotional exhaustion, high levels of depersonalization and low to moderate levels of personal accomplishment (23).

In primary care, one out of three doctors and nurses suffer from burnout, as shown in some studies that measure the prevalence of this syndrome in these professionals. One of these studies was done with specialists of different medical disciplines in Santa Cruz de Tenerife, Spain (26). Another similar study done in Madrid, Spain, concluded that the levels of exhaustion were slightly higher compared to the former study. A different study carried out in Barcelona, Spain, estimated that over 40% of interviewees had high levels of emotional exhaustion and depersonalization and 30% had low levels of personal accomplishment. All these studies used the MBI-GS version for healthcare professionals and they all got a response percentage over 60% (27).

**AIMS**

The main aim of this study was to assess the level of empathic ability and burnout in a group of domiciliary physiotherapists and occupational therapists working for a company providing functional rehabilitation services.

The secondary aims were to examine which variables could modify the levels of empathy and burnout of the studied sample. Therefore, the following were analysed: bivariate relations between JSPE outcomes (level of empathy ability) and healthcare professionals (physiotherapists or occupational therapists); the correlation between direct questions (self-perception of empathy changes) and age; the perception of empathy changes in males and females during their professional career in domiciliary care; and the correlation between empathy and burnout and their subscales (professional efficacy, exhaustion and cynicism).

## METHOD

**Study design and environment:** An observational analytical transversal study was done from January to May 2011 in a state-subsidised private company of domiciliary functional rehabilitation for the metropolitan area of Barcelona.

**Sample:** The study was first addressed to all the physiotherapists and occupational therapists working for the company who wanted to take part in it voluntarily and signed the corresponding informed consent form. Their anonymity and confidentiality was guaranteed. The inclusion criteria were: to be self-employed, to be a physiotherapist and/or occupational therapist working for the company. Out of a total of 95 possible participants that fulfilled the criteria, finally 77 (68 physiotherapists and 9 occupational therapists) took part in the study, the remaining 18 were excluded because they did not meet the aforementioned criteria.

**Variables and data gathering instruments:** The participants in the study were given the informed consent form (complying with the necessary bioethical requirements), a withdrawal form and a questionnaire with the following variables: descriptive sociodemographic data (age, sex, professional specialty and years of experience in domiciliary rehabilitation), two direct yes-no questions (*do you think you are an empathic person at work?* And *do you think your level of empathy has changed since you started working in domiciliary care?*), the Jefferson Scale of Physician Empathy (JSPE, assessing empathy) and the Maslach Burnout Inventory, general Survey (MBI-GS, assessing burnout syndrome) with their three subscales (professional efficacy, exhaustion and cynicism) (13).

**Method and data gathering:** The data gathering instruments were given to the 77 professionals (physiotherapists and occupational therapists) and then collected by the researchers. The volunteers had 20 minutes to complete all the forms anonymously. The variables were collected in a single session with no posterior follow-up.

**Data analysis:** The univariate and bivariate statistical analysis was done using IBM® SPSS v.17.0 software programme. The final sample included all those volunteers that fulfilled the inclusion criteria, completed the data collection forms, and had signed the informed consent form. In order to analyse the main and secondary aims, techniques of univariate and bivariate descriptive analysis were used: qualitative variables were analysed with the chi square parametric test and quantitative variables were analysed with ANOVA (CI 95%, significance $p < 0.05$ at n-1 degrees of freedom and considering a normal distribution) and Pearson's linear correlation coefficient (CI 95%, significance $p < 0.05$ at n-2 degrees of freedom and considering a normal distribution).

**Sample description:** The final sample consisted of 77 participants, 68.8% (n = 53) females and 31.2% (n = 24) males with a mean age of 33.45 years (minimum 22, maximum 64 years. Typical deviation 10.10. Asymmetry 1.267). Age was grouped into percentiles so that participants could be divided into four similar groups and then compare the youngest and oldest groups (under 26 n=22; 27-30 n = 15; 31-40 n = 20; over 41 n = 17. Three participants did not answer this question). Most participants (88.3%, n = 68) were physiotherapists and the rest (11.7%, n = 9) were occupational therapists. In relation to professional experience, 48.6% had 5 years or less of experience in domiciliary rehabilitation (n = 35) and 51.4% had more than 5 years of experience in this field; 5 participants did not answer.

## RESULTS

### Univariate variables

Mean score in the JSPE was 38.44 over a total of 60 points. Table 1.

**Table 1**

Mean scores in the Jefferson Scale of Physician Empathy (JSPE)

| | | |
|---|---|---|
| N | Valid | 77 |
| | Missing | 0 |
| Mean | | 38,44 |
| Median | | 39,00 |
| Typical desviation | | 10,496 |
| Asymmetry | | -0,513 |
| Asymmetry (typical error) | | 0,274 |
| Minimum | | 7 |
| Maximum | | 58 |
| Percentiles | 25 | 32,00 |
| | 50 | 39,00 |
| | 75 | 45,50 |

The mean score of the MBI was 58 over a total of 112. Table 2.

**Table 2**

Results of the MBI for each subscale and total scores.

| | | MBI exhaustion subscale | MBI cynicism subscale | MBI efficacy subscale | MBI Total |
|---|---|---|---|---|---|
| N | Valid | 77 | 77 | 77 | 77 |
| | Missing | 0 | 0 | 0 | 0 |
| Mean | | 16,73 | 14,45 | 26,82 | 58,00 |
| Median | | 16,00 | 13,00 | 28,00 | 57,00 |
| Typ. dev. | | 4,480 | 4,044 | 4,019 | 9,217 |
| Asymmetry | | 1,147 | 1,325 | -1,141 | ,907 |
| Asymmetry typ. error | | ,274 | ,274 | ,274 | ,274 |
| Minimum | | 9 | 7 | 15 | 41 |
| Maximum | | 32 | 27 | 35 | 89 |
| Percentiles | 25 | 14,00 | 12,00 | 24,00 | 53,50 |
| | 50 | 16,00 | 13,00 | 28,00 | 57,00 |
| | 75 | 19,00 | 16,00 | 30,00 | 62,00 |

The mean in the exhaustion subscale of the MBI-GS was 16.73 over a maximum of 35 points, the mean in the cynicism subscale was 14.45 over 42, and the mean in the professional efficacy scale was 26.82 over 35.

The answer to the direct question *do you think you are an empathic person at work?* showed that 100% of the participants (n = 77) considered themselves to be empathic. When answering the question *do you think your level of empathy has changed since you started working in domiciliary care?*, 76.3% (n = 58) of respondents said it had improved (51 physiotherapists and 7 occupational therapists), 21.1% (n = 16) had not perceived any changes (14 physiotherapists and 2 occupational therapists), and 2.6% felt their empathic ability had declined (2 physiotherapists). One participant did not respond.

### Bivariate variables

In the bivariate analysis correlating the level of empathy according to the JSPE and the healthcare profession, physiotherapists got a mean score of 37.79 (minimum 7, maximum 58; typical deviation 10.922) whereas occupational therapists had a mean score of 43.33 (minimum 38, maximum 49; typical deviation 4.123; p = 0.138).

In relation to one's self-perception of any changes in the level of empathy through a direct question, in the group under 26 years (n = 22) one respondent felt it had got worse, 4 felt it had not changed and 17 felt it had improved. In the 27-30 group (n = 15), 6 respondents said there was no change and 9 said it had improved. In the 31-40 group (n=20), 1 respondent said it had got worse, 5 said it was the same and 14 said it had improved. In the group over 41 (n = 17) all the respondents felt it had improved (p = 0.125). When comparing the two sexes, 73.08% of all the females in the study (n = 38) and 83.33% of males considered their level of empathy had improved, 23.07% of females (n = 12) and 16.66% of males (n = 4) said it had not changed, and only 2 women (3.85%) considered it had declined (p = 0.480).

In the bivariate analysis comparing the scores obtained in the JSPE and sex, women got a mean of 37.60 (minimum 7, maximum 58, typical deviation 10.481) and men got a mean of 40.29 (minimum 18, maximum 57, typical deviation 10.511, p = 0.301).

When correlating the scores in the JSPE and the years of experience, those workers with less than 5 years of experience had a mean of 37.11 (minimum 7, maximum 58, typical deviation 10.951) and those with more than 5 years of experience had a mean of 40.19 (minimum 11, maximum 57, typical deviation 9.882, p = 0.215).

The results from Pearson correlation analysis between the JSPE and the three MBI-GS subscales were significant in the subscale of professional efficacy (p = 0.015), which demonstrates that there is a linear tendency between these two variables and an r = 0.275.

## CONCLUSIONS

Although the term "empathy" is often used and known by all healthcare professionals, this study shows a certain ambiguity in its understanding since one's own perception of empathy does not seem to correspond with the results obtained in the JSPE. The concept of empathy should be internationally agreed on since in the literature we cannot find a specific, clear and universal definition of the term (7).

The direct dichotomous question about one's individual perception of empathy is likely to have shown greater sensitivity if it had a Likert-type response, this way it could have better fine-tuned the self-perception of level of empathy, since it does not match the results of the JSPE, which showed a moderate to high level of empathy.

The results of this study suggest that there is no correlation between the variables of age, sex, years of professional experience, healthcare specialty, level of empathy or burnout level as no significant differences were found.

The MBI-GS scale yielded low levels of exhaustion and cynicism and a high level of professional efficacy. There was a statistically significant linear correlation between the level of empathy and professional efficacy and a lack of correlation between the subscales of cynicism and exhaustion of the MBI-GS compared to the JSPE.

This study, together with other published studies (28, 29), encourages reflection on the need for training actions and unifying the concepts of definition of empathy, communicative skills and interrelation abilities in the field of healthcare. The biopsychosocial model allows us to optimise the rehabilitation process, improve therapeutic outcomes and consequently the patient's level of satisfaction, and therefore improve our clinical competence (30, 31).

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Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

ORIGINAL ARTICLE

# EFFECTIVENESS OF A NORDIC WALKING PROGRAMME TO IMPROVE FUNCTIONAL CAPACITY IN ADULT PATIENTS (40-80 YEARS) WITH PARKINSON'S DISEASE. A SYSTEMATIC REVIEW

[1]Soler Rabassa J, [2]Donat Roca R [0000-0001-6699-6857], [2]Borao Soler O [0000-0002-2402-3501], [2]Serra Ferrer M [0000-0001-8523-8568]

[1]Degree in physiotherapy. Fundació Universitària del Bages. Faculty of Health Sciences, Manresa, (UAB).
Casa Soler, s/n , 08610 Avià, Barcelona. Tel: 618 386 687 juliasolerrabassa@gmail.com
[2] Faculty of Health Sciences, Manresa, Universitat de Vic-Universitat Central de Catalunya (UVicUCC).
Av. Universitària, 4-6, 08242 Manresa, Espanya.

## ABSTRACT

**Introduction.** Parkinson's disease (PD) is the second regarding the incidence of neurodegenerative diseases in Spain (235.9 new cases for every 100,000 people - year) in people aged between 45 and 85 years old. It involves a large financial outlay per person per year, which will be augmented by the increase in the aging population. Growing evidence shows that Nordic Walking (NW) is beneficial to health, low cost and has an easy application. The evolution of the practice and its growth has been very important in recent years due to the increase in the demand for healthy activities by the population. Even so, there is a dispersion of various initiatives and techniques that have been created and modified.

**Objectives.** To determine the effectiveness of Nordic Walking as intervention for the improvement of functionality in adult subjects (40-80 years) with Parkinson's disease.

**Methods.** A bibliographic search of clinical trials using the health sciences databases PUBMED and PEDro has been carried out.

**Results.** Seventeen clinical trials have been identified, of which only 7 have been selected to be analyzed according to the inclusion criteria of the bibliographic review. Positive results are obtained regarding aerobic capacity and quality of life. Nordic walking improves balance, reduces bodily rigidity and promotes mobility in general by facilitating daily activities. The functional variables (aerobic capacity, balance and quality of life) have been mostly measured from 6MWT, TUG, BBS and the PDQ-39 questionnaire.

**Conclusions.** The results of this review corroborate the suitability of the use of Nordic walking as physical activity in terms of improving aerobic capacity, motor and balance symptoms and quality of life. New research would be desirable, but taking into account sample size, the different phases of disease evolution and the use of more reliable tests according to the clinical variables and functional expectations of Parkinson's patients.

**KEYWORDS:** Parkinson'sdisease. Nordicwalking. Exercisetherapy. Balance. Quality of life.

## INTRODUCTION

Parkinson's disease (PD) is a degenerative disease of the central nervous system (CNS). It is characterised by dysfunction and loss of dopaminergic neurons [1,2]. In Spain the incidence of PD is estimated at about 235.9 new cases per 100,000 people/year, for the age range from 45 to 85. Current data establish the onset of PD between 50 and 59 years of age although it can start after the age of 40 in some cases [3]. The disease is more prevalent in males with 359.6 per 100,000 people/year [4,5].

The most relevant motor symptoms of patients with PD are the following:

- Tremor: although this is the symptom that socially identifies a PD sufferer, 15% of these patients do not develop it. However, it is one of the first symptoms to appear. It is a slow and rhythmic shaking that usually starts in the distal part of the upper limbs, unilaterally, and is more evident at rest [2,6,7].
- Rigidity: this limited range of motion of a joint is associated with the "cogwheel" phenomenon and with pain. It is also related to a stooped posture caused by the most marked flexor pattern [6–8].
- Bradykinesia[1]: there is a slight arm swinging or motor block during gait as well as akinesia of speech and respiratory muscles (soft, weak voice), which results in a reduced respiratory capacity [2,6,8].
- Posture instability: it normally occurs as a consequence of the other clinical characteristics that lead to a posture and pattern that compensate for this loss of balance [6,7].

On the other hand, in the last few years there has been a growing interest in healthcare in the use of Nordic walking (NW) as a therapeutic tool [9]. Among the multiple indications of this activity, many of them are directed to people with problems with coordination and/or balance, agility, loss of dissociation between pelvic and shoulder girdle and all this with the aim of working the upper and lower limbs together. That is why NW is considered a safe and easy tool to reduce the effects of some chronic diseases such as PD [10,11].

In normal conditions, NW does not require a great level of concentration because it is quite an automatized activity. In case of disability, pole walking can be even more tiring than conventional gait [12].

The effective application of a clinical intervention tool like NW involves the study of the physiological cost required to do this activity as well as of the limitations of the physical capacity of the walker. The studies available emphasise that heart rate (HR) and volume of oxygen ($VO_2$) must be monitored since NW is an aerobic exercise that requires the control of our physical capacity [13]. The current literature on this issue in rehabilitation is limited and has very heterogeneous samples. Choosing the appropriate evidence-based physical assessment tools is key in order to obtain relevant results in the measurement of the effectiveness of NW as an intervention in adult patients (40-80 years) with PD for the functional variables of aerobic capacity, balance and quality of life [14].

## METHOD

A bibliographic search using the PEDro and PUBMED databases was performed between November 2016 and January 2017.

### Inclusion criteria

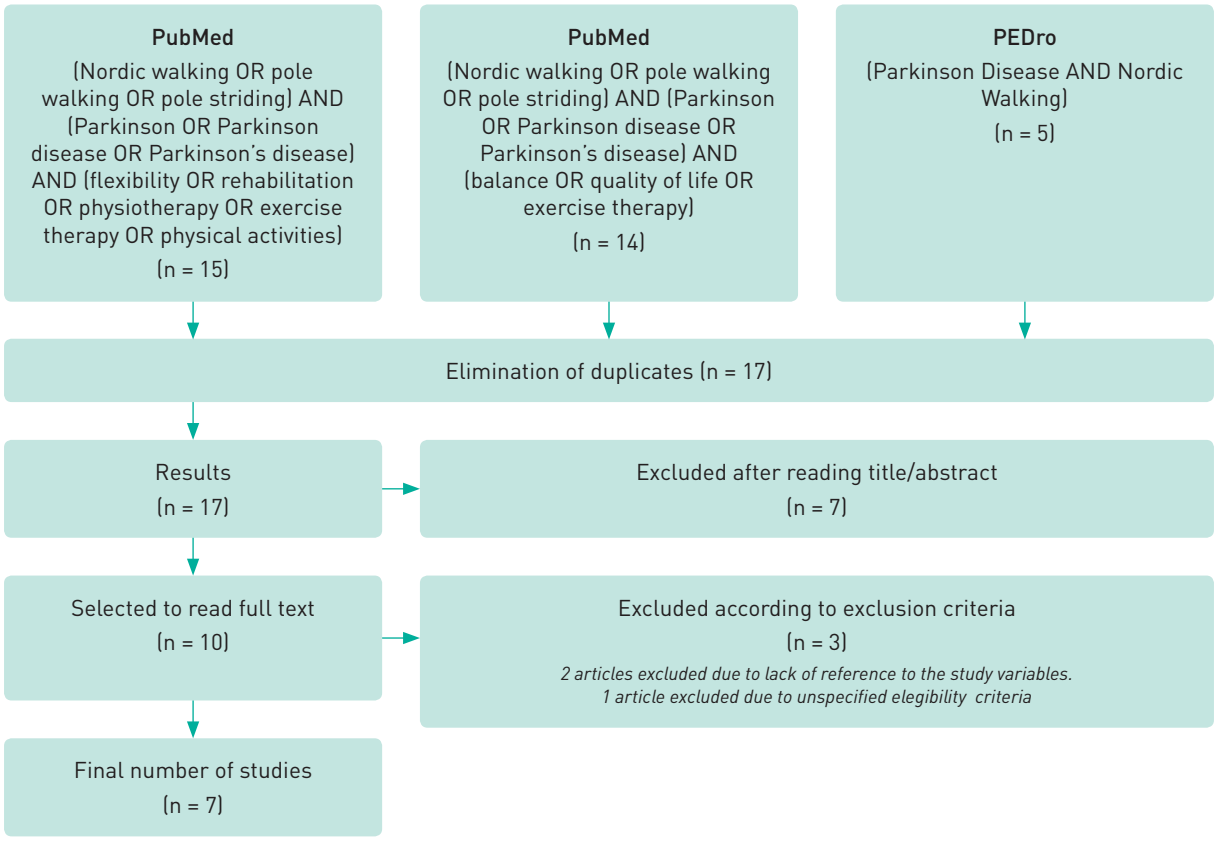
- Clinical trials (>4/10 PEDro scale).
- Population – mixed between 40 and 80 years.
- NW used as a therapeutic tool.
- Articles including patients diagnosed with PD in any of its stages.

### Exclusion criteria

- Articles that do not clearly combine NW with PD.
- Articles that include patients with different types of parkinsonian symptoms instead of patients clearly diagnosed with PD.

The flow diagram below shows the search method in a detailed way with the results obtained after applying the different filters and in the different databases, as well as the quantification of the results obtained in this search to get the final number of analysed articles.

1 Bradykinesia: slowed voluntary movements.




## RESULTS

Finally the studies that fulfilled the search and selection criteria were 7 (Table 1). Data search focuses on the year of publication, authors, evidence level, and results explained in a descriptive way and chronologically ordered from the most to the least recent.

### Dominance

The dominance of the results obtained from the final analysed documents in this bibliographic review as a whole are the following.

### Characteristics of the sample

Sex and sample size: most participants are male. Only in two articles females predominate. There is quite a lot of variability in the number of patients, from a maximum of 90 to a minimum of 6 (Figure 1).

Age: the population of the selected studies has a mean of 66.25 years ± 6.75 (SD).

Severity level: according to the Hoehn and Yahr scales (HY), this is classified into four levels, from the least severe to the most severe (Figure 2). Most of these articles include patients at stage I-III according to the Hoehn and Yahr scale. Only one of the articles includes patients at stage I-IV. The detailed distribution of subjects in each article according to severity level is not specified.

### Characteristics of the study

Withdrawal rate: None of the studies presents a significant withdrawal rate (> 20%), which describes a strong patient adherence to NW in each study (Figure 3). Regarding intervention duration (Table 2), there are two articles that significantly deal with interventions lasting more than 10 [17] and 20 [18] weeks, with a withdrawal rate of 0%.

Randomisation level: According to the PEDro scale, none of the articles meet the criteria of patient and therapist blinding. Only a study had a blind assignment and 42.9% of the reviewed studies had a blinded assessor.

**Table 1**

Summary of the results of the analysed studies.

| Year | Authors | Evidence level (PEDro) | Results |
|---|---|---|---|
| 2017 | Monteiro EP *et al.* (15) | 6/10 | Improvements in UPDRS III (p<0.001), balance scores (p<0.035), TUG SS distance (p<0.001), TUG FS distance (p<0.001), and LRI (p<0.001) were found in the two groups. However, the NW group showed significant differences (p<0.001) when compared to the FW group for functional mobility. |
| 2016 | Bang DH *et al.* (16) | 8/10 | Significant improvement in the NW group: UPDRS-M (p=0.006), BBS (p=0.002), TUG (p=0.048), 10 MWT (p=0.047), and 6 MWT (p=0.003).<br>There were no significant differences in the incidence rate of falls between groups (p>0.05). |
| 2015 | Cugusi L *et al.* (17) | 5/10 | Decrease in resting HR (p<0.05) and in diastolic blood pressure at rest (p<0.05).<br>Increase in both walked distance (p<0.05) and in lower limb muscle strength (p<0.005) in the NW group.<br>Increase in balance ability and safety (p<0.005). |
| 2011 | Reuter I *et al.* (18) | 6/10 | Improvement in the Berg-Balance scale of all groups (p<0.001).<br>Decrease of HR at submaximal intensity (p<0.001) and systolic blood pressure (p=0.004) in the NW and the walking group. Decrease in scores of the PDQ 39 in all the groups (p<0.001). |
| 2010 | Ebersbach G *et al.* (19) | 6/10 | Significant improvement in the LSTV-Big group compared to the other two groups (UPDRS-III (p<0.001) and TUG (p=0.033)).<br>No significant differences were found in the other two variables. |
| 2008 | Van Eijkeren *et al.* (20) | 4/10 | The difference in PDQ-39 was marginally significant for the subgroup of 9 patients (p=0.08) but was significant for the entire group (p<0.01).<br>All treatment effects persisted 5 months after the treatment at T3. |
| 2000 | Baatile J *et al.* (21) | 4/10 | Significant improvement in quality of life at the end of the treatment (p<0.028).<br>Significant differences occurred in the UPDRS total score following Pole Striding (p<0.026) |

**Figure 1**

Sample size and sex in each article.

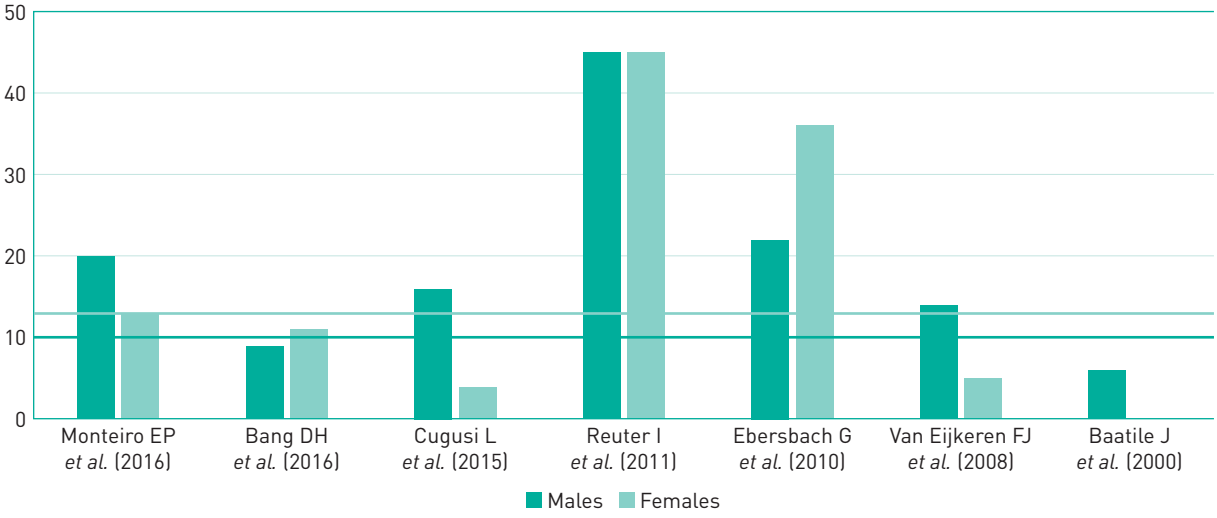


**Figure 2**

Severity levels of the sample using the Hoehn and Yahr scale (coloured bars, positive; patterned bars, negative).

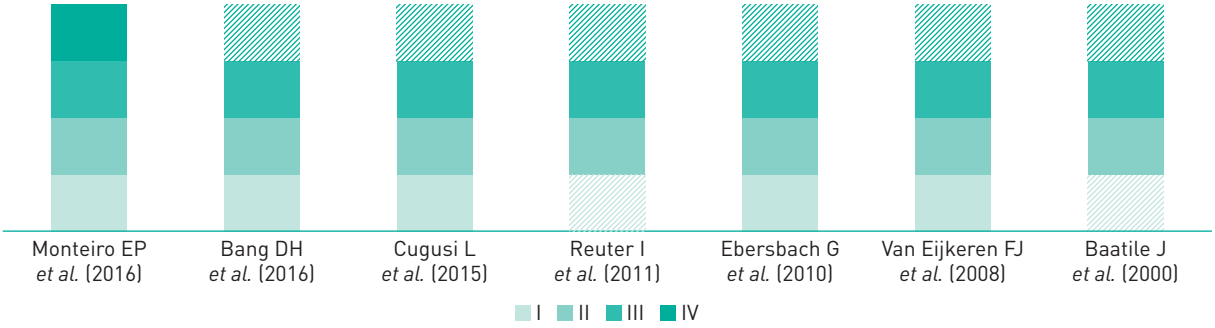



**Figure 3**

Sample and withdrawal rate.

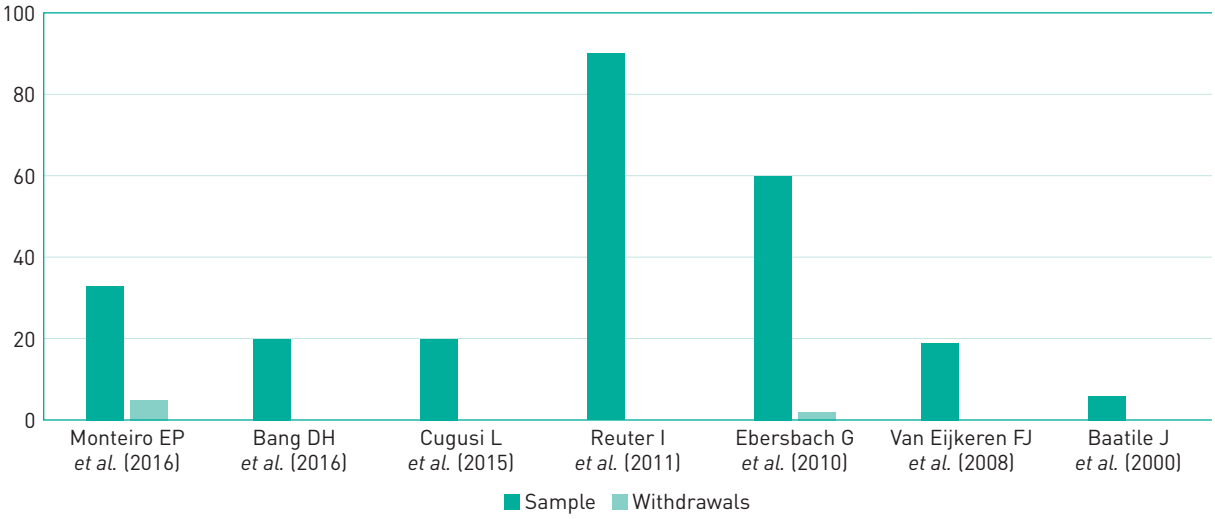



**Table 2**

Duration of interventions.

| Author and year | Frequency | Number of weeks | Total sessions | Time per session (min.) |
|---|---|---|---|---|
| Monteiro *et al.* (2016) | 2 days/week | 9 | 18 | 60 |
| Bang *et al.* (2016) | 5 days/week | 4 | 20 | 60 |
| Cugusi *et al.* (2015) | 2 days/week | 12 | 24 | 60 |
| Reuter *et al.* (2011) | 3 days/week | 24 | 72 | 70 |
| Ebersbach *et al.* (2010) | 2 days/week | 8 | 16 | 60 |
| Van Eijkeren *et al.* (2008) | 2 days/week | 6 | 12 | 60 |
| Baatile *et al.* (2000) | 3 days/week | 8 | 24 | 60 |

**Global dominance within each clinical variable**

Assessment tools used in the study:

Figure 4 shows the percentages of use of different assessment tools for each of the variables analysed in the selected articles. For the aerobic capacity variable (measured in 6 articles), the most commonly used test is the 6 Minute Walking Test (6MWT), use of 50%.

Out of the 7 articles, 6 took balance into account. 33% of them used the Test Time Up &Go (TUG) test just as the other 50% used the combination of the two tests. Therefore, balance has been measured, in most articles, using the TUG test together with the Berg Balance Scale (BBS) or only using the former.

The Berg test is used on its own only in one of the 6 articles that measure balance.

The quality of life variable is measured through the Parkinson's Disease Questionnaire (PDQ-39) in all the four articles it is assessed.

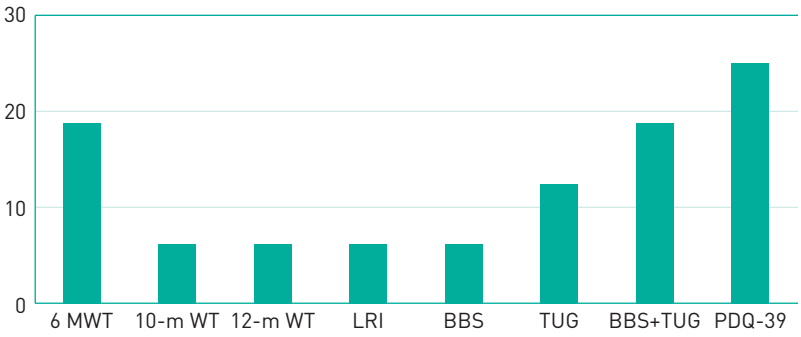
**Relationship between analysed variable, assessment tool and % of improvement:**

Table 3 shows the % improvement for each variable and evaluation tool used.

Apart from the aerobic capacity and balance variables, all the articles that assessed any changes in quality of life show a reduction in PDQ-39 scores, which means a general improvement of this clinical variable. Reuter *et al.* [18] pay special attention to cognitive improvements since, in their case, this was the only subgroup that showed a clear difference when compared to other study groups. In this clinical trial, the NW group showed the most considerable improvement ($p < 0.02$). In other cases there is an aggravation, for example in emotional wellbeing, stigma, cognition, communication, and body discomfort. In some cases, the changes related to social support are not specified.

**Figure 4**

Percentage of use of the different assessment tools.




*6 MWT: 6 minute walking test*
*10-m WT: 10 meter walking test*
*12-m WT: 12 meter walking test*
*LRI: Locomotor Rehabilitation Index*
*BBS: Berg Balance Scale*
*TUG: Time Up & Go Test*
*PDQ-39: Parkinson's Disease Questionnaire-39*

**Table 3**

Percentages of improvement for each variable and assessment tool used.

| Variable | Assessment tool | % Improvement |
|---|---|---|
| Aerobic capacity | 6MWT | **Increase from baseline distance:**<br>21.27% → Bang DH *et.al.* [16]<br>16.35% → Cugusi L *et.al.* [17]<br>16.98% → Van Eijkeren FJ *et.al.* [20] |
| Balance | TUG | **Reduction of time in seconds:**<br>Un 17,8% → Monteiro E *et al.* [15]<br>Un 33,28% → Bang DH *et al.* [16]<br>Un 7,5% → Cugusi L *et al.* [17] i Ebersbach G *et al.* [19]<br>Un 15,38% → Van Eijkeren FJ *et al.* [20] |
| Balance | BBS | **Balance improvement (%):**<br>No improvement → Monteiro E *et.al.* [15]<br>12.45% improvement → Bang DH *et.al.* [16]<br>12.99% improvement → Cugusi L *et.al.* [17]<br>5.51% improvement → Reuter *et.al.* [18] |

## DISCUSSION

This review aims to determine how effective a NW intervention is in terms of functional improvement in patients with PD aged between 40 and 80. That is why the specific aims of this study were the analysis of aerobic capacity, balance and quality of life in these patients. NW is a physical activity that is performed in relatively long distances and with a high level of fatigue.

The lack of satisfactory results when NW is used, particularly in relation to quality of life, can have a correspondence in the sample size of the different studies, many of which did not include more than 20 patients. The representativeness of gender distribution basically corresponds to epidemiological values that describe a male dominance. This is not so in all the articles though.

Taking into account that the initial stage of PD can affect people in their 40s and its greatest incidence is between 50 and 59, the mean age of the samples in these articles is little representative of all the stages in which the disease can appear and develop. Life expectancy for PD sufferers is established at 78.3 ±8.6 years for males and 80.4 ±8.7 years for females [22]. Thus we can see that some articles have an old population sample, which can involve certain limitations to the use of NW due to the physical condition and cognitive deterioration of this population [23]. This may be caused by the negation of the disease at the initial stages and the unawareness of the adequacy of NW in these initial stages by neurologists [24,25]. It may also be caused by the absence of patient follow-up at this stage as they are non-institutionalised. On the other hand, working with an ageing population makes it difficult to find elderly patients with comparable physical conditions that can all be included in the same study since, with age, they can suffer from other pathologies or limitations such as heart problems or fractures that could prevent them from practising NW [26].

Hoehn and Yahr stages make up a descriptive categorical scale of PD. It should be used in its original from for the demographical presentation of patient groups. If so, the data should be described through medians and ranges and not through means and standard deviations [27].

The small number of withdrawals in all the studies in this review can be explained by a good treatment adherence. This could be the reason for the general improvement in the analysed variables in spite of them not being statistically significant in terms of sample size [18].

For this bibliographical review we have selected clinical trials, most of which have a significantly low randomisation level. In none of them there is therapist or patient blinding, that is why the general evidence level is defined as low (Figure 10). Only one of the articles gets a maximum score of 8/10 points on the PEDro scale, considered good quality evidence in this review [16].

In order to assess the level of tolerance to exertion, we can see that the UKK Walk Test uses an equation that combines the time needed to walk a distance of 2 km and other parameters like age, sex, BMI, HR and is used to measure physical fitness and resistance or cardiorespiratory capacity. It is therefore considered the most appropriate test for this type of intervention [13,28]. In spite of this, from all the tests used to assess aerobic fitness reported in the studies analysed, the 6MWT is the most commonly used. This test measures aerobic capacity, cardiovascular function, fatigue and gait and it is indicated for patients between stages I and IV on the HY scale. So it is indicated for the population in the studies reviewed. Nevertheless, more specific information is needed to determine the percentage of patients at every stage of the HY classification within the interval chosen in each article. The more severe the stage (stage IV) and, consequently, the more walking aids are needed, the less valid the test becomes. The same happens with the 10-m WT, which is even less advisable than the former test for stage IV on the HY scale [29].

The clinical trials using the 6MWT get positive results in general [16,17,20] but it must be stressed that the minimum detectable change in this test is established at 82m of difference between the pre- and post-intervention values to be considered significant. Therefore, only the article by Van Eijkeren *et al.* [20] has significant results in spite of not having a control group. As a consequence, we cannot firmly conclude that the final values are the result of the NW intervention or just a placebo effect.

Balance, related to the second specific aim of this review, is assessed through the TUG and BBS tests or through a combination of both. The studies that correlate NW and balance all yield positive results. Nevertheless, more than half of them do not reach the minimal detectable change by TUG (established at 3.5 seconds) [17,19,20]. Bang *et al.* [16] obtain the results with the most significant improvement (4.72 seconds) in the TUG test. In this case the authors also assess balance from a qualitative point of view through the BBS. The results of the BBS are also positive although in all cases at the beginning of the study all patients were in a range of low risk of falls (between 41 and 56 points). The use of poles could be the reason for this postural adjustment, dissociation of pelvic and shoulder girdles and, consequently, less rigidity [30].

In half the articles that used the PDQ-39 questionnaire there were no significant changes that demonstrate a clear improvement in quality of life or, in some cases, it even got worse [21]. This little decline in quality of life, more specifically in emotional state, stigma and communication, may be explained by the high incidence of depression in PD sufferers. It is sometimes complicated to determine if these emotional problems are a direct result of the disease itself or a consequence of a disabi-

lity caused by the disease. In an article by Reuter *et al.* [18] the changes were, generally speaking, scarcely significant except for the results regarding cognition. The study emphasises that the NW group, which is the group with the highest level of perceived exertion, at the end of the treatment, has patients who felt that they could better concentrate, memorize, and recall information in other routine activities. Anyway, cognitive functions are not formally assessed after the intervention and this perception of improvement in cognition may be taken for a simple improvement in emotional wellbeing [31]. Ebersbach *et al.* [19] found no significant differences in PDQ-39 between groups. Their analysis shows that the study had a power of 27% to detect a difference of PDQ-sum-scores between the three groups. At least 74 subjects need to be included in each group to detect significant differences in PDQ -39 outcome between groups.

## CONCLUSIONS

The results of the current review confirm the effectiveness of aerobic training in the improvement of motor symptoms and quality of life in patients with PD. Nevertheless, there are not many studies on the use of NW as a physiotherapy treatment for conditions like PD. In some cases, positive outcomes can be a consequence of other factors or because there is no control group, which can challenge their validity.

Further research is needed in order to get significant results related to the functional variables analysed in this review. It is important to choose the best assessment tools for this population and intervention, such as the UKK Walk Test, with demonstrated reliability in patients whose age coincides with the onset and establishment of the disease. It would also be convenient to have more studies on the ground NW is practised. In general, this type of information is not provided in the clinical trials and it could be a key factor for outcome variability.

## STUDY LIMITATIONS

The main limitation of this bibliographical review is the inclusion of articles with an inappropriate sample selection. Many studies exclude patients with severe concomitant conditions that are often characteristic of old age. In many cases sample selection only includes males of advanced age. This makes it difficult to extrapolate the results to younger populations diagnosed with PD and females.

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Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

TRANSLATED ARTICLE

# EFFECT OF MANUAL THORACO-ABDOMINAL COMPRESSIONS ON HEALTHY SUBJECTS

Matthieu Vellard[a] Jean-Louis Gaudron[b] William Bertucci[c] Flavien Quijoux[d]

[a]Hospital of Cognac, 16100 Cognac, France.
[b]School of kinesiotherapy, European centre of education in re-education and functional rehabilitation (CEERRF), 93200 Paris, France.
[c]University of Reims Champagne Ardenne, department of Human biomechanics, ergonomics and clinical research, 51100 Reims, France.
[d]Cognition and Action Group, CNRS-IRBA-Paris Descartes, UMR 8257, 45, rue des Saints-Pères, 75270 Paris, France.

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## ABSTRACT

**Introduction.** The aim of this study is to assess the impact of manual thoraco-abdominal compressions on expired flow rate during forced expiration.

**Method**. Thirty-two healthy participants (16 females and 17 males) performed forced expirations with and without manual thoraco-abdominal compressions. Expiratory flow was measured with a spirometer (Spirobank II®, MIR, Rome, Italy). Activation of the rectus abdominal muscle was measured using an electromyographic data acquisition system and the repeatability of manual compressions was previously assessed using the Grip System® instrumented gloves (Tekscan, South Boston, MA, USA).

**Results**. Manual thoraco-abdominal compressions are repeatable ($p > 0.05$). Their application implies a reduction of expired air flow (MEF and FEF 25/50/75) compared to a situation without manual thoraco-abdominal compressions ($P < 0.01$).

**Conclusion**. The use of manual thoraco-abdominal compressions on healthy participants does not seem to increase peak expiratory flow, on the contrary, it seems to decrease it.

**Level of evidence**. 4.

## INTRODUCTION

Chest physiotherapy is a group of techniques that aim to enhance global and/or regional ventilation and lung compliance, reduce airway resistance and remove secretions.[1] One of the main fields of action is the treatment of airway congestion through expectoration of excess mucus in the lungs in hypersecretion diseases. [2] Using decongestion techniques, the increase of air flow (IAF) tries to achieve optimum flow rate with an increase of secretions. [3] This technique is based on models of respiratory physiology like the increase of the phenomenon of thixotropy of pulmonary mucus due to an increase of air flow rate.[4] IAF has a beneficial effect on the amount of aspired bronchial secretions in patients with mechanical ventilation and in the compliance of their thoracopulmonary system.[5] Apart from drug treatments, these techniques reduce the symptoms of lower airway infections, hospitalization time and recidivism. [6]

In practice, IAF consists in applying manual or instrumental pressure on the patient's chest during expiration. [7] The aim of these manoeuvres is to increase intrathoracic pressure. Air flow is regulated by the Q = P/R relationship (Q is flow in $m^3/s$, P is pressure in Pa and R is flow resistance in $Pa.s.m^{-3}$). If resistance is stable, the increase of pressure must cause an increase of measured flow. This manoeuvre would remove the secretions adhered on the bronchial walls to be then expectorated. [8] Nevertheless, some studies show that these techniques do not improve the patient's vital signs when they have bronchial fibroscopies.[9] Nozoe *et al.*[10] did not observe any significant increase in expiratory flow rate (DEP25 and 50) when applying IAF to patients suffering from COPD (chronic obstructive pulmonary diseases).

In spite of the theoretical models these kinesiotherapy techniques are based on, their real effect in relation to any modification of mobilised lung volumes or expired air flow rate has not been demonstrated.

In this context, this study aims to assess the impact of thoraco-abdominal compressions associated to rapid IAF on mobilised lung volume and expired air flow rate in healthy individuals.

## METHOD

### Aim and assessment criteria

The aim of this study is to assess the effectiveness of thoraco-abdominal compressions in the increase of maximal expiratory volume during the first second (MEVS) and peak expiratory flow (PEF), PEF25 (peak expiratory flow at 25% of forced vital capacity), PEF50 (peak expiratory flow at 50% of forced vital capacity), PEF75 (peak expiratory flow at 75% of forced vital capacity) and also in forced vital capacity (FVC). The main assessment criteria are the maximal flow rates (PEF, MEF25/50/75) measured in the mouth during an expiration.

### Population in the study

The participants in the study were selected in a training centre for masso-kinesiotherapy after signing an informed consent form. The inclusion criteria were the following:

- Adult from 18 to 25 years.
- Having no competitive sports practice and limited to up to 2 hours a week.

A physical examination was carried out by a graduate kinesiotherapist in order to find visible signs of any chest dysmorphia. The healthcare staff interviewed each patient to know if they smoked, had any disorder of the ventilatory system, had a history of respiratory or cardiac problems or any comprehension disorders, according to the exclusion criteria of the study. During the interview, the participants performed a spirometry to detect any abnormal flow or volume that would exclude them from the study. This also helped participants to get familiar with spirometries (Fig. 1).

### Material

The material used in the study is the following: Tekscan (South Boston, USA) grip pressure gloves were used with a linearity below ± 3% and a repeatability below ± 3.5% [11] to measure the pressure applied by the healthcare provider. To assess the activity of the rectus abdominal muscle, an ADInstrument® (Oxford, United Kingdom) electromyography data acquisition system and the Lab Chart 7® (Oxford, United Kingdom) were used. Superficial muscular activity is recorded with a 1 kHz sample frequency and then some digital filters are applied – more specifically a FIR band-pass filter with a 10 Hz to 500 Hz phase maintenance and a 50 Hz band-stop filter to limit any electromagnetic interferences. The net signal is aliased through a Bartlett triangular window with a length of 301 samples. Based on this EMG signal pretreated by the programme, the signal's mean efficacy value (RMS) is calculated for the T time interval of each ventilation cycle according to the equation:

The RMS values of each ventilation cycle, which are sensitive and reliable variables derived from the EMG signals [12,13,14], are compared in the two conditions for each individual participant. The measures of flows and volumes (MEVS, PEF, MEF25/50/75 and FVC) were taken using a Spirobank II® (MIR, Rome, Italy) spirometer. According to the manufacturer, the precision of the equipment is ± 3%.

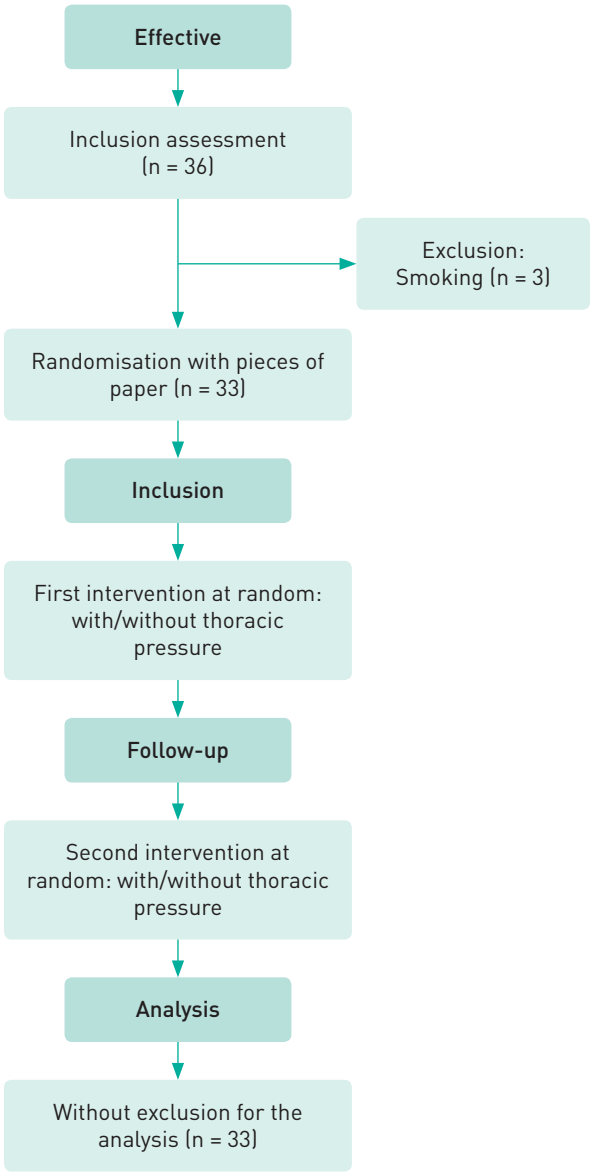
### Protocol

*Assessing the repeatability of manual compressions*

The assessment of intra-examiner repeatability of the thoraco-abdominal compressions was done in an anticipated manner using GRIP TekScan® pressure gloves. For this assessment, the examiner – a graduate kinesi-

**Figure 1**

Flow diagram of selection.

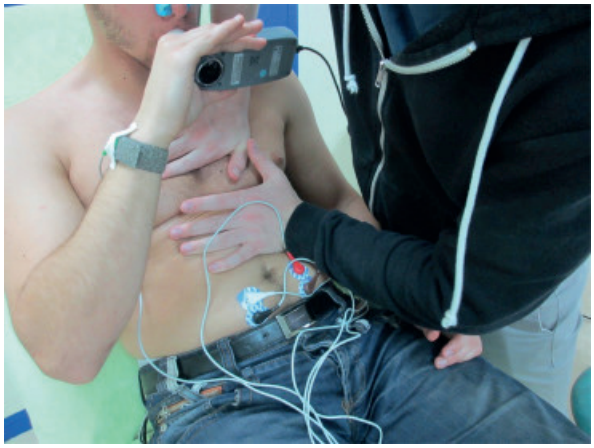



otherapist trained in IEF (increased expiratory flow) manoeuvres with manual compressions – performed ten series of three thoraco-abdominal compression manoeuvres on each participant.

During the tests, the participant is half sitting at 45° on a couch with his/her head resting on the back of the couch, arms along the body and legs stretched. The kinesiotherapist stands on the patient's right side and places the hypothenar eminence of the left hand at the level of the patient's angle of Louis. Then, the hypothenar eminence of the right hand at the level of the navel. The angle formed by the direction of his/her forearms is 90°. Then the patient is asked to take a deep breath through the

**Figure 2**

Setting up the spirometer.



nose. During this period, the therapist stops applying pressure on the chest. Then, the patient is asked to blow as much as possible through the mouth while applying some pressure downwards and backwards with the left hand and upwards and backwards with the right hand. The instructions the kinesiotherapist gives are *"inhale deeply and then blow as much as you can with your mouth open"*. When the patient starts to inhale, the kinesiotherapist applies manual compressions.

*Measuring the efficacy of thoraco-abdominal compressions*

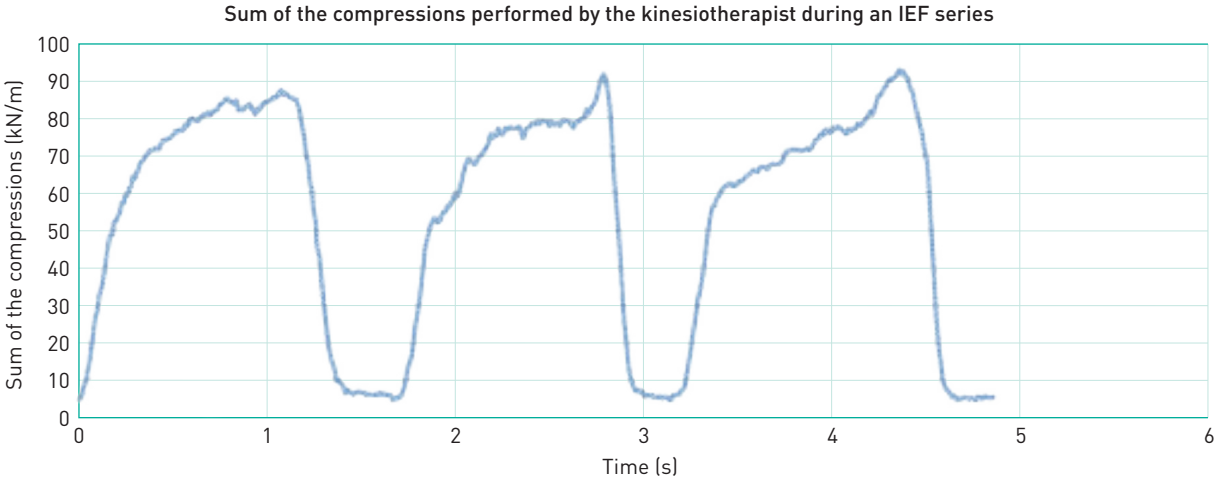
In a second part of the test, we measure the efficacy of the thoraco-abdominal compression on the PEF, MEF25/50/75 and MEVS expiratory flow. In order to do it, we put the spirometer at the level of the mouth before the examiner puts his hands on the right place. The material is organised before the tests. In order to minimise the amount of air escaping from the nose, a nose clip is used [15] (Fig. 2)

The application of EMG electrodes on the rectus abdominal muscle is done on a clean, shaved skin, rubbed with Nuprep® cream (Lion, France).[16] Muscular activity of the rectus abdominal muscle is measured to confirm the repeatability of the muscular condition between the condition "with the examiner's manual pressure" and the condition "without the examiner's manual pressure" for each participant. This is done in order to reduce confounding factors.

The experiment is carried out in two stages. First, the participant performs 3 cycles of forced ventilation. To do this, he/she inhales deeply and then blows as much as possible through the mouth (with the mouth wide open). The kinesiotherapist gives the following instructions: "inhale deeply", "blow as hard as possible". Throughout the whole experiment, the kinesiotherapist enthusiastically encourages the participant. [17]

**Figure 3**

Sums of the compressions performed manually on the participant's chest based on time for a series of three thoracic compressions.




Second, the kinesiotherapist applies manual thoraco-abdominal compressions in the same way as in the preliminary tests. Before starting the experiment, during the interview, the examiner asks the participant to draw a piece of paper from one of two hats on a table with the labels *"with the examiner's manual compression"* or *"without the examiner's manual compression"* and then puts it back inside the hat again. The piece of paper defines the first condition in the experiment as a way of randomising the order of the actions. [18]

### Statistics

In order to do the parametric statistical tests (Statistica® programme, version 7.1, StatSoft, Maisons-Alfort, France), the normality of the variables is studied by means of normal probability graphs (for EMG signals) and the Shapiro-Wilk test (for PEF and MEF25/50/70 flows and MEVS and FVC expiratory volumes)

If the variables have a normal distribution, the Student's t-test for paired samples is used to compare the means of the two conditions with a significance threshold of $\alpha = 0.05$. For random variables that have any kind of distribution, the Wilcoxon matched pairs test was preferred to the Student's t-test.

## RESULTS

All the variables (flows, volumes, manual compressions and RMS) have normal distributions ($P > 0.05$).

### Population

The population in this study consists of 33 participants, students of masso-kinesiotherapy with no respiratory diseases. There are 16 women (48.5%) and 17 men (51.5%) with an age mean of 23 ± 1.7 years and a mean BMI (body mass index) of 22.5 ± 3.1 kg/m.

### Repeatability of thoraco-abdominal compressions

The comparison of mean manual compressions during a ventilation cycle with the Student's t-test demonstrates that there are no significant differences between the two manoeuvres of thoraco-abdominal compressions ($P > 0.05$) (Fig. 3).

### Assessing the impact of thoraco-abdominal compressions

The comparison of the means of RMS values of the activity of the rectus abdominal muscle using the Student's t-test shows no significant differences in terms of the superficial activity to these muscles between the conditions, *"with the examiner's manual compression"* or *"without the examiner's manual compression"* ($P > 0.05$) (Fig. 4).

Regarding expiratory flows and volumes (Table I), the Student's t-test shows a significant reduction when thoraco-abdominal compressions are applied during MEVS ($P = 0.021$), PEF ($P = 0.003$), PEF25 ($P = 0.027$), PEF50 ($P < 0.001$) and PEF75 ($P < 0.001$). Only FVC was not significantly different in the two conditions ($P = 0.39$).

**Figure 4**

Example of acquisition of EMG data taken from the right rectus abdominal muscle. 1: respiratory cycles of the participant on his/her own; 2: respiratory cycles of the participant with the kinesiotherapist.

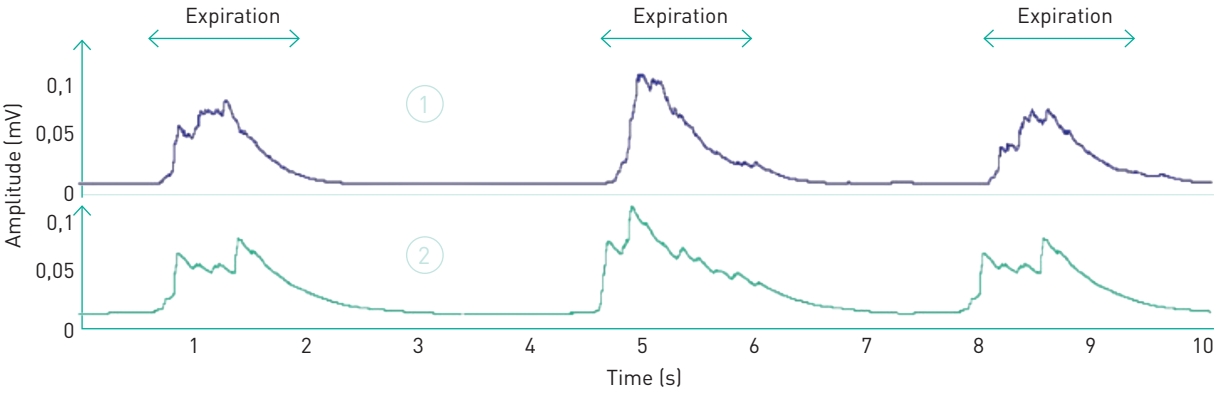



**Table I**

Results of expiratory pulmonary flow and volume

| | Participants alone | | | Participants with kinesiotherapist | | | |
|---|---|---|---|---|---|---|---|
| | Mean | Standard deviation | *P* value Shapiro-Wilk | Mean | Standard deviation | *P* value Shapiro-Wilk | ***P* value in Student's test** |
| MEVS | 3,55 | 0,61 | 0,153 | 3,43 | 0,66 | 0,064 | 0,021[a] |
| PEF | 8,18 | 2,08 | 0,309 | 7,84 | 1,89 | 0,353 | 0,003[a] |
| PEF 25 | 7,02 | 1,58 | 0,429 | 6,77 | 1,52 | 0,565 | 0,027[a] |
| PEF 50 | 4,59 | 0,95 | 0,601 | 4,08 | 0,95 | 0,711 | < 0,001[a] |
| PEF 75 | 2,41 | 0,58 | 0,137 | 1,96 | 0,50 | 0,070 | < 0,001[a] |
| FVC | 3,91 | 0,84 | 0,072 | 3,97 | 0,81 | 0,050 | 0,39 |

MEVS: maximal expiratory flow per second (L); PEF: peak expiratory flow (L/s): PEF25: peak expiratory flow at 25% of forced vital capacity (L/s); PEF50: peak expiratory flow at 50% of forced vital capacity (L/s); PEF75: peak expiratory flow at 75% of forced vital capacity (L/s); FVC: forced vital capacity (L).

[a] Indicates a significant difference found in the Student's t-test with a threshold of $P < 0.05$.

## DISCUSSION

This study is part of an assessment system of kinesiotherapy practices. It aims to assess the effect of thoraco-abdominal compressions associated with rapid IAF of expiratory volume in healthy individuals.

After demonstrating the intra-examiner repeatability of thoraco-abdominal compressions ($P > 0.05$), these results suggest that the application of standardised thoraco-abdominal compressions does not increase the participants' expiratory flow during rapid IAF.

On the contrary: manual compressions tend to reduce them ($P < 0.05$). On the other hand, they do not reduce FVC ($P = 0.39$) with the activation of expiratory muscles ($P > 0.05$). In fact, we have found no significant differences in relation to the RMS of the rectus abdominal muscle when applying manual compression during expiration by the kinesiotherapist and when manual compression is not applied.

The difference of the IAF impact on healthy participants and participants with some disease has been examined by Sivasothy *et al.*[19] The authors found that the use of manual compressions to assist expectoration has no impact on the cough expiratory flow rate of healthy patients and reduces it in patients with COPD. Notwithstanding, in the case of any disorders of muscle activity, this technique allows to increase expiratory flow.

Within respiratory diseases, the recommendations of use of IAF for patients with COPD are grade C and for those with mucoviscidosis, grade A. [20] The biblio-

graphical review from which these recommendations are taken suggests that IAF are kinesiotherapy techniques whose effectiveness has not been scientifically proven when treating many conditions. The effect of expiratory rib cage compressions in airway clearance has been studied by Guimarães *et al.*[21] Their results demonstrate that this techniques does not increase mucociliary clearance and can even cause limitations in the expiratory capacities of some patients. Therefore, we believe it is important to point that our results on healthy patients seem to be similar to those obtained in intubated and ventilated patients. Unoki *et al.* found some more similar results for patients receiving mechanical ventilation. [22] Actually, with or without chest compressions, endotracheal aspiration removes the same amount of secretions and the patient's oxygenation is the same. However, we know that pulmonary biomechanics is altered in patients with mechanical ventilation. [23] This could account for the beneficial results of cough assist therapies through manual pressure that we can find in the bibliography. [24,25,26] Moreover, the effects of rapid or slow IAF are not limited to the increase of expiratory flow. Freynet *et al.*[27] also observed an improvement of bronchial drainage in patients receiving mechanical ventilation. In intensive care units, thoraco-abdominal compressions allow to accelerate the patient's recovery and reduce their time in the unit. [28] In spite of this, the previous use of hyperinsuflation could play an important role in the measured results. It must be emphasised that, during pulmonary fibroscopy, IAF does not significantly modify the patient's vital signs but reduce his/her discomfort during the examination. [9] These results coincide with our study, since thoraco-abdominal compressions do not seem to affect decongestion, which is their main aim. We cannot extrapolate these results obtained in healthy people to patients with pathologies.

Antonello and Delplanque state that manual chest and/or abdominal compressions allow "to increase expiratory volume and/or flow, with IAF or cough efforts, for example". [7] Our results prove that the effectiveness of these techniques that increase flow can be questioned because their effects on expiratory flow and volume are not sufficient. The reduction of expiratory flow can be explained by the Q = VS relationship (where Q is flow in $m^3/s$, V is the velocity of the liquid in m/s and S the section of the tube holding the liquid in $m^2$). In fact, the application of manual chest compressions can cause a reduction in the section of the bronchi or an increase of air flow resistance, which would explain the reduction of airflow measured in the patient's mouth. In order to study this hypothesis it would be necessary to perform measurements using a plethysmography and manometry.[29]

In spite of all the means used to avoid confounding factors in this study, its results must be explained. The measurement of the repeatability of manual compressions as well as the measurement of flows with and without kinesiotherapy were done using a single examiner for the two experiments. Apart from his basic education and professional experience, this kinesiotherapist did not receive any complementary training in the field of respiratory kinesiotherapy. This drawback could have a strong impact on the results and this makes that they cannot be applicable to all kinesiotherapists. In a future study, it will be necessary to multiply the examiners and to study inter-examiner repeatability. Although our sample is homogeneous, we should add a word of caution. Since this study includes healthy participants, it is not possible to make our results applicable to patients with a pathology. In addition, the lack of assessment of the kinesiotherapy methods on healthy participants reduces the possibility of comparing these results with those in the bibliography. In order to expand the scope of our results, we could have previously calculated the power to find an optimal sample size, which would preferably include participants with a condition. From a methodological point of view, the measurement of muscle activity focuses on the rectus abdominal muscles without measuring the other expiratory muscles. This choice is justified by the action of the rectus abdominal muscles during a forced expiration [30] and by the technical limitations that do not allow us to measure the abdominal muscles together.

## CONCLUSION

This study deals with the practice assessment found in several areas of healthcare. The aim is to assess the impact of manual thoraco-abdominal compressions on expiratory flows in healthy individuals.

The results of the study question the effectiveness of manual chest compressions to increase MEVS and PEF. In healthy participants, expiratory flow is greater when the participant blows on his/her own. This underlines the importance of learning and self-management of the disease in participants that have no lesions in the expiratory muscles. Nevertheless, we cannot widen the scope of these results to participants suffering from a pathology.

**The most important aspects are the following:**

- There is a strong intra-examiner repeatability in expiratory assistance techniques.
- The application of manual thoraco-abdominal compressions reduces expiratory flow.
- When properly informed, the participants have greater expiratory flows without the help of the kinesiotherapist.
- When there are lesions in the expiratory muscles, the use of kinesiotherapy techniques with manual compressions should be less relevant.

**SUPPORT**

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**DECLARATION OF INTERESTS**

The authors declare no conflict of interest.

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PHYSIOTHERAPY UPDATES

TRANSLATED ARTICLE

# THE INTERPLAY OF EXERCISE, PLACEBO AND NOCEBO EFFECTS ON EXPERIMENTAL PAIN

Luana Colloca[1], Nicole Corsi[2] & Mirta Fiorio[3]

[1]Department of Pain Translational Symptom Science, School of Nursing, University of Maryland, Baltimore, 655 W. Lombard Street, 21201, Baltimore, USA. Departments of Anesthesiology and Psychiatry, School of Medicine, University of Maryland, Baltimore, MD, USA. Center to Advance Chronic Pain Research, University of Maryland, Baltimore, MD, USA.
[2]Department of Pain Translational Symptom Science, School of Nursing, University of Maryland, Baltimore, 655 W. Lombard Street, 21201, Baltimore, USA. Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Via Casorati 43, 37131, Verona, Italy. Luana Colloca and Nicole Corsi contributed equally.
[3]Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Via Casorati 43, 37131, Verona, Italy.



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## ABSTRACT

Over the last few decades, placebo, and nocebo effects in general, have been investigated at rest. This proposed study explores whether they could work even when the experience of pain occurs during a movement. Exercise itself can have a hypoalgesic effect, suggesting that placebo- and exercise-induced hypoalgesia could foster pain reduction. In the present study, we investigated the interplay of exercise, placebo and nocebo effects on pain. To this aim, we developed a machine-controlled isotonic motor task to standardize the exercise across participants and used a well-validated model of placebo and nocebo manipulations with reinforced expectations via a conditioning procedure including visual cues paired with heat painful stimulations. Participants reported expectations and pain on a trial-by-trial basis. We found that the standardized isotonic exercise elicited a reduction of pain intensity. Moreover, both exercise and placebo induced comparable hypoalgesic effects. When the exercise was added, placebo and nocebo effects were influenced by expectations but were not affected by fatigue or sex differences. Exercise-, placebo- and nocebo-induced pain modulation are likely to work through distinct mechanisms and neurophysiological research is needed to fully exploit the implications for sport, rehabilitation and pain management.

Hence, applying a placebo (and nocebo) procedure during movement execution will offer the possibility to eventually foster hypoalgesia while pain is experienced.

In the current study, we investigated pain modulation when a controlled and calibrated exercise is performed and explored the possibility to minimize nocebo hyperalgesic effects and enhance placebo analgesic effects as a result of the combination of exercise-induced hypoalgesia and cognitive factors, such as positive and negative reinforced expectations. To this end, we used a well-validated placebo and nocebo procedure (2,3,4,5) in which heat thermal stimulations were delivered on the volar forearm of healthy participants either at rest (Pain-Rest condition) or during the execution of a well-controlled and standardized isotonic task (Pain-Exercise condition). To control for differences in motor performance, we tailored the movement to the individual strength by using the 30% of their Maximum Voluntary Contraction (MVC).

We hypothesized that exercise execution and placebo effects would strongly reduce pain perception. Moreover, we predicted that the exercise-induced hypoalgesic effect would counteract the nocebo hyperalgesic effect.

Understanding the effects of exercise, placebo and nocebo on pain experience is fundamental to optimizing pain management in real-world settings.

## MATERIALS AND METHODS

### Study participants

Fifty study participants were invited to participate in this within-subject study design at the University of Maryland Baltimore, School of Nursing. A total of 46 healthy participants (24 women) aged from 18 to 53 years (mean age ± sem: 27.41 ± 1.07) were enrolled (Table 1). The sample included White (68%), Asian (19.56%), African-American (10.87%) and Hispanic (8.7%) participants. Study participants were recruited locally by advertising the research project across Schools at the University of Maryland campus.

**Table 1**

Characteristics of the study participants, levels of thermal stimulations and perceived fatigue.

| | Men | Women |
|---|---|---|
| n | 22 | 24 |
| Age (mean ± sem) | 26,91 ± 1,19 | 27,88 ± 1,75 |
| Weight (lbs) | 168,24 ± 5,36 | |
| Height (ft in) | 5'25''0,22 ± 7,96 | |
| BMI | 26 ± 0,75 | |
| Systolic blood pressure (mmHg) | 120,20 ± 2,09 | |
| Diastolic blood pressure (mmHg) | 75,15 ± 1,33 | |
| BPM | 66,37 ± 1,51 | |
| Intensity of pain used (°C) Red | 47,52 ± 0,37 | |
| Intensity of pain used (°C) Yellow | 44,55 ± 0,37 | |
| Intensity of pain used (°C) Green | 41,51 ± 0,37 | |
| BORG Scale (Natural history phase) | 1,86 ± 0,13 | |
| BORG Scale (Acquisition phase) | 2,61 ± 0,15 | |
| BORG Scale (Test phase) | 2,97 ± 0,19 | |

Abbreviations: Lbs = libras, BMI = body mass index, mmHg = millimeter of mercury, BPM = beats per minute, °C = Celsius degrees. Data are presented as mean ± sem.

Four participants were excluded because they did not meet the criteria of inclusion. Participants were prescreened over the phone to determine potential eligibility before scheduling the appointment. Eligibility was confirmed in person via a self-report medical history. Exclusion criteria included cardiovascular diseases, neurological diseases, pulmonary abnormalities, kidney and liver diseases, history of cancer within the past 3 years, history of chronic pain disorder, any psychiatric condition, lifetime alcohol and/or drug dependence, impaired hearing, pregnancy or breast-feeding, abnormal blood pressure values, nicotine use over the last six months, color-blindness, or a history of surgery performed on the arm, shoulder, wrist or hand. A urine drug toxicology test was performed and those with positive results for marijuana, cocaine, opiates, amphetamine, methamphetamine, ecstasy, phencyclidine, hydrocodone, oxycodone or hydromorphone were excluded from the study.

The study was approved by the University of Maryland Institutional Review Board (IRB, Prot # HP00065783). All methods were performed in accordance with the relevant international and local guidelines and regulations for human research. A written informed consent has been obtained from each study participant that included a section about the use of the authorized deception. During the consent process, participants were informed that the experimental procedure would include some misleading information and that they will be told in a written and verbal manner about the nature of the deception at the end of the experiment. Participants were therefore debriefed and were asked to complete a written exit form in which they were offered the opportunity to withdraw their data from the study at any time. None of the participants chose to withdraw their data from the study.

The entire experimental session lasted approximately three hours, and participants were monetarily compensated for their time ($90).

### Force assessment, exercise execution and fatigue assessment

We assessed the MVC, which is a quantitative measure of muscle strength and represents the maximum amount of force that a person can produce during an isometric exercise (9). MVC was measured for each participant by using the Biodex 4 Pro equipment (Biodex Medical System, Shirley, New York, USA). This is a sophisticated and reliable equipment that allowed us to assess and control participants' force during the experiment. To assess the MVC, participants sat down on a chair with the upper part of the body stabilized with belts across the shoulders. They were asked to perform four isometric movements at four different angles (15°, 30°, 45°, 60°). Specifically, participants had to pull on a handle attached to a robotic arm where each movement required 5 seconds of isometric contraction followed by 10 seconds of rest. We set the height of the dynamometer in order to have the center of rotation matching the participant's elbow position. The arm was fixed with an additional strap in order to help participants perform the exercise correctly. The assessment of the MVC allowed us to set the movement at the 30% of the maximum force for each participant during the experiment in order to reduce the risk of fatigue (10,11) and standardize the movement for all the participants throughout the procedure

At the end of the MVC assessment, we computed the mean of the peak torque recorded at each position and we calculated the 30% of the MVC. During the force assessment, we recorded the peak velocity of the exercise (degree/second), the average velocity (degree/second), the acceleration and deceleration time (milliseconds). However, during the experimental procedure, velocity (60 deg/sec) and range of motion (i.e. the amplitude of the exercise, 80°) were kept constant for all the participants to standardize the exercise performance. By doing so, we standardized the motor task across participants. During the experiment, participants were asked to perform three extension-flexion movements (i.e. isotonic task) during half of the trials while receiving the thermal stimulation on the dominant forearm. Specifically, the isotonic motor task was performed in 5 trials (15 movements) during the exercise phase, 18 trials (54 movements) during the acquisition phase, and 9 trials (27 movements) during the test phase when placebo and nocebo effects were tested with and without movement task. At the end of each phase, participants rated their level of fatigue on a Borg scale (12), from 0 (no fatigue) to 10 (extremely severe fatigue).

### Ain stimulation, calibration and assessment

Painful stimulations were delivered by means of the Pathway system (Medoc Advances Medical System, Rimat Yishai, Israel), an equipment delivering heat thermal stimulation starting from 32 °C to the highest deliverable temperature of 50 °C. The heat stimulations were delivered through a 3 × 3 cm probe. Painful stimulations were delivered to the same part of the forearm to avoid the involvement of distinct receptorial areas. We used an elastic bandage to attach the probe gently on the participant's dominant volar forearm and to ensure it remained stable on the skin area. Importantly, the painful stimulations were delivered on the same forearm executing the movement to maximize the sensory reduction. The pain *calibration* started with the assessment of the warm detection (the level of thermal stimulation perceived as warm but not painful). Participants were then asked to report by pressing the Pathway remoter button, the level of pain that they would perceive as 20 out of 100 on the Visual Analogue Scale (VAS) (i.e. low pain), 50 out of 100 (i.e. medium pain) and 80 out of 100 (i.e. high pain). The identified *highest* level was used as reference to subtract three Celsius degrees to reach the medium level of pain and to reduce from the medium level additional three Celsius degrees to obtain the lowest level of delivered intensity. This procedure allowed as to standardize among participants the levels of temperatures used during the acquisition phase to reinforce expectations (Table 1). The heat painful stimulations were delivered while participants performed the arm extension and flexion exercises during half of the trials and at rest in the other half (control trials). Each heat stimulation lasted 10 seconds and after 2 seconds, participants rated the level of perceived pain (5 sec). Pain expectation and perceived pain was measured using a VAS anchored from 0 (no pain) to 100 (maximum tolerable pain).

### Experimental procedure

Following the calibration of force and pain sensitivity in each participant, the experimental procedure consisted of three phases including: (1) natural history, to test for the effect of the exercise in modulating pain perception prior to any expectancy manipulation; (2) acquisition phase to reinforce expectations by exposing participants to the experience of pain increases and reductions; (3) test phase, to assess the occurrence of nocebo and placebo effects (Fig. 1A).

In all the experimental phases, participants performed the three extension-flexion movements in half of the trials in which they were receiving the painful stimulations. A picture was displayed before the heat stimulation to inform participants whether to perform the exercise or to rest.

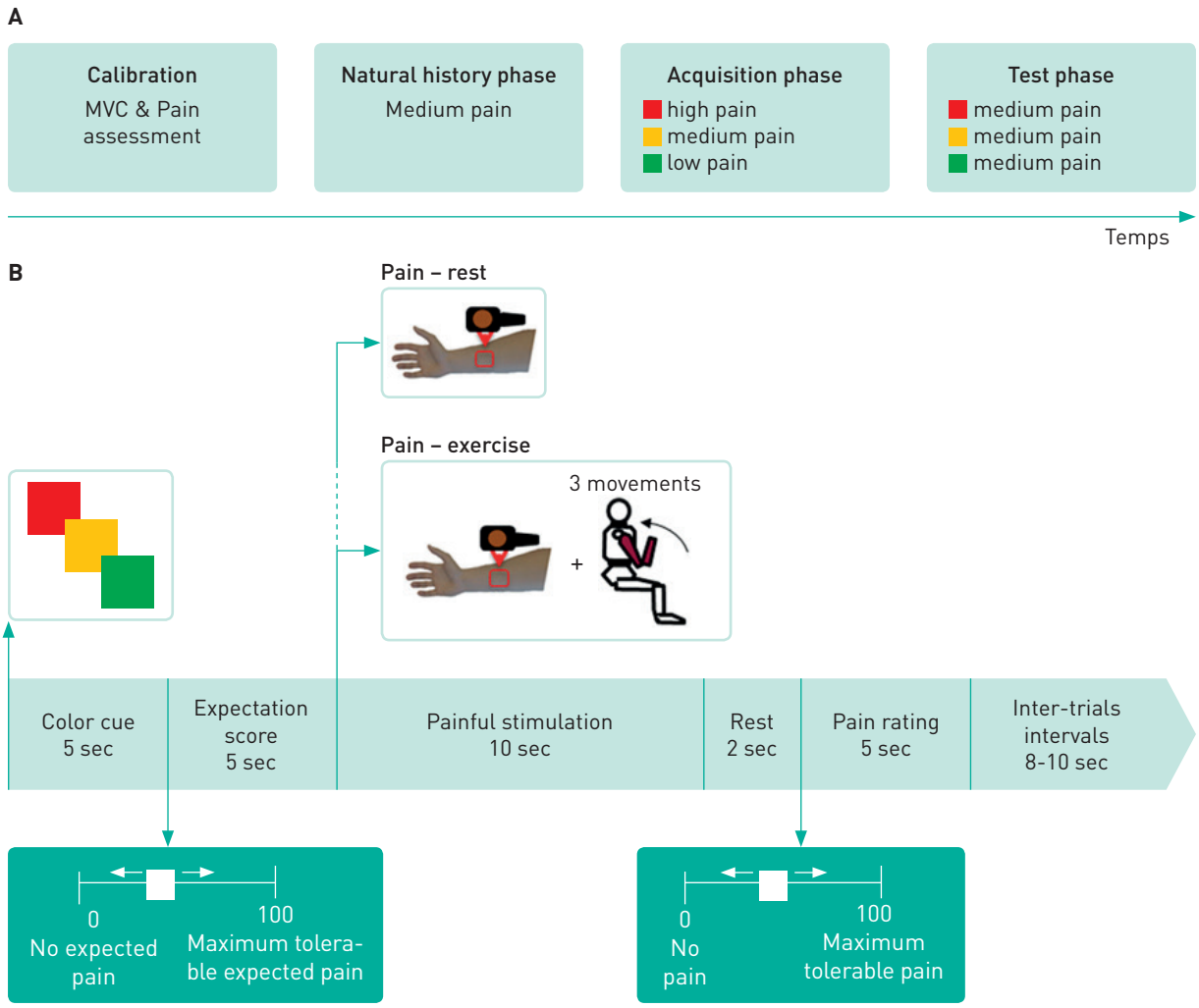
An inter-trial-interval of 10 sec was used to prevent habituation (Fig. 1B).

The delivery of event (heat stimulation, visual cues, VAS scales) was managed by pre-programmed scripts using Eprime (Psychology Software Tools, Inc., Sharpsburg, PA, USA; version 2.0). To control for time effects, we counterbalanced the presentation of visual cues during each phase (i.e., Pain-Exercise and Pain-Rest conditions) by assigning participants randomly to one of four sequences. The sequence did not influence the size of placebo and nocebo effects ($p = 0.249$). In order to maintain constant attention throughout the experimental procedure, participants were asked to count the number of visual color cues presented during the acquisition and test phase trials.

### Natural history phase

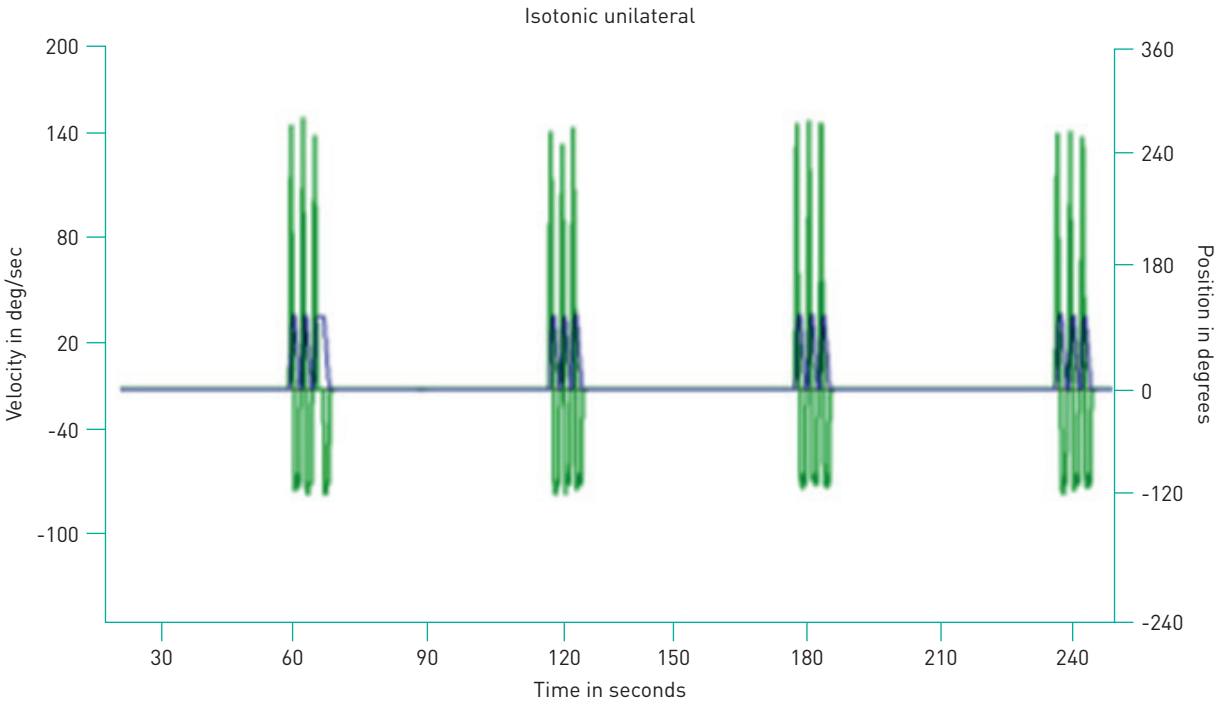
During the natural history phase, participants received the identified *medium* level of painful stimulation to the volar forearm with 5 trials in which participants completed a motor exercise and 5 trials in which they rested (Fig. 2). Half of the painful stimulations were delivered along with 3 repetitions of elbow extension and flexion exercises set at 30% of the participants' MVC (Pain-Exercise condition). The remaining painful stimulations were given at rest (Pain-Rest condition). Trials of the Pain-Rest condition were intermixed with Pain-Exercise condition's trials. This phase tested the hypothesis that the isotonic motor task would have resulted in pain reduction when compared to the same levels of painful stimulations delivered while at rest.

**Figure 1**




Study design and trial representation. The experiment consisted of one session to calibrate the level of force and pain for each participant, and three subsequent phases. During the *calibration* phase, we assessed the levels of pain necessary to induce a sensation of low, medium, and high pain for each individual. We also assessed the maximum voluntary contraction (MVC) of the dominant arm for each participant. During the *natural history* phase, we delivered a medium level of pain for a total of 10 trials. In half of the trials, participants performed the isotonic movement tailed to their individual MVC. During the *acquisition* phase, the participants learned to associate three visual color cues (red, yellow, green) with three distinct levels of pain (high, medium and low pain intensities) for a total of 12 trials. Participants performed the isotonic movement in half of the trials. During the *test* phase, we set the intensity of the painful stimulations at the same medium level for all the three cues (presented 6 times for each visual *color* cue) and the isotonic task was introduced in half of the trials. (A) During each trial of the acquisition and test phase, after the color cue presentation, participants were asked to rate the level of expectation about the upcoming stimulation by means of a 0–100 VAS ranging from no expected pain to maximum *expected pain*. Then, the painful stimulation was delivered for 10 seconds. After two seconds of rest, participants were asked to rate the level of *perceived pain* by means of the 0–100 VAS ranging from 0 = no pain and 100 = maximum tolerable pain. Participants were alerted whether or not to perform the isotonic movement by a sign (e.g. arm performing the movement) displayed on the monitor. An inter-trials interval with variable timing was introduced to avoid habituation (B).

**Figure 2**




Extension-flexion isotonic movement. Participants performed the extension-flexion isotonic movement while receiving the heat thermal stimulation. The MVC was constantly monitored. The figure shows the Biodex output with the recording of the MVC from a representative participant while performing the movements (Pain-Exercise condition). (C) Values are expressed as mean ± sem **p < 0.001 Abbreviations: DEG = degrees, deg/sec = degrees per second.

### Acquisition phase

This procedure allowed us to reinforce participants' expectations based on the type of association between cue and heat intensities (i.e. highest pain with red cue, lowest pain with green cue) as previously performed (1,4). Participants were told that a red cue would precede the delivery of a moderately high level of painful stimulation, a yellow cue would precede the delivery of a medium level of pain and a green cue would precede a low painful stimulation. In the acquisition phase, participants received the three levels of painful stimulations (high, medium and low).

Each visual cue (red, yellow and green) was presented for 5 sec. Five seconds after the visual cue presentation and before the heat stimulation delivery a VAS scale was displayed to ask participants about their expectation for the upcoming painful experience ("Please rate your expectation about the upcoming pain"). The heat stimulation was therefore delivered and participants were asked to rate on the 0–100 VAS scale the perceived painful sensation ("Please rate your perceived pain"). The acquisition phase consisted of a total of 36 trials divided into two sessions of 18 trials each, with half of them combined with the extension and flexion task.

### Test Phase

During the *test* phase, participants were shown each visual cue (red, yellow and green) 6 times, for a total amount of 18 painful stimulations with half of them combined with the extension and flexion task. All thermal stimulations were delivered at a medium intensity regardless of the color cue presented. Nine painful trials were intermixed with three elbow extension-flexion exercises set at 30% of the MVC. For each trial, after the visual cue presentation (5 sec), participants rated their expectation (5 sec) on the 0–100 VAS. After each painful stimulus was delivered, participants rated their perceived pain.

### Data Analysis

Based on previous studies that have applied a similar paradigm (11,13), we expect an effect size of d = 0.32. Assuming an anticipated effect size of d = 0.32 and a p-value (or type I error rate) equal to 0.05 to claim statistical significance the required sample size is n = 34 participants. Power analyses were conducted with G*Power 3 (14). Given that there were no published data regarding the modulation of exercise-induced hypoalgesia and we included both men and women, the enrollment was n = 50 participants.

In the natural history phase, VAS pain reports were analyzed using repeated measures (rm) ANOVA with Condition (Pain-Rest vs. Pain-Exercise) and Trials as within-subject factors.

During the acquisition and test phases, expectation and pain VAS scores were collected on a trial-by-trial basis. VAS scores for expectations and perceived pain were analyzed separately in the acquisition and test phase using rmANOVA with Condition (Pain-Rest vs. Pain-Exercise), Color cue (red, yellow, green) and Trials as within-subject factors. Moreover, an additional analysis was conducted in order to compare any significant Pain-Rest vs. Pain-Exercise effect across phases by means of rmANOVA with Condition (Pain-Rest vs. Pain-Exercise), Color cue (red, yellow, green) and Phases (2 block acquisition vs. test phase) as within-subject factors. Post-hoc comparisons and paired t-tests with Bonferroni adjustment for multiple comparisons were conducted where necessary. Placebo effects were operationally defined as the difference between Green-Yellow associated trials and nocebo effects were operationally defined as Red-Yellow associated trials. The exercise-induced hypoalgesia was defined as the difference in pain ratings between the Pain-Exercise and Pain-Rest conditions. The Pain-Exercise and Pain-Rest difference was used to compare the level of pain changes induced by placebo and nocebo manipulations by means of Univariate ANOVA.

Spearman coefficient (1-tailed, given the unidirectional hypotheses) was used to correlate placebo and nocebo effects with expectations, pain sensitivity (i.e. level of intensity used to elicit medium pain) and fatigue levels. Sex effects were tested by independent samples t-test including the comparison between the follicular versus the luteal phase (women). The strength of two correlations was compared using the Fisher r-t-z transformation.

All the analyses were performed using the Statistical Package for the Social Sciences (SPSS) software package (SPSS Inc, Chicago, Illinois, USA, vers. 21). The level of significance for all analyses was set at $p \leq 0.05$.

## RESULTS

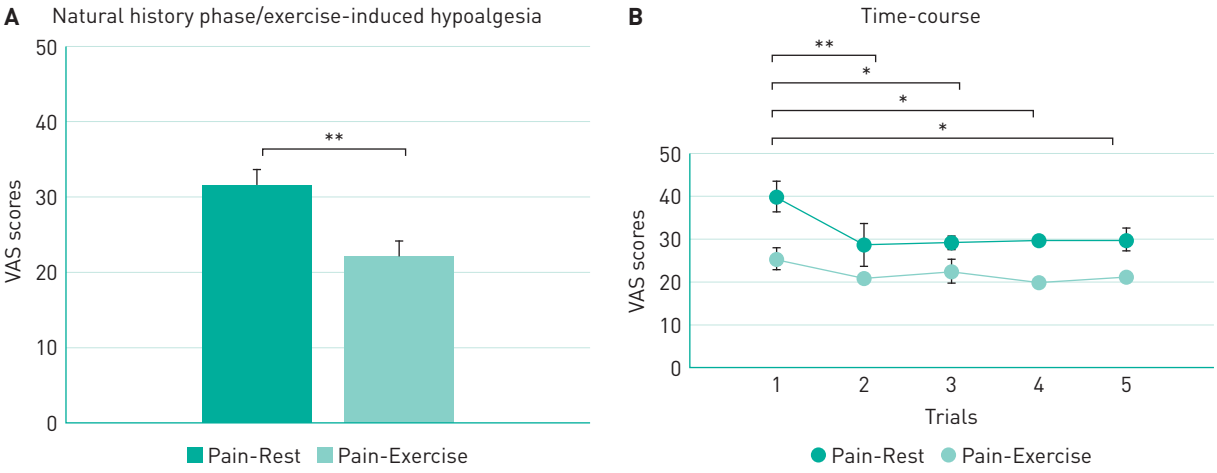
### Natural history phase

The effect of exercise on pain was explored before any placebo or nocebo manipulation and all the stimulations were delivered at a medium level of pain as derived from an initial calibration procedure. In the natural history phase, participants reported that the same medium heat stimulations were perceived as less painful in the Pain-Exercise (mean ± sem, 22.05 ± 2.11) than the Pain-Rest condition (31.54 ± 2.05) (Condition, $F(1,45) = 9.489$, $p = 0.004$), suggesting that performing an isotonic exercise during the delivery of a heat painful stimulation induced per se a hypoalgesic effect (Fig. 3A). The factor Trials was significant (Trials, $F(1,45) = 14.968$, $p < 0.001$, Fig. 3B) with a significant Condition*Trials interaction ($F(1,54) = 9.727$; $p = 0.003$). Trials 1 were significantly different than Trials 2 ($p < 0.001$), 3 ($p = 0.027$), 4 ($p = 0.011$) and 5 ($p = 0.019$) indicating that the effect reduced over time (Fig. 3B).

### Acquisition phase

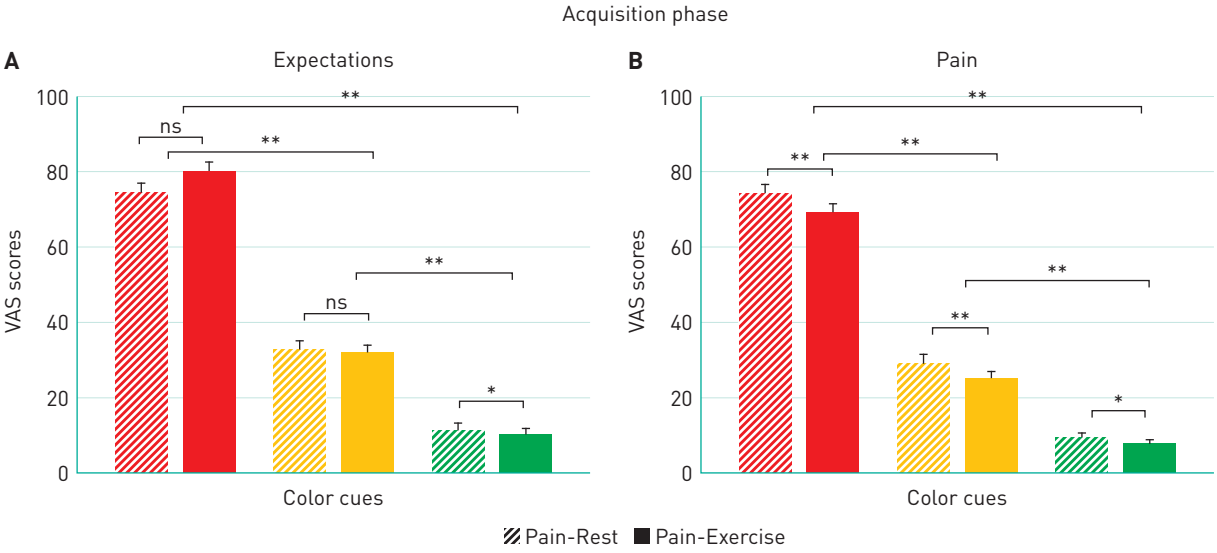
During this phase, expectation and pain VAS scores were collected for each trial. The analysis of *expectation* scores revealed a significance for the factor Color cue ($F(2,90) = 560.412$, $p < 0.001$). This indicates that participants learned to anticipate that the stimulati-

**Figure 3**




Natural history phase/exercise-induced hypoalgesia. During the exercise alone phase, the same medium level of pain intensity was given without displaying any color cues and performing any pain manipulations to reinforce expectations. Participants performed the isotonic movement in half of the trials. Participants reported as less painful the heat thermal stimulations delivered while performing the exercise (Pain-Exercise condition, full bar) compared to the rest condition (Pain-Rest condition, striped bar). (A) The hypoalgesic effect changed over time with the first set of trials significantly different than Trials 2, 3, 4 and 5, respectively (B).

**Figure 4**




Expectation and pain scores in the acquisition phase. During the *acquisition* phase, expectations scores reflected the anticipation of three distinct expected levels of pain in accordance with the color cue (the colors of the bars represent the colors of the cues) and the verbal instructions. (A) Pain ratings given at rest (Pain-Rest condition, striped-color bars) and during the extension-flexion motor task (Pain-Exercise condition, full-color bars) confirmed that participants had learned to distinguish the three intensities of pain (i.e., high after the red cue, medium after the yellow cue and low after the green cue). (B) The thermal stimulations received in the Pain-Exercise condition were perceived as less painful than the stimulations received in the Pain-Rest condition further confirming the exercise-induced hypoalgesic effect.

ons preceded by the red cue were more painful (VAS score: 77.50 ± 16.36) than those preceded by the yellow (control) cue (32.56 ± 11.60; red vs yellow cue associations, $p < 0.001$) and the stimulations preceded by the green cue were less painful (10.78 ± 6.40) than those preceded by the yellow cue (green vs yellow, $p < 0.001$) (Fig. 4A). The factor Trials was not significant (Trials, $F(5,225) = 2.158$, $p = 0.06$).

Similarly, *pain* scores showed a main effect of the Color cue ($F(2,90) = 449.588$, $p < 0.001$). Painful stimulations were reported as more painful when associated with the red (71.87 ± 16.63) than the yellow cue (27.18 ± 9.82, red vs yellow, $p < 0.001$) and less painful when associated with the green (8.60 ± 5.87) than the yellow cue (green vs yellow cue associations, $p < 0.001$) (Fig. 4B). There was a main effect of the factor Trials (Trials, $F(5,225) = 3.154$, $p = 0.009$) with a significant Condition*Color cue* Trials interaction ($F(10,450) = 4.597$; $p < 0.001$).

Painful stimulations at Rest were more painful than those accompanied by the exercise (Red: Pain-Rest vs Pain-Exercise: 74.42 ± 2.30 and 69.31 ± 2.78; $t(45) = 3.610$; $p < 0.001$; Yellow: Pain-Rest vs Pain-Exercise: 29.16 ± 1.53 and 25.24 ± 1.55; $t(45) = 3.705$; $p < 0.001$; Green: Pain-Rest vs Pain-Exercise: 9.5 ± 1 and 7.68 ± 0.87; $t(45) = 2.515$; $p = 0.016$) (Fig. 4B), further confirming that the exercise induced a hypoalgesic effect, participants learned to discriminate the three level of pain intensity and their expectations were tuned consistently with the upcoming heat stimulations.

In accordance with our hypothesis, the heat painful stimulations delivered during the Pain-Exercise condition (34.08 ± 1.28) were perceived as less painful than those delivered in the Pain-Rest condition (37.69 ± 1.20) (Condition, $F(1,45) = 22.657$, $p < 0.001$).

### Test phase

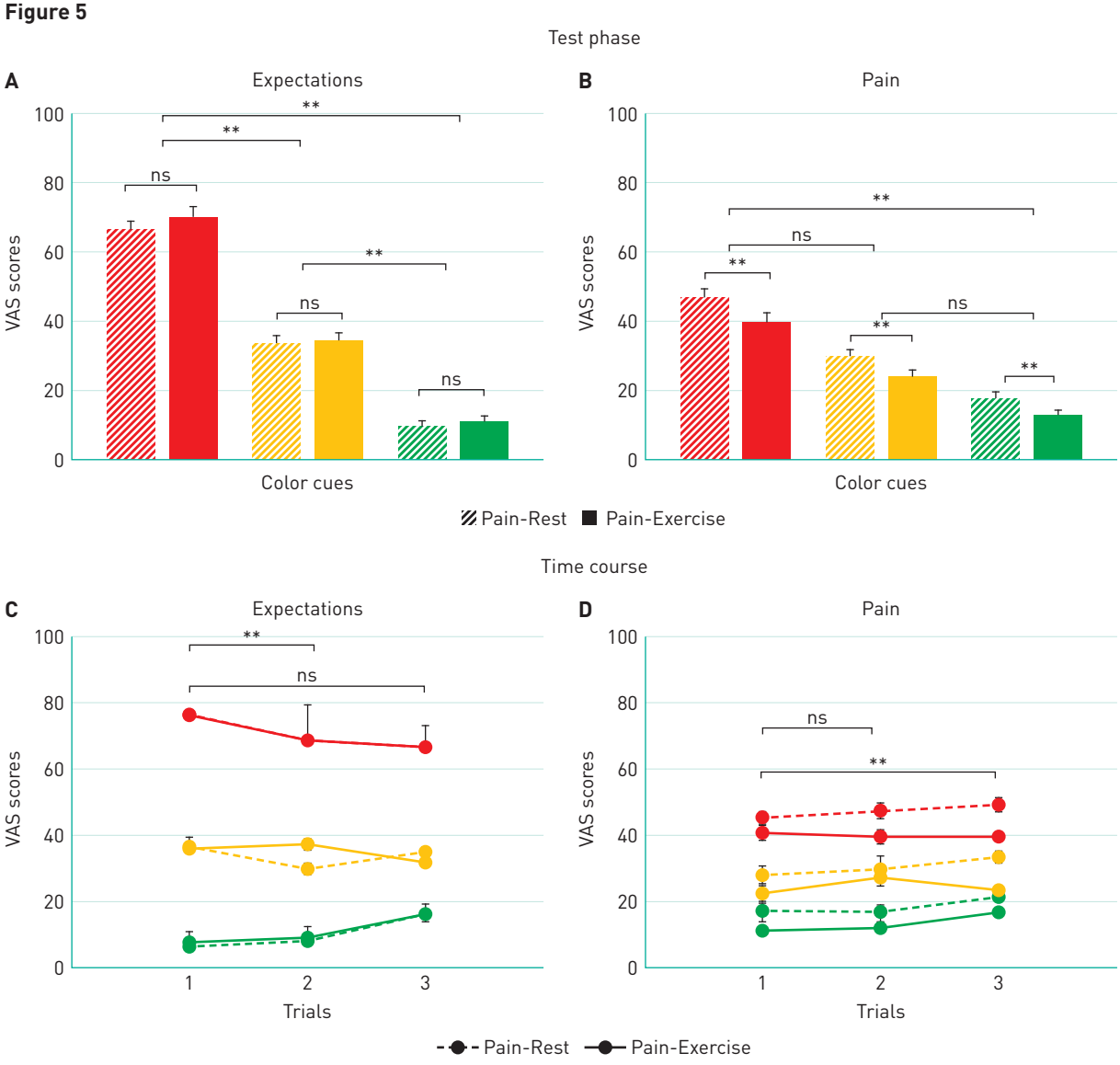
In the test phase, when we set surreptitiously all the painful stimulations at the medium level of intensity, *expectation* VAS scores showed that despite the violation between sensory stimulations and cues, participants continued expecting low, medium and high upcoming pain (Color cue, $F(2,90) = 436.825$, $p < 0.001$). Post-hoc comparisons showed that the stimulations preceded by the red cue were expected as more painful (70.49 ± 16.01) than those preceded by the yellow cue (34.34 ± 11.50, red vs yellow, $p < 0.001$) and those preceded by the green cue (10.40 ± 6.42) to be less painful than those preceded by the yellow cue (green vs yellow cue associations, $p < 0.001$) (Fig. 5A). The factor Trials was significant (Trials, $F(2,90) = 9.567$, $p < 0.001$) with a significant Condition*Color cue* Trials interaction ($F(4,180) = 4.385$; $p = 0.002$). Post-hoc comparisons indicated that the first set of trials (red, yellow, green rest and motor conditions, respectively) differed from trials 2 ($p < 0.001$) but not from trials 3 ($p = 0.239$) (Fig. 5C).

Remarkably, despite the intensity of stimulation being the same for all cue-pain associations, the VAS *pain* ratings followed the same pattern as expectations (Color

cue, $F_{(2,90)} = 109.843$, $p < 0.001$). Overall, participants reported that they perceived as more painful stimulations given after the red cue (43.44 ± 16.41) as compared to the yellow cue (26.99 ± 11.55, red vs yellow, $p < 0.001$), and they perceived as less painful stimulation associated with the green anticipatory cue (15.44 ± 9.48) than after the yellow cue (green vs yellow, $p < 0.001$) (Fig. 5B), indicating the presence of significant nocebo and placebo effects.

Moreover, we tested for the effects of exercise in conjunction with placebo and nocebo. We observed that the stimulations delivered during the Pain-Exercise condition were overall perceived differently than those delivered in the Pain-Rest condition (Condition, $F(1,45) = 33.703$, $p < 0.001$), however the Color cue*Condition interaction was not significant ($F(2,90) = 1.167$, $p = 0.316$), Fig. 5D. The factor Trials was significant (Trials, $F_{(2,90)} = 7.383$, $p = 0.001$) but with no significant Condition*Color cue*Trials interaction ($F_{(4,180)} = 1.811$; $p = 0.129$). Post-hoc comparisons showed that the set of the first trials did not differ from the second one ($p = 0.476$) but differed from trials 3 ($p < 0.001$) (Fig. 5D). Expectation scores were associated with the placebo and nocebo effects, both during exercise and at rest (Pain-Rest: nocebo:

**Figure 5**




Expectation and pain scores in the test phase. During the *test* phase (when all painful stimulations were set at the medium level of intensity), participants reported three different levels of expected pain (A) and three levels of perceived pain (Pain-Rest condition, striped-color bars) at rest and during the extension-flexion exercises (Pain-Exercise condition, full-color bars). (B) The time-courses of expectations (C) and pain reports (D) indicated relatively stable trends over the test sessions. Although, participants perceived as less painful the stimulations given in conjunction with the motor task, the delta (Green-Yellow at Rest vs Green-Yellow during the exercise and Red-Yellow at Rest vs Red-Yellow during the exercise, respectively) were not affected indicating no additive effects of the isotonic movement on placebo and nocebo effects. All data are expressed as mean ± sem. **$p < 0.001$; *$p < 0.05$; *ns* = not significant. Abbreviation: Exerc = Exercise.

r = 0.290, p = 0.050; Pain-Exercise, nocebo: r = 0.444, p = 0.002; placebo: r = 0.368, p = 0.012; placebo: r = 0.592, p < 0.001] (Fig. 6A,B). These correlations appear to be equal in significance as revealed by the Fisher z values (z = –0.83; p = 0.203 for nocebo and z = –1.37; p = 0.085 for placebo conditions), suggesting that exercise and cue-driven placebo and nocebo effects are likely to work independently.

### Comparison across phases

The hypoalgesic contribution of exercise was larger in the test phase than in the acquisition phase (Phase, $F(1,45) = 7.148$, $p = 0.010$), independently of the color cue (Color cue*Phase interaction $F(2,90) = 0.157$, $p = 0.855$), suggesting that exercise-induced hypoalgesia could be enhanced throughout training.

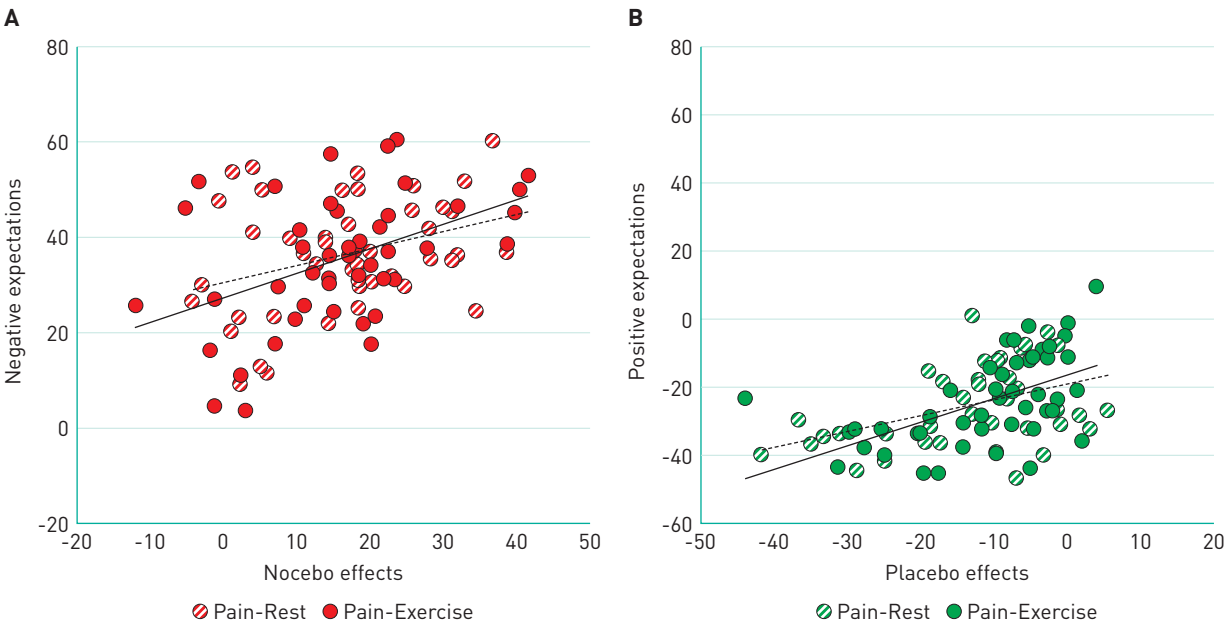
Finally, we compared the pain changes induced by exercise, placebo and nocebo manipulation alone and found that the three procedures differed significantly ($F(2,135) = 104.291$; $p < 0.001$). Post-hoc comparisons indicated that the hypoalgesic effect induced by the exercise (natural history phase) and by the placebo manipulation (test phase) was not different ($p = 0.771$), indicating no additive effect. By contrast, the nocebo manipulation was significantly different in magnitude than both placebo ($p < 0.001$) and exercise alone ($p < 0.001$).

### Effects of perceived fatigue, level of pain used and sex

At the end of each phase, participants rated their level of fatigue on a Borg scale, from 0 (not at all) to 10 (extremely severe). To rule out any influence of fatigue on the placebo and nocebo effects obtained in the test phase, correlational analyses (Spearman) were performed between the scores at the Borg scale and the placebo and nocebo responses. No significant correlation was found neither in the Pain-Exercise condition (placebo: r = 0.175, p = 0.246; nocebo: r = 0.156, p = 0.299) nor in the Pain-Rest condition (placebo: r = 0.038, p = 0.803; nocebo: r = 0.128, p = 0.395).

Finally, we explored whether individual pain as reflected by the level of intensity used to elicit medium pain, affected the magnitude of placebo analgesia and exercise-induced analgesia. We found no influences of pain levels on exercise-induced hypoalgesia (r = –0.056, p = 0.357), placebo induced analgesia without the isotonic task (r = –0.085, p = 0.288), and placebo induced analgesia with the isotonic task (r = –0.058, p = 0.351). The individual level of pain correlated inversely with nocebo effects observed at rest (r = –0.280; p = 0.03) but not during the execution of the isotonic task (r = –0.031; p = 0.419). This inverse correlation may indicate that participants who were more tolerant, received higher heat stimulations and exhibited lower nocebo effects likely because of less anxiety/arousal towards painful stimulation.

**Figure 6**




Expectations, placebo and nocebo effects. VAS pain ratings for nocebo (A) and placebo (B) effects were significantly correlated with expectation scores in the test phase for both the Pain-Rest (striped circles) and in Pain-Exercise (full circles) conditions.

Additionally, we determined the influence of sex and female menstrual phases. We found no difference between men and women with regards to placebo ($t(44) = 0.755$, $p = 0.454$), nocebo ($t(44) = -0.845$, $p = 0.403$), and exercise-induced hypoalgesia ($t(44) = -0.723$, $p = 0.473$). Moreover, we checked for any difference due to the menstrual cycle phases in women. Out of 24 women participants, 10 completed the study during the follicular phase and 11 during the luteal phase. Three of them were excluded from this sub-analysis because of the menopause period and absence of menstruation due to birth control methods. We found that placebo ($t(19) = 1.786$, $p = 0.090$), nocebo ($t(19) = -0.127$, $p = 0.900$) and expectations (positive: $t(19) = 0.064$, $p = 0.949$; negative: $t(19) = -0.713$, $p = 0.484$) were not influenced by the follicular cycle. By contrast, women who participated in the study during the luteal phase displayed stronger exercise-induced hypoalgesic effect as compared to those in the follicular phase (test phase, $t(19) = -2.802$, $p = 0.011$). Future research is needed to understand how gonadal hormones may influence exercise-induced hypoalgesia.

## DISCUSSION

The aim of this study was to investigate the interplay between exercise, placebo and nocebo effects on pain modulation. We demonstrated in a within-subject study design that both exercise and placebo effects reduce heat painful sensations. The pain reductions induced by placebo effects via reinforced positive expectations and exercise were equal in magnitude suggesting that placebo- and exercise-induced hypoalgesia may represent two important distinct modalities of pain inhibition. Importantly, nocebo effects were nevertheless present even during exercise, as revealed by the higher pain ratings following the red cue compared to the green and yellow cues during the motor task.

Exercise, placebo (and nocebo) are likely to work throughout distinct pain modulatory systems. Further mechanistic research that combines exercise and expectation manipulations could provide potential new strategies for optimizing nonpharmacological pain interventions.

Recent studies have demonstrated that motor performance in athletes, non-athletes and patients with motor deficits can be bi-directionally modulated by expectations, placebo and nocebo effects [10,15,16,17,18,19,20,21]. For example, Benedetti and colleagues (2007) showed that pharmacological conditioning with opioids improves pain endurance and motor performance in study participants who underwent a submaximal effort tourniquet technique [19]. Maganaris and colleagues (2000) enrolled 21 athletes to study effects of deceptive administration of anabolic steroids on the maximum force production during bench press, dead lift, and squat exercises. Results showed an improvement and a maintenance of the performance in participants who believed they ingested the steroids [22]. Further studies showed that placebo procedures can improve different parameters of motor performance, such as force [10], resistance to fatigue [23], and speed [24]. Beedie and colleagues (2007) investigated the role of positive versus negative beliefs on repeated 30m-sprint performances [24]. Participants were informed they had received an ergogenic aid and they received information about either the positive or the negative impact of the treatment on the performance. Meanwhile, all the participants received an inert substance, the group informed about the improvement of both endurance and performance showed an enhancement of the speed. Conversely, those who were informed about the negative effect on the performance, recorded a worsening of the speed [24]. Similarly, a decrease of muscle work was found in non-athletes during a leg extension exercise after the application of a sham electrical device that the participants thought to have negative effects [25].

Herein, we expanded placebo and nocebo research in the contexts of pain and motor performance using a within-subjects design combined approach. Pain and motor performance have primarily been investigated separately and tested with different protocols. Deliberately, we created a combined experimental paradigm in which painful heat stimulations were delivered during the execution of isotonic task. Both painful stimuli and movements were tailored to the individual pain sensitivity (i.e. individual level of medium heat pain) and strength (i.e., 30% of the maximal strength) respectively. Consistent with the literature on exercise-induced analgesia [26,27,28,29], we found that the isotonic task reduced pain perception when heat stimulation was delivered at the same time as the movement. We compared in the same study participants the reduction of experimental pain induced by exercise per se, placebo effects (via reinforced positive expectations) with and without the execution of the isotonic task. Importantly, the exercise and placebo with motor task equally reduced the pain experience. The nocebo hyperalgesic effect remained significantly high irrespectively of the condition (Rest vs Exercise). This may suggest that exercise does not abolish the nocebo hyperalgesic effect, likely because of the strength of negative expectations in inducing nocebo effects [30,31].

These effects might be interpreted in at least two distinct ways. First, sensory reduction that has been proposed as a characteristic of voluntary movement [32,33,34,35] may have shaped the integration of sensorial and motor inputs generating a reduction of perceived intensity of pain. Within this frame of reference, expectations about the pain may have interfered with the predictions of pain and the sensory feedback. For example, it has been suggested that whenever we perform an action, copies of the motor command are dispatched as coro-

llary discharges to sensory structures that predict the sensory consequences of the action (36,37,38). Internal predictions about the movement execution and upcoming painful stimuli were likely integrated and finely shaped by expectations.

Second, attention may have played a role. Some may argue that exercise execution *per se* capitalized participants' attention towards the movement, thus distracting them from the painful stimuli and consequently making them feel less pain. Although we did not explicitly measure the level of attention, we are inclined to think that this is not the case based on the fact that the modulation of pain during the execution of the isotonic movement was constantly present in the acquisition and test phases as well as for all the cues (red, yellow, green). Interestingly, expectation scores were significantly correlated with both placebo and nocebo effects during movement execution expanding our previous results (1). The individual level of used pain correlated inversely with nocebo effects. This inverse correlation may indicate that participants who were more tolerant, received higher heat stimulations and exhibited lower nocebo effects likely because of less anxiety/arousal towards pain (1). Another important aspect is that those subjects who displayed placebo or nocebo responses at rest, continued to be responders in the movement condition adding to the reproducibility of placebo effects (39). While exercise and placebo-induced hypoalgesia appear to be two distinct sides of the pain modulation phenomenon, our innovative result opens interesting perspectives in the placebo and nocebo research, with potential implications for sport, rehabilitation and pain management.

Some pitfalls and limitations remain to be discussed. Due to equipment limitations, we did not include a control condition in which the contralateral arm was stimulated at rest. In addition, we did not ask participants whether or not they engaged in regular physical activity. However, we recruited from a student population and the participants were screened for healthy conditions(40). Furthermore, to better and deeply understand the role of attention, future studies may investigate the extent to which attention (i.e. addition of a working memory task) affects the perception of pain during a well-controlled movement execution, thus identifying an additional factor that helps to reduce the experience of pain. This paradigm is suitable for future mechanistic studies in which exercise-induced hypoalgesia, expectations, and violation of expected outcomes can be investigated with neurophysiological approaches (i.e. TMS). For example, Fiorio and colleagues (2014), by applying transcranial magnetic stimulation over the primary motor cortex, found that a placebo-induced modulation of force was paralleled by changes in the excitability of the corticospinal system as shown by increased amplitude of the motor evoked potentials and decreased duration of the cortical silent period, hinting of a cognitive enhancement of corticospinal excitability (10). Nocebo manipulations are also associated to corticospinal changes (11).

In sum, our study was innovative in nature because it demonstrates that two modalities of descending pain systems can be simultaneously activated to gain hypoalgesia opening up new research avenues with important mechanistic approaches and potential clinical applications for sport, rehabilitation and pain medicine.

## CONCLUSION

Herein, we demonstrated that pain sensations can be reduced by both the execution of an isotonic exercise and the reinforcement of participants' expectations, thus highlighting two important modalities of pain inhibition. Translating these findings in the real-world setting is of utmost importance for pain management in clinical settings, in order to optimize not only rehabilitation programs, but also therapeutic strategies and treatment outcomes.

## ADDITIONAL INFORMATION



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**CONTRIBUTIONS**

C.L., C.N. and F.M. designed the study; C.N. collected the data under C.L.'s supervision; C.N. and C.L. analyzed the data; C.N. and C.L. wrote the first draft of the manuscript; C.L. and F.M. revised the manuscript and prepared the final version.

**COMPETING INTERESTS**

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PHYSIOTHERAPY UPDATES

ABSTRACT

# A MULTIMODAL PHYSIOTHERAPY PROGRAMME PLUS DEEP WATER RUNNING FOR IMPROVING CANCER-RELATED FATIGUE AND QUALITY OF LIFE IN BREAST CANCER SURVIVORS

Cuesta-Vargas AI[1], Buchan J, Arroyo-Morales M.

[1] Physiotherapy, University of Malaga, Malaga, Spain; School Clinical Science, Queensland University of Technology, Brisbane, Qld, Australia.

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DOI: 10.1111/ecc.12114

## ABSTRACT

The aim of the study was to assess the feasibility and effectiveness of aquatic-based exercise in the form of deep water running (DWR) as part of a multimodal physiotherapy programme (MMPP) for breast cancer survivors. A controlled clinical trial was conducted in 42 primary breast cancer survivors recruited from community-based Primary Care Centres. Patients in the experimental group received a MMPP incorporating DWR, 3 times a week, for an 8-week period. The control group received a leaflet containing instructions to continue with normal activities. Statistically significant improvements and intergroup effect size were found for the experimental group for Piper Fatigue Scale-Revised total score (d = 0.7, P = 0.001), as well as behavioural/severity (d = 0.6, P = 0.05), affective/meaning (d = 1.0, P = 0.001) and sensory (d = 0.3, P = 0.03) domains. Statistically significant differences between the experimental and control groups were also found for general health (d = 0.5, P < 0.05) and quality of life (d = 1.3, P < 0.05). All participants attended over 80% of sessions, with no major adverse events reported. The results of this study suggest MMPP incorporating DWR decreases cancer-related fatigue and improves general health and quality of life in breast cancer survivors. Further, the high level of adherence and lack of adverse events indicate such a programme is safe and feasible.

**KEYWORDS:** Aquatic exercise. Breast cancer. Survivors. Deep water running.Fatigue. Multimodal physiotherapy.

ABSTRACT

# PATTERNS OF CLINICAL REASONING IN PHYSICAL THERAPIST STUDENTS

Sarah Gilliland[1], Susan Flannery Wainwright[2]

[1]PT, DPT, PhD, Department of Physical Therapy, Crean College of Health and Behavioral Sciences, Chapman University, Irvine, CA 92618 (USA). Address all correspondence to Dr. Gilliland at: sgillila@chapman.edu.

[2] PT, PhD, Department of Physical Therapy, Jefferson School of Health Professions, Thomas Jefferson University, Philadelphia, Pennsylvania.

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## ABSTRACT

**Background and Purpose.** Clinical reasoning is a complex, nonlinear problem–solving process that is influenced by models of practice. The development of physical therapists' clinical reasoning abilities is a crucial yet underresearched aspect of entry-level (professional) physical therapist education.

**Objectives**. The purpose of this qualitative study was to examine the types of clinical reasoning strategies physical therapist students engage in during a patient encounter.

**Methods**. A qualitative descriptive case study design involving within and across case analysis was used. Eight second-year, professional physical therapist students from 2 different programs completed an evaluation and initial intervention for a standardized patient followed by a retrospective think-aloud interview to explicate their reasoning processes. Participants' clinical reasoning strategies were examined using a 2-stage qualitative method of thematic analysis.

**Results.** Participants demonstrated consistent signs of development of physical therapy–specific reasoning processes, yet varied in their approach to the case and use of reflection. Participants who gave greater attention to patient education and empowerment also demonstrated greater use of reflection-in-action during the patient encounter. One negative case illustrates the variability in the rate at which students may develop these abilities.

**Conclusions.** Participants demonstrated development toward physical therapist--specific clinical reasoning, yet demonstrated qualitatively different approaches to the patient encounter. Multiple factors, including the use of reflection-in-action, may enable students to develop greater flexibility in their reasoning processes.

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PHYSIOTHERAPY UPDATES

ABSTRACT

# PELVIC-FLOOR PROPERTIES IN WOMEN REPORTING URINARY INCONTINENCE AFTER SURGERY AND RADIOTHERAPY FOR ENDOMETRIAL CANCER

**Stéphanie Bernard[1], Hélène Moffet[2], Marie Plante[3], Marie-Pier Ouellet[4], Jean Leblond[5], Chantale Dumoulin[6]**

[1]PT, MSc, Department of Rehabilitation, Faculty of Medicine, Université Laval, Québec, Québec, Canada, and Center for Interdisciplinary Research in Rehabilitation and Social Integration, Québec, Québec, Canada.
[2]H. Moffet, PT, PhD, Department of Rehabilitation, Faculty of Medicine, Université Laval, and Center for Interdisciplinary Research in Rehabilitation and Social Integration. Address all correspondence to Dr Moffet at: Helene.Moffet@rea.ulaval.ca.
[3]M. Plante, MD, Department of Gynecologic Oncology, University Hospital of Québec City, Québec, Québec, Canada.
[4]M.-P. Ouellet, MD, Faculty of Medicine, Université Laval, and University Hospital of Québec City.
[5]J. Leblond, PhD, Center for Interdisciplinary Research in Rehabilitation and Social Integration.
[6]C. Dumoulin, PT, PhD, School of Rehabilitation, Faculty of Medicine, Université de Montréal, Montréal, Québec, Canada, and Research Centre of Institut Universitaire de Gériatrie de Montréal, Montréal, Québec, Canada.

[Bernard S, Moffet H, Plante M, et al.Pelvic-floor properties in women reporting urinary incontinence after surgery and radiotherapy for endometrial cancer. Phys Ther. 2017;97:438–448.]



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Bernard S, *et al*; Pelvic-Floor Properties in Women Reporting Urinary Incontinence After Surgery and Radiotherapy for Endometrial Cancer, Physical Therapy 2017; 97 (4): 438–448, doi:10.1093/ptj/pzx012.



## ABSTRACT

**Background.** Endometrial cancer is the fourth most prevalent cancer in Canadian women. Radiotherapy (RT) is frequently recommended as an adjuvant treatment. There is a high prevalence (>80%) of urinary incontinence (UI) after RT. It is plausible that UI is associated, at least in part, with alterations of the pelvic-floor muscles (PFM).

**Objective.** The aim of this exploratory study was to compare the PFM functional properties of women reporting UI after hysterectomy and RT for endometrial cancer with those of women with a history of hysterectomy but without UI.

**Design.** A descriptive cross-sectional study was conducted. Eleven women were recruited for the affected group, and 18 were recruited for the comparison group.

**Methods.** Urogenital and bowel functions were assessed using International Consultation on Incontinence Questionnaires, and PFM properties were evaluated using a Montreal dynamometer.

Nonparametric tests were used for comparison of personal characteristics, functional status, and muscle properties. A correspondence analysis detailed the association between UI severity and PFM properties.

**Results.** Maximal opening of dynamometer branches, maximal vaginal length, PFM maximum force and rate of force development in a strength test, and number of rapid contractions during a speed test were reduced in the affected group. No significant difference was found for the endurance test. The severity of UI was found to correspond to the rate of force development and the number of rapid contractions in a speed test, endurance, age, and vaginal length.

**Limitations.** The results are limited to the population studied. The small sample size limited the strength of the conclusions.

**Conclusions.** Some evidence of alterations in PFM properties were found in women with UI after hysterectomy and RT for endometrial cancer. These alterations appeared to be associated with UI, suggesting a possible role for rehabilitation.

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PHYSIOTHERAPY UPDATES

ABSTRACT

# UPPER LIMB NEURODYNAMICS AND COMPRESSION NEUROPATHY: SYSTEMATIC REVIEW

**Bryan Littré**

8, place de la Mairie, 93420 Villepinte, França

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## ABSTRACT

**Aims.** The aim of this review is to examine the role of upper limb neurodynamic manoeuvres in the treatment for neural compression syndrome.

**Method.** A systematic review was done from December 2016 to April 2017 only selecting randomised controlled trials where an experimental group with a neurodynamic component is compared to a control group.

**Results.** Twenty-three randomised controlled trials were analysed. Neuromeningeal gliding manoeuvres are of interest in the treatment of neural compression syndrome. Neural gliding seem to be as effective as conservative treatments whose effectiveness has been demonstrated and seem more effective when combined with another treatment.

**Discussion and conclusion.** Neurodynamic manoeuvres have a therapeutic effect. Not all neurodynamic manoeuvres are the same and the treatment of interfaces all along the nerve tissue seem appropriate, taking into account the phenomenon of multiple nerve compression. The analysis of cost and effectiveness in the treatment of idiopathic carpal tunnel syndrome shows the superiority of kinesiotherapy over surgery.

**Level of evidence.** 2.

**KEY WORDS:** Neural compression. Upper limb. Neurodynamics. Neuropathy. Radiculopathy.

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PHYSIOTHERAPY UPDATES

ABSTRACT

# NEUROCOGNITIVE PHYSIOTHERAPY IN CHILDREN AND MOTOR LEARNING

**Patricia Martín Casas**

Neurological and paediatric physiotherapist. PhD awarded by Universidad Complutense de Madrid.

## ABSTRACT

**Introduction:** Cognitive therapeutic exercise (CTE), also known as neurocognitive rehabilitation, was developed in the 70s in Italy by professor Perfetti, who developed it for adults, and Dr Puccini, who developed it for children. The rehabilitation method is still evolving thanks to different study groups in different countries. Based on the original ideas of CTE, we propose a comprehensive interpretation of developmental alterations in children, based on available scientific evidence, which postulates the integration of sensitive, motor, cognitive, and emotional-relational aspects for the acquisition and transference of learning through development. Considering human development as an indivisible whole is essential to apply this method when assessing and treating any developmental alteration in children. The aim of this talk is to connect the CTE principles and methodology with the current knowledge of children's development and motor learning.

**Material and methods:** By doing a bibliographical review of publications on children's development and motor learning in the main healthcare databases, we will analyse the main key elements of CTE in paediatric physiotherapy.

**Discussion and conclusions:** The use of CTE in paediatric physiotherapy is scientifically meaningful and relevant when relating its principles and methodology to the latest studies on children's development and motor learning. The assessment of a baby or child from an integral perspective, including environmental factors, and the design of a treatment that has the child at the centre together with the family and educational environment, is absolutely valid according to the literature. Paediatric physiotherapy based on this method is supported by a poor body of evidence so further studies are needed since it offers a unique approach with very interesting possibilities

Col·legi de Fisioterapeutes de Catalunya

PHYSIOTHERAPY UPDATES

LEARN HOW TO DO RESEARCH

# BIOETHICS AND BIOETHICAL REQUIREMENTS IN RESEARCH

**Dr. Jordi Esquirol Caussa[1,7,8], Sra. Vanessa Bayo Tallón[2,3,4,7], Sra. Maider Sánchez Padilla[2,3,7], Dr. Josep Sánchez Aldeguer[5,7,9], Dr. Ishar Dalmau Santamaria[6,7,10]**

[1] MD, PhD Internal Medicine [2] Physiotherapist [3] Master's degree in osteopathy [4] Master's degree in translational research in physiotherapy
[5] MD, PhD General Medicine [6] MD, PhD Medicine and Surgery
[7] Physiotherapy Research Centre, Escoles Universitàries Gimbernat (affiliated with Autonomous University of Barcelona (UAB)).
[8] Teknon Medical Centre. Barcelona, [9] College of Medicine. Autonomous University of Barcelona (UAB).
[10] Dept. of Medicine, Physiotherapy. Autonomous University of Barcelona (UAB).

Contact (first author): Dr. Jordi Esquirol Caussa. Tel.: 93.589.37.27 jordi.esquirol@eug.es

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## ABSTRACT

Deontological codes are sets of ethical rules applicable to the professional field of any healthcare branch (medicine, nursing, physiotherapy, etc.) and other professions. Bioethics is the science of behaviour, values and moral principles in the application of knowledge in healthcare and studies the ethical aspects of clinical practice and research.

The Declaration of Helsinki of the World Medical Association defines the ethical principles behind biomedical research and must be adhered to by any research involving living beings.

Principalist bioethics consists of four basic principles that must be applied to all clinical and research activities: autonomy, beneficence, non-maleficence, and justice. These are prima facie principles and only in cases of ethical conflict, a principle will prevail over the rest, always prioritising public ethics (justice and non-maleficence) over private ethics (autonomy and beneficence).

Healthcare Ethics Committees and Research Ethics Committees safeguard the correct observance of ethical rules in everyday clinical practice, making recommendations in case of ethical conflict both in particular and general cases, and the correct adequacy to ethical guidelines and their compliance in all the stages of a research project in the field of healthcare.

**KEY WORDS:** Principle-based ethics. Bioethics. Professional ethics. Ethical codes. Clinical ethics. Clinical Ethics Committees. Research Ethics Committees.

## MORALS AND ETHICS

Morals can be defined as the abstract study that qualifies ideas as desirable or undesirable "out of habit", configuring them and providing norms that are not written or have a reasoned basis. By contrast, ethics is a product of reasoned reflection about actions, to qualify these actions as correct or incorrect through critical thinking, reasoning, and argumentation-based deliberation (using the scientific method and knowledge). Ethics applied to professional actions makes up deontology, which is a set of explicit guidelines (deontological code) of what is considered to be a correct action in the healthcare area (medicine, nursing, physiotherapy, etc.).

## BIOETHICS

Bioethics is a discipline of healthcare sciences that merges life sciences (*Bios*) and value systems (*Ethos*), a bridge between present and future, a study of future consequences of today's actions. It is Ethics applied to the field of life sciences, the science of behaviour, of values and moral principles in biological and healthcare sciences. It is the interdisciplinary, systematic study of human behaviour in life sciences and healthcare through values and moral principles. Bioethics studies, in an interdisciplinary way, the ethical problems, moral issues and conflicts that arise when applying scientific and technical knowledge in all the areas of healthcare, both when dealing with individual patients (clinical training) or with the society as a whole (public health), and their present and future consequences for society and nature (the environment). Bioethics studies the ethical aspects of clinical practice, applied science and research, practically managing these values and conflicts between values.

## THE DECLARATION OF HELSINKI

The Virginia Declaration of Rights (1776) and the he Declaration of the Rights of Man and of the Citizen of the French Revolution (1789) proclaimed equality in rights of all human beings for the first time in a legislative text. After World War II, The United nations General Assembly (1948) proclaimed the Universal Declaration of Human Rights. In 1964 the Helsinki declaration was developed by the World Medical Association and defined the ethical principles for medical research involving human subjects. The Declaration has been amended several times, its last amendment was in 2013 in Fortaleza (Brazil). The Declaration of Helsinki must always be observed in biomedical research involving human beings and must be explicitly stated in any publication that derives from it. It is also aware of the need that an Ethics Committee approves any research project before it is carried out.

## PRINCIPALIST BIOETHICS

In democratic societies with plural values, the four main principles of Principalist Bioethics derived from the Belmont report (1979) and the book *Principles of Biomedical Ethics* by Beauchamp and Childress (illustrations 1 and 2) tend to be applied:

- **Principle of autonomy:** derived from Kant's concept of categorical imperative. It respects the rational decisions taken by patients as they can freely decide on their own life. It requires that patients receive and understand the correct and complete information, participate in clinical decision making with full autonomy (shared clinical decision making, in diagnostic and therapeutic actions), and have their freedom of choice respected with no coercion or pressure. This principle ensures the end of *paternalism* of healthcare providers towards their patients, ensuring the protection of the most vulnerable people. This principle is the basis for two documents: the *informed consent form* and the *advance healthcare directive document.*

- **Principle of beneficence** It refers to the duty to be of a benefit to patients, according to their own values: it requires the best updated scientific knowledge and professional excellence, professionalism and empathy, avoiding paternalism without falling into relativism, making the patient also responsible through a motivational interview, sharing the decision making process and adapting these decision to each individual case (*patient-centred care*).

- **Principle of non-maleficence:** It derives from the Hippocratic aphorism *"primum non nocere"* (first, do no harm) and it imposes to prevent any harm to the patient, this being understood as prioritising the reduction of risks for the patient (any action can have undesirable effects). The combination of the principles of beneficence and non-maleficence lead to the necessary analysis of risks and benefits of each and every healthcare action (*benefit/risk relationship*) and the need to develop and apply *Clinical Practice Guidelines* that are part of the *"Lex Artis"*.

- **Principle of justice**, understood as the principle of equity. It implies the fair distribution of resources (distributive justice): provide the patient with the necessary resources without causing any prejudice to other people and distributing all the resources in an equitable way (time, personal or economic resources). Treating equally those who are equal and differently those who are different, with no discrimination on the grounds of age, sex, origin, social class or personal beliefs. Its

application requires an accurate analysis of costs (time, personal and economic) and of the possible benefits of every single healthcare action in order to determine the best *cost/benefit relationship* for each patient and for society, taking into account the circumstances at that time.

These four principles of bioethics are equally important and they are called *prima facie* principles (Illustration 1): they are non-hierarchical *a priori*, no one principle is more important than the other and they will only be prioritised in case of conflict. When this occurs and the specific circumstances of a given case dictate, the principles of non-maleficence and justice will be prioritised as inalienable under any circumstance (public or civil ethics, good practice and human rights, ethics of inalienable minima): they impose a duty with society and not with ourselves, they compel everybody and are independent of one's opinions and wishes (Illustration 3). In case there is an ethical conflict between these principles, the principles of autonomy and beneficence (private ethics or particular criteria, ethics of maxima) are recommendable but not compulsory since they are duties with oneself and not with society, moral responsibility, personal values, ideals of conscience, and intimate virtues.

## ETHICS COMMITTEES

Ethics committees are interdisciplinary consultative bodies that study specific cases in detail and give their opinion on ethical problems in healthcare and medical research. Healthcare settings have set up Healthcare Ethics Committees (HEC) and prognosis committees, and research centres have set up Human Research Ethics Committees (HREC) and Human and Animal Ethics Committees (HAEC). These committees are appointed by those responsible for healthcare centres and healthcare research centres for a limited period of time, their members are volunteers and they review both general recommendations and individual cases (their deliberations and conclusions are not legally binding but they try to reach a minimum agreement between the parts involved). Their composition is diverse and plural, including all the different points of view existing in society as it is expected from democratic societies, and interdisciplinary since the issue they have to deal with cannot be approached from just a single branch of knowledge.

The aims of Ethics Committees are to review and follow up research protocols involving humans and animals (HREC, HAEC) and avert the potential dangers posed by biotechnological advances in healthcare (HEC). Their functions are to protect the rights of patients and research participants (also for other living beings and the environment), facilitate the decision-making process in case there are ethical problems related to healthcare, establish protocols for frequent ethical problems and provide healthcare professionals with ethics training.

**Illustration 1**

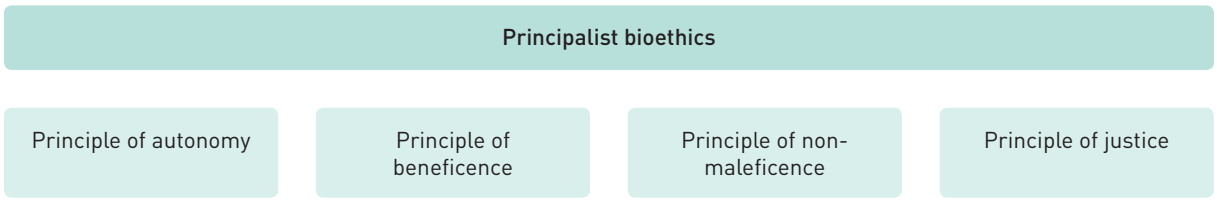

**Illustration 2**

| Principle | Procedure |
|---|---|
| Autonomy | Correct and complete information; participation of patients and respect for their decisions and preferences, protection of the most vulnerable people.<br>Documents: informed consent form and advance healthcare directive document. |
| Beneficence | To be of a benefit to patients; professionalism, excellence.<br>Avoid paternalism and relativism, aim for co-responsibility. |
| Non-Maleficence | Avoid harm.<br>Assess risk/benefit relationship.<br>*Lex artis*: elaborate and use clinical practice guidelines and clinical action plans. |
| Justice | Equity; fair Distribution of resources (distributive justice, limited resources limit autonomy)<br>Assess cost/benefit relationship |

**Illustration 3**

| | |
|---|---|
| | ***Prima facie:*** **obligatory application of the four principles**<br>**Hierarchization only in cases of ethical conflict** |
| Non-Maleficence<br>Justice | ETHICS OF MINIMA<br>(Always **inalienable**)<br>• Compel everybody, independent from opinions and wishes<br>• Duty with others and not with oneself.<br>Civil ethics of ethics of minima (superior level): we are all equal, morally and legally (principle of universality). |
| Autonomy<br>Beneficence | ETHICS OF MAXIMA<br>(**Recommended** but not compulsory in case of ethical conflict)<br>• No longer moral when demanded under coercion<br>• Duty with oneself but not with others (intimate virtues)<br>  • Private ethics or ethics of maxima: we are all morally different (principle of particularization) |

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PHYSIOTHERAPY UPDATES

LEARN HOW TO DO RESEARCH

# PLACEBO AND NOCEBO RESPONSES: THE IMPORTANCE OF HUMAN FACTORS IN MEDICAL TREATMENTS

**Dr. Ishar Dalmau i Santamaria[1,6,9], Sra. Noelia Serrano Domínguez[2,3,6], Sra. Mireia Relats Vilageliu[2,6], Dr. Jordi Esquirol Caussa[4,6,7], Dr. Josep Sánchez Aldeguer[5,6,8]**

[1] MD, PhD [2] Physiotherapist [3] Master's degree in translational research in physiotherapy
[4] MD, PhD Internal Medicine [5] MD, PhD General Medicine
[6] Physiotherapy Research Centre. Escoles Universitàries Gimbernat (affiliated with Autonomous University of Barcelona (UAB)).
[7] Teknon Medical Centre. Barcelona. [8] College of Medicine. Autonomous University of Barcelona (UAB).
[9] Dept. of Medicine, Physiotherapy. Autonomous University of Barcelona (UAB).
Contact (first author): Dr. Ishar Dalmau i Santamaria. Tel.: 93.589.37.27 ishar.dalmau@eug.es

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## ABSTRACT

Placebo and nocebo effects have long been considered a nuisance in clinical research. Nowadays though it is a very active field with different research groups all over the world revealing very promising results that help us understand their mechanisms of action. Although we tend to talk about a placebo or nocebo effect, there actually exist different types, with different mechanisms of action, and for different systems, medical conditions and therapeutic interventions. For example, it has been demonstrated that there are different brain mechanisms connected with expectations, rewards, and even with anxiety as well as with different learning phenomena such as cognitive and Pavlovian conditioning and social learning. Some studies also point to the existence of some genetic variants (placebome) and our capability of response to placebo. Regarding experimental models that help us to better understand the neurobiology of the placebo effect, we can find pain and Parkinson's disease.

The placebo effect is in fact a psychosocial effect in which stimuli such as oral messages or therapeutic rituals change the body chemistry and activate some specific circuits (opioid-cholecystokinergic-dopaminergic) in the patient's brain. Moreover, it has been proven that the cellular mechanisms that are activated in the placebo condition are the same that some medicaments activate, which suggests a possible cognitive-affective interference in the action of medicaments. Finally, it has also been demonstrated that the functional degeneration of the prefrontal cortex reduces or neutralises the placebo response, as it occurs in Parkinson's disease.

**KEY WORDS:** Placebo. Nocebo. Belief. Expectation. Intention. Empathy. Therapeutic ritual. Psychoneuroendocrinoimmunology. Neuroscience.

## PLACEBO. HISTORICAL BACKGROUND

The use of placebo as a scientific test goes back to the 18th century when it was used to counteract the effects of therapeutic magnetism developed by the German doctor Franz Mesmer. Nevertheless, the systematic study of placebo started after World War II with the appearance of randomised double-blind controlled clinical trials as the best study design to assess the effectiveness and safety of drugs. Placebo is any inactive, harmless or inert substance that is used as a medicament but lacks pharmacological activity. This substance is administered to control groups in a clinical trial, simulating the administration of a drug, with the aim of comparing the effects of the drug on the experimental group. Colloquially, the terms placebo and inactive substance are used as synonyms.

However, the beneficial effect of placebo is subject to, and this is the key aspect of the phenomenon, the belief that the patient has in the benefits of a given therapeutic intervention. According to the Real Academia Española, placebo (From Latin *placēbo* 'I will please', the first-person singular future active indicative of *placere* 'I please') is "any substance that, although it lacks any therapeutic action, produces some beneficial effect on the patient if taken with the belief that the substance is in fact effective".

## PLACEBO EFFECT AND RESPONSE

We must distinguish between placebo effect and placebo response. The placebo effect is observed in the placebo group of a clinical trial which is caused by the placebo biological phenomenon, due to an ineffective pharmacological principle (a substance) but also due to a treatment with a non-specific effect (a procedure). The study of the placebo effect is basically the analysis of the relationship between the patient's complex psychosocial context and its effects on the patient's mind (neurobiological or psychological changes). The placebo response is self-explanatory and can be more specifically analysed through experimental protocols. It is the positive effect produced by the placebo biological phenomenon, that is to say, by an ineffective pharmacological principle or a non-specific treatment. Therefore, placebo is any substance or procedure that, in the context of the therapist-patient relationship and through neurobiological or psychological changes, draws a positive response on the patient.

## NOCEBO

We call nocebo (from Latin n*ocēbo*, the first-person singular future active indicative form of *noceo* 'I harm') any non-specific component in the response to treatment or therapeutic measure that, unlike placebo, has negative or harmful characteristics. The nocebo effect is defined as the aggravation of symptoms or signs of a disease due to conscious or unconscious expectations of the negative effects or a treatment or therapeutic measure. It is the effect of the patient's own pessimistic expectations regarding a therapeutic intervention, for example a pharmacologically inert substance, which can cause harmful, painful or unpleasant effects. We can consider the nocebo effect the opposite of the placebo effect.

## NON-SPECIFIC, BENEFICIAL OR ADVERSE EFFECTS OF A TREATMENT

Many authors still confuse the terms and the meaning of non-specific and beneficial or adverse effects of a treatment with the placebo or nocebo effect.

There are factors that can potentially contribute to the improvement or aggravation of a symptom and they are neither placebo nor nocebo, for example: the pharmacodynamics of drugs and their specific adverse or undesirable effects; the natural history of a disease that can be self-limited or with symptoms that fluctuate with no external intervention or the characteristics of the patient, the agent or aggressive entity, the environment or a regression to the mean; the associated bias (Hawthorne effect); a judgment error; or other non-specific, beneficial or non-beneficial effects that have not yet been properly studied or analysed.

## THE IMPORTANCE OF HUMAN FACTORS IN MEDICAL TREATMENTS

Arthrosis and back pain are the second and third reasons respectively for medical consultations related to chronic pain in the US, involving a cost of up to 635 billion dollars/year. The drugs prescribed for these conditions are moderately effective and their side effects can range from nausea and constipation to addiction and death.

In 2014 a study done in Canada assessed the role of communication between healthcare providers and patients in the treatment of chronic low back pain. Half the participants in the study received a physiotherapy treatment with low electrical stimulation and the other half received a simulated stimulation or sham treatment (the equipment was ready but electrical currents were not delivered). In the group of patients treated with simulated stimulation (placebo) there was a reduction in pain intensity by 25%. Those patients who were administered real stimulation (experimental group) reduced their pain intensity by 46%. Each of these group was subdivided in half. One of these halves had a unique and brief conversation with the physiotherapist who was treating them whereas the physiotherapist treating the other half asked them questions and listened to their answers attentively. Moreover, the physiotherapists in the second group expressed empathy regarding the patient's situation and used words of support to wish them well. The patients receiving a sham treatment and actively communicating with their physiotherapist reported a reduction in pain intensity by 55%. The patients receiving electrical stimulation and actively communicating with their physiotherapist reported a reduction in pain intensity by 77%.

The study of the placebo and nocebo effects is in fact the study of the therapeutic ritual and its central role in the final therapeutic outcome. The biochemical and cellular changes in the patient's brain under the placebo effects are very similar to those induced by drugs. These outcomes have profound implications in clinical trials and in clinical practice both for pharmacological and non-pharmacological interventions like acupuncture. Along these lines, an old Chinese proverb says "when the wrong man uses the right means, the right means work in the wrong way."

## THE PLACEBO AND NOCEBO MECHANISMS

Two mechanisms of action connected with placebo and nocebo have been described:

1. Cognitive, psychobiological (information the patient receives and any verbal instruction given during the experiments) mechanisms: they explain the effects of expectations, beliefs (both the patient's and the therapist's) and persuasions about the final therapeutic outcomes. These mechanisms act on the basis of conditioning and participate in conscious physiological processes like that of pain.

2. Basic learning mechanisms: based on Pavlovian conditioning (classical conditioning) and on instrumental or operant conditioning. These mechanisms are involved in unconscious functions like that of hormonal secretion.

In relation to the neurobiological bases of placebo, it has been demonstrated it participates in the endogenous opioid system, the endocannabinoid system and it is also involved in neurotransmitter release like cholecystokinin (CCK).

On the other hand, some brain structures have been found to be related to the impact of expectations on the beneficial or non-beneficial outcomes of placebo and nocebo respectively, for example those structures that influence the perception of health or those connected with the brain's reward system. In line with this, it has been demonstrated that patients with Alzheimer's are immune to sham treatments and they have to take high doses of analgesics to relieve their pain. This is based on the evidence that the brain areas involved in predicting the future have connection problems with other areas and they cannot receive the signals of endogenous opioids correctly.

## BEYOND PLACEBO AND NOCEBO

However, the implications about the power of the effects of expectations in relation to placebo and nocebo go beyond the fact that a placebo treatment is subject to the patient's belief or expectation about the benefits of a therapeutic intervention. In 2011 Bingel *et al*. published a study that demonstrates that beliefs and expectations can boost or inhibit the therapeutic effects of a drug, more specifically remifentanil (a strong μ-opioid receptor agonist), in healthy volunteers. With this study, the authors concluded that a positive expectation about the benefits of a drug significantly improved (twice as much) the analgesic benefits of remifentanil whereas negative expectations were inhibited. Moreover, the subjective effects were corroborated by significant changes in neuronal activity in those brain areas involved in coding pain intensity. More specifically, the effects of positive expectations were associated with activity in the endogenous pain-modulating system and the effects of negative expectations, with activity in the hippocampus. Finally, the authors suggest that it would be wise to integrate beliefs and expectations in drug treatment regimens together with the patient's traditional considerations in order to optimise treatment outcomes.

## WHAT CAN WE LEARN ABOUT PLACEBO?

Based on the studies on placebo and nocebo in relation to the role of human factors in medical treatments, the following conclusion can be drawn:

1. Understand, thanks to basic research, how psychological processes affect the chemistry of the central nervous system and how these alterations can shape peripheral physiology and organ functions.

2. Consider the implications about the design of clinical trials since an experimental trial is compared to a placebo treatment, which, in practice, is part of the treatment itself.

3. Consider the implications for healthcare since placebo has an ethical consideration in terms of its use as a treatment, taking into account that it is not exempt of risks, but also reconsidering the meaning of placebo in clinical training and practice.

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PHYSIOTHERAPY UPDATES

CONGRESS REVIEW

# THE CONUNDRUM THAT IS THE SHOULDER (JEREMY LEWIS)

David Barranco i Reixachs

Physiotherapist. Master's degree in sports physiotherapy and readaptation to physical activity. Master's degree in translational physiotherapy. Adjunct lecturer at Universitat de Lleida – Campus Igualada.

Summary of the IFOMPT Conference Glasgow 2016

The shoulder is the most mobile and fastest joint in the body. For example, a baseball pitcher can throw the ball at 170 km, which for the joint it means an angular speed of 9,000°/second with a deceleration of 500,000°/s$^2$. Unlike other primates, which have less mobility in the shoulder girdle, the human shoulder cannot do strength activities or activities that require body hanging for long (like brachiating for hours). That is why those professions that demand being in this position, with arms up, for a long time are the ones usually associated with increased levels of shoulder pain. In terms of function, the shoulder does not move in an isolated way but it requires the whole kinetic chain to move optimally. Therefore, in order to assess a dysfunctional movement, we must assess all the segments of the kinetic chain since the cause may not be in the shoulder girdle itself.

Some specific clinical tests have been used to determine the origin of the symptoms but the main problem of these specific tests is that they are not specific. All the muscles of the rotator cuff do not have an individual insertion but they converge to form an aponeurosis. Another reason why differentiation is difficult with a clinical test is the existence of bursae that reduce friction. These bursae can release pro-inflammatory and nociceptive substances. Therefore, any test that stretches and/or compresses a bursa directly or indirectly will cause pain.

Imaging is not a reliable tool for determining the cause of pain either. 22% of the population has rotator cuff tear but only a third of these are symptomatic. Taking all the asymptomatic adults over 40, 96% of them present ultrasonographic alterations. In the case of magnetic resonance diagnosis, there are findings of 55% of symptomatic patients versus 52% of asymptomatic patients, which means that imaging diagnosis does not tell us where the pain is coming from. A serious implication is that many patients can end up being operated on shoulder tissues that are not related to their symptoms.

Another factor associated with the subacromial impingement syndrome is posture and muscular imbalance. Forward head posture, pectoralis minor shortening, or the posture of the scapula have been proven not to be related to the presence of subacromial impingement syndrome.

Thus, we know we cannot differentiate which structures are affected through specific tests or confirm the diagnosis through imaging and we also know that posture is not related to the presence of symptoms.

Therefore, treating poor posture, stretching a short muscle or treating the structure guided by a diagnosis based on orthopaedic tests or imaging is not the best option.

The suggested treatment (*Shoulder Symptom Modification Procedure*) is based on identifying symptomatic movement, posture or activity and then add the components that modify these symptoms: taping, movement facilitation, etc. Only manual scapular facilitation can improve articular range of motion by 41% in patients with shoulder pain. We must not forget though biopsychosocial factors since they are the most relevant predictors of a good prognosis.

In spite of this, it is believed that the acromion is a cause of injury and that pain comes from the tendon. This belief is what is normally used to justify acromioplasty surgery, whose use has increased with time. This is mainly due to an opinion article by Neer written in the 70s. An important fact that was not taken into account was that tendon overload tends to create inflammation around, making the rotular tendon visible. When the same happens with a tendon of the cuff we may get the impression that the tendon has no space. Some studies demonstrate that exercise is as effective as surgery in the treatment of subacromial impingement syndrome but it does not have the complications involved in sur-

gery. In fact, exercise reduces the need for surgery in up to 80% of cases. In the same way, in partial rotator cuff tears there are no differences between the outcomes of exercise and surgery although there are substantial differences in terms of cost. In full rotator cuff tears, exercise reduces the need for surgery up to 75%.

When administering a treatment, we must take into account the marginal gains theory, in which any added detail that can improve the recovery from an injury must be applied, no matter whether it is nutritional, ergonomic, technical or just a piece of advice on your health (sleep, smoking, sedentariness, etc.)

In conclusion, exercise is as effective as surgery when treating subacromial impingement syndrome and atraumatic partial or full tears. A structural diagnosis is practically impossible and there is a very low correlation between radiological findings and symptoms.

Symptom modification may be a strategy to overcome these problems. The exercises for the scapula are the same as those for the rotator cuff. Therapeutic exercise is important but we must consider the marginal gains theory.

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PHYSIOTHERAPY UPDATES

CONGRESS REVIEW

# EXPANDING OUR UNDERSTANDING OF THE INFLAMMATORY PROCESS AND ITS ROLE IN TISSUE HEALING (TIM WATSON)

David Barranco i Reixachs

Physiotherapist. Master's degree in sports physiotherapy and readaptation to physical activity. Master's degree in translational physiotherapy. Adjunct lecturer at Universitat de Lleida – Campus Igualada

Summary of the IFOMPT Conference Glasgow 2016

The inflammatory process is key in tissue repair but there still exists the perception that it is a physiological error. Obviously, when inflammation is out of control, bringing it under control is essential. But in the normal sequence of healing, inflammation does not need to be interrupted but facilitated as a way of having a quality healing process.

Traditionally the inflammatory process has been presented as a series of isolated processes, in which bleeding occurs from the very first moment up to the next minutes or hours. This is followed by inflammation, which starts after the first few minutes and lasts a few days. A few days or even weeks/months after the inflammatory process, the regeneration process takes place. Finally, there is the remodelling stage starting a few weeks later and lasting a few months.

But all these different processes are in fact a single process with extremely overlapping stages. A tissue can be undergoing the inflammation stage and at the same time the remodelling stage can occur.

The problem of trying to eliminate the components of inflammation is that it takes longer for them to carry out their function as precursors of the proliferation stage. Anti-inflammatory drugs can increase the time the tissue needs to heal completely. On the other hand, increasing the magnitude of the inflammation is not what our intervention aims at but its transition towards healing, which is logical and evident.

When a tissue is injured, mastocytes and platelets activate the appropriate chemical mediators and cytokines in order to induce a vascular and cellular response. These responses activate some other chemical mediators and cytokines that cause vasodilation and vasopermeability. This involves an increase in blood flow and exudation, which leads to tissue swelling. There is also an attraction and increase of phagocytic activity to clean the area and, at the same time, macrophages release proliferation mediators.

There are many mediators that affect the mechanisms of pain and inflammation. A clear example is bradykinin, which is released by plasma proteins. Bradykinin increases vascular dilation and permeability stimulating the release of histamine. At the same time it activates the arachidonic cascade, which increases the production of prostaglandins and irritates the nerve endings causing pain. Similar processes take place with other mediators like substance P and prostaglandins.

Seventy-two different mediators have been found to be involved in the inflammatory process and tissue repair but it is thought to be a total of more than a hundred mediators. These mediators are grouped into different families of cytokines but they are normally classified into: those previously created and stored, those newly created, and those of plasmatic origin. In these mediators, interrelations, backups, redundancies and overlaps abound. Overlaps are safety systems since in case there is a missing mediator, others can take over, as it occurs with tumour necrosis factors, which interact with many other mediators in order to achieve cell proliferation and induction of inflammation or fibroblast growth factors, which stimulate the angiogenesis process required for tissue repair.

The wide variety of therapeutic interventions that physiotherapists use seem to produce a pro-inflammatory rather than an anti-inflammatory effect. There is evidence of the relationship between mechanical stress and the synthesis of bFGF and IGF, between mechanical stretching and the behaviour of fibroblasts, and also of the impact of these different manual therapies at cellular level.

For example, shock waves stimulate IL-6, IL-8, MMP-2, MMP-9, VEGF, TGFß and HIF-1α, which will start a pro-inflammatory reaction, stimulating the extracellular matrix and collagen, enhancing a tendon healing response. In the same way, exercise and mechani-

cal loads will stimulate the synthesis of PGE2, TFGß, MMP-1, MMP-3, IL-8, Ca2+ and NO, which will activate osteoblast activity and, consequently, bone regeneration. This remodelling is caused by an increase in the callus remodelling rate, an earlier expression of type II collagen, an increase in the production of alkaline phosphatase, an increase in the differentiation of chondrocytes, an earlier callus formation, an increased regulation of endochondral ossification, and an increase of bone mineralization.

Mechanotransduction is not a new concept but it has become relevant again in the last few years. It can be defined as the process through which cells sense and respond to mechanical stimuli by converting them to biochemical signals that elicit specific cellular responses, if we think of the need of tissue repair through the synthesis of collagen and extracellular matrix through fibroblasts. PDGF, bFGF and TGF, which are released by platelets and macrophages, are needed in order to activate fibroblasts but for this process to be complete oxygen is needed and this will be obtained through the angiogenesis in the affected area. Angiogenesis is stimulated by the bFGF, TGFß1 and VEGF mediators, which are also secreted by macrophages. Finally platelets and macrophages are activated by mechanical stimuli.

In spite of this, as physiotherapists, we do not really need to know what type of interleukin is activated with exercise or which cyclooxygenase is secreted with physical therapy. What we really need to know is the global effect we bring about with our intervention.

Finally, we must understand that many of the effects that justify our treatments are often based on only one point of view. Actually tissue repair and therapies are the cause and consequence of a mechanical, physiological, neural, chemical and bioelectrical interaction.

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PHYSIOTHERAPY UPDATES

FINAL YEAR PROJECT

# EFFECT OF PEAK ESTRADIOL LEVELS BEFORE OVULATION ON THE DYNAMIC BALANCE AND NEUROMUSCULAR CONTROL OF YOUNG ADULT WOMEN: COHORT STUDY

**Abel Balcells**
Universitat de Lleida

## ABSTRACT

**Background.** The effect of feminine hormones as an injury risk factor has been long studied but the data obtained are not very conclusive. The first studies focused on determining when in the menstrual cycle there were more anterior cruciate ligament (ACL) injuries since its prevalence is notably different between sexes. Based on these studies, researchers started considering the effect of estradiol (E2), the most common type of oestrogen in connective tissue, since the peak of estradiol during the menstrual cycle coincided with the moment with the most injuries. At the same time, other studies have demonstrated the presence of E2 receptors in connective tissues and later on the negative impact oestrogens can have on tissue properties. Finally, the latest articles have started to analyse the effect of neuromuscular control in dynamic situations.

**Aim.** Assess the changes in dynamic balance and neuromuscular control in young adult women of childbearing age who are physically active in between the primary follicular stage and right before ovulation compared to women who take oral contraceptives.

**Method.** This is a triple-blinded prospective cohort study with a sample of 120 young adult women (20-39 years old) who are physically active. The participants will be assigned to two equal groups: 60 women in the group exposed to E2, that is to say, those who do not use contraceptives and 60 women not exposed to the peak of E2 since they use contraceptives. Dynamic balance will be measured with the Y Balance Test (YBT) and neuromuscular control will be measured with a superficial electromyography (sEMG) of the tibialis anterior (TA), the peroneus longus (PL), the vastus medialis (VM), and the biceps femoris (BF) muscles. The follow-up will consists of two assessment sessions, programmed beforehand thanks to a pre-followup carried out in the previous two months, on the first menstruation day and the day when the peak of E2 occurs

**Results.** Those women not using contraceptives are expected to have their balance reduced and experiment changes in neuromuscular control to have it controlled during the pre-ovulation peak of E2 in comparison to women who take oral contraceptives, who will keep a stable concentration of E2.

**Conclusions.** Knowing about the changes in balance and neuromuscular control in women during their menstrual cycle can help us decide when to assess their balance and the best moment to progress in their proprioceptive and balance treatment.

**KEY WORDS:** Oestrogens. Estradiol. Oral contraceptives. Dynamic balance. Y Balance Test. Neuromuscular control. Superficial electromyography.

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PHYSIOTHERAPY UPDATES

FINAL YEAR PROJECT

# RANDOMISED CLINICAL TRIAL TO ASSESS THE EFFECTIVENESS OF THE ACAPELLA PEP THERAPY IN PATIENTS, AGED 14 TO 18, DIAGNOSED WITH BRONCHIAL ASTHMA

Anaïs Comas Gracia

Universitat Internacional de Catalunya

## ABSTRACT

**Introduction.** Bronchial asthma is a chronic inflammatory disease of the respiratory airways characterised by episodes of sensation of breathlessness, cough, wheezing, and tightness in the chest. Its physiology is determined by obstructive processes in the airways, which involves bronchial hyperreactivity, mucus hypersecretion, and chronic inflammation of the airways leading to different degrees of respiratory failure. Bronchial asthma is associated with difficulty to remove air from the patient's lungs due to the narrowing of the airways, the thickening of these airways and increased phlegm. The main treatment is basically the administration of bronchodilators in order to reduce the narrowing of the airways or anti-inflammatories to reduce their inflammation. Positive expiratory pressure systems are instrumental techniques used in respiratory physiotherapy that prevent the premature blockage of airways and help phlegm secretion. Several studies present these techniques as complementary material in the treatment of bronchial asthma or other respiratory diseases. In spite of this, there is no scientific evidence for this technique in respiratory physiotherapy combined with a pharmacological treatment in 14-to-18-year-old patients with moderate bronchial asthma.

**Aim.** Analyse the intercrisis periods, their severity, and the quality of life of paediatric patients with moderate persistent bronchial asthma combining an Acapella positive expiratory pressure system with a pharmacological treatment.

**Material and method**. 40 paediatric patients aged between 14 and 18 with bronchial asthma will be distributed into two random groups: a control group receiving only a pharmacological treatment and an intervention group receiving a pharmacological treatment and respiratory physiotherapy. The patients will be assessed at the beginning, 3 months and 6 months after the study using a quality of life questionnaire and a personal asthma diary.

**Expected results and conclusions.** Including this technique in the treatment is expected to have positive effects on the quality of life of patients with moderate bronchial asthma, reducing the number of crises and their severity, which would allow us to reduce the administration of bronchodilators or rescue medicines and hospitalizations. Since there is little evidence regarding this technique, this study is expected to obtain the necessary scientific evidence for it to be included in the treatment of moderate bronchial asthma.

**KEY WORDS:** Bronchial asthma. Respiratory physiotherapy. Paediatrics. Pharmacological treatment. Respiratory rehabilitation. Quality of life. Acapella PEP. Acapella Choice.

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PHYSIOTHERAPY UPDATES

FINAL YEAR PROJECT

# FACTORS RELATED TO PAIN PERCEPTION IN THE FOOD MANUFACTURING INDUSTRY

Jaume Guerra Sánchez
Universitat Rovira i Virgili

## ABSTRACT

**Background.** Work settings are a good place to progress in the achievement of goals like health assessment, education, advice and promotion.

The adequate involvement of physiotherapy in the workplace implies the immediate availability of a treatment, which can be given regularly and at the best moment within the working day.

Physiotherapists and healthcare professionals have an important role in the prevention and management of work injuries and diseases. Many companies choose to offer their workers prevention programmes and actions carried out by physiotherapists. In this way, they try to reduce one of the main causes of days off work and the associated high economic cost for the country.

Good health is a facilitating function, that is to say, it allows us to achieve different goals, including the correct performance of our professional duties and responsibilities. Companies want to optimise their workers' health since it is closely related to work productivity, both from a qualitative and quantitative point of view. Therefore, reducing the appearance (incidence) and existence (prevalence) of those health problems that can lead to absenteeism, incompetence or deficient work is a primary goal of public health. There exist many challenges to be attained in relation to musculoskeletal disorders (MSKD) such as their detection and treatment, establishing a relationship between risk factors and manual occupational activities, as well as facilitating working environments that can minimise their incidence. Thus this study focuses on detecting the prevalence of musculoskeletal symptoms in manual manufacturing workers and finding the risk factors impacting on this prevalence.

**Aim.** Describe the profile of those workers with a higher risk of having a musculoskeletal disorder and the characteristics of these episodes. Determine the risk factors and the most vulnerable working areas.

**Material and methods.** Transverse observational study of workers in the food manufacturing industry. Data gathered using the Spanish version of the Standardised Nordic Questionnaire. The data was analysed with the SPSS v.20 programme.

**Results.** The participants were 37.2% (n 155) women and 62.8% (n: 262) men, aged between 19 and 66 ($\bar{X}$: 43 and SD: 11) , with 1 to 45 years of seniority ($\bar{X}$:9 and SD: 7.36). The main prevalence affected the back (34%), cervical spine (30%), and shoulder (31%) particularly in the poultry butchering and slaughter sections. Risk increased among workers aged between 19 and 44 with an OR of 1.79 $CI_{95\%}$ [1.015 – 3.152], women with an OR of 2.611 [1.839 – 3.708] in relation to men and in both cases it increased in young adults (19 - 44 years) with an OR of 1.257 $CI_{95\%}$ [0.961 – 1.643] in relation to older adults (45 - 66 years). Seniority also increased the risk with an OR of 3.13 $CI_{95\%}$ [2.054 – 4.794], Chinese workers with an OR of 5.72 $CI_{95\%}$ [2.934 – 11.181] in relation to Pakistani workers and the latter with an OR of 2.55 [1.293 – 5033] in relation to Spanish workers.

**Conclusion.** Demographic and occupational variables as well as smoking, alcohol consumption, seniority and nationality were significantly associated with the development of MSKD in these workers.

**KEY WORDS:** Manufacturing. Industry. Prevalence. Nordic questionnaire. Work-related musculoskeletal disorders.

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PHYSIOTHERAPY UPDATES

FINAL YEAR PROJECT

# ASSESSING NEUROMUSCULAR DISORDERS OF THE LOWER LIMB IN ROLLER HOCKEY PLAYERS

Jordi Arboix

Universitat Blanquerna – Ramon Llull

## ABSTRACT

**Background.** There is currently a high incidence of injuries both in professional and amateur sports. One of the causes that determine the risk of injury are neuromuscular factors, among which we must highlight neuromuscular imbalances between the dominant and the non-dominant leg. According to current evidence, a difference between legs of 10-15% when performing isokinetic strength and vertical jump tests may involve a higher risk of injury.

**Aims.** The main aim of this study was to determine if roller hockey players have any neuromuscular imbalances in the lower limbs. A secondary aim was to assess the coincidence between the dominant leg (subjectively determined) and the stronger leg (objectively determined as the one with the higher performance level).

**Methods.** Some roller hockey players (n = 27, age = 20.59 ± 3.81) did the unilateral CMJ test, the Hop test, the Triple Hop test and the Crossover Hop test, and the COD (Change of Direction) test. In all of them the dominant and non-dominant leg were compared as well as the stronger and weaker leg.

**Results.** The hockey players in the study have imbalances between both legs, with up to 33.33% of these players having an ASI (Asymmetry Index) of >10% in some of the tests. There was only a coincidence of 41%-59% between the dominant and the stronger leg depending on the test.

**Conclusions.** The roller hockey players present lower limb neuromuscular imbalances. Identifying the dominant leg is not a reliable criterion to choose the leg with a higher performance level, that is why it is recommended to use the stronger leg criterion when calculating leg asymmetry. In this way, it is recommended to use these neuronal tests and the ASI as a way of determining the physical condition of hockey players and identifying those who are at a higher risk of injury. Knowing this can help hockey teams to design specific training loads and preventive measures for each individual player.

**KEY WORDS:** Roller hockey. Neuromuscular asymmetries. Injury prevention. Asymmetry index (ASI).

# AGENDA

**7th International Conference & Exhibition on Physiotherapy & Physical Rehabilitation**
**Date and city:** March 25th and 26th (2019), Rome
**Information:** https://physiotherapy.annualcongress.com

**XXVIII Congress Isokinetic Medical Group**
**Date and city:** From April 27th to April 29th (2019), London
**Information:** www.footballmedicinestrategies.com/en/2019-wembley/3988/482/

**WCPT Congress 2019**
**Date and city:** From May 10th to May 13th (2019), Geneva
**Information:** www.wcpt.org/news/2019-congress-venue-Dec15

**II Global Congress on Phisiotherapy**
**Date and city:** August 15th and 16th (2019), Prague
**Information:** https://scientificfederation.com/gcp-2019

**XI Congress of the European Pain Federation EFIC®**
**Date and city:** From September 4th to September 7th (2019), Valencia
**Information:** https://efic-congress.org

**III World Congress of Sports Physical Therapy**
**Date and city:** October 4th and 5th (2019), Vancouver
**Information:** https://www.sportphysio.ca/calendar-of-upcoming-events/spc2019/

**IV International Congress on Pelvic Floor SEFIP**
**Date and city:** From October 24th to October 26th (2019), Barcelona
**Information:** http://sefip2019barcelona.com

**IFOMPT Conference**
**Date and city:** From October 6th to October 8th (2020), Melbourne
**Information:** www.ifompt.org

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