Impact of physical activity delivered by videoconference on the management of endometriosis symptoms: a pilot study

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For correspondence:
jean.marie-anne@laposte.net

M.-A. Jean[1,2*], L. Lenôtre[2,3], C.A. Philip[5], E. Faller[5,6], U. Herbach[7], S. Warembourg[4], P. Branche[8], T. Milane[1,2], G. Escriva-Boulley[1,2]

[1] Université de Haute-Alsace, Université de Strasbourg, Université de Lorraine, LISEC UR 2310, F-68100, Mulhouse, France.

[2] Faculté des Sciences et Techniques, Université de Haute-Alsace, 18 Rue des Frères Lumière, 68200 Mulhouse, France

[3] PASTA - Processus aléatoires spatio-temporels et leurs applications, Inria Nancy - Grand Est, Villers-lès-, Nancy, France

[4]Clinique gynécologique et obstétricale, Hôpital de la Croix-Rousse, groupe hospitalier Nord, CHU de Lyon-HCL, 103, grande rue de la Croix-Rousse, 69317, Lyon cedex, France.

[5]Service gynécologique et obstétricale, Hautepierre Hospital, Strasbourg University Hospital, 1 place de l'Hôpital, 67000 Strasbourg, France.

[6]ENDOALSACE, Strasbourg Expert Center for Endometriosis, Hautepierre Hospital, Strasbourg University Hospital, 1 place de l'Hôpital, 67000 Strasbourg, France

[7] Université de Lorraine, CNRS, Inria, IECL, F-54000 Nancy, France

[8]Structure Douleur Chronique de l'Hôpital de la Croix Rousse, Service Anesthésie Réanimation, Hospices Civils de Lyon, 103 Grande Rue de la Croix-Rousse, F-69317, Lyon, France

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ABSTRACT

Background: Endometriosis symptoms are pervasive and affect all areas of life. Thus, instead of or complementary to the medical treatments, patients currently use self-management strategies such as physical activity (PA) or exercise to deal with their symptoms. Results from several studies which have investigated the effect of PA in endometriosis context showed improvement in symptoms, however these results are inconsistent. Despite the potential benefit of PA, women with endometriosis generally adopt more sedentary behaviours and have difficulties to engage in or maintain PA because of their symptoms.

Objectives: The first aim of the present pilot study was to investigate the effect of an adapted PA program delivered via videoconferencing on perceived pain and fatigue and well-being. The second aim was to identify the most effective types of PA.

Methods: Ten volunteers who suffer from endometriosis were recruited for a 3-month PA program delivered by videoconference consisting of 1 up to 2 hours per week. The PA proposed could be grouped by type: (1) mobility and stretching sessions, (2) muscle-strengthening sessions, (3) interval cardio training sessions, and (4) mixed muscle-strengthening and cardio sessions. Participants were asked to complete a questionnaire measuring perceived pain, perceived fatigue and perceived well-being were measured using the visual analogue scale (0-10) before and after each session. They completed another pre- and post-program questionnaire allowing the measurement of socio-demographic variables, global mean pain during a week and crisis, quality of life (EHP-30), level of PA (IPAQ), motivational variables related to physical activity (EMAPS) and self-concept. Chi-squared goodness-of-fit tests and autocorrelations were performed to determine the effects of PA sessions on the variables, and to study the cumulative effect of sessions on these parameters over time, respectively.

Results: Six volunteers participated in the PA sessions and only 4 responded to the post-intervention questionnaire. Our results showed a significant difference in the delta pain score before and after the sessions ($p < .01$) and autocorrelation of delta pain scores indicated that there are no additional effects on pain during the intervention, or that more time is needed to see an effect. These results showed that the intervention had an immediate effect on perceived pain. Differences in delta fatigue and delta well-being were not significant for most participants,

the evidence is not sufficient to conclude on the effectiveness of the intervention on perceived fatigue and well-being. The graphical representation of the delta scores showed that stretching, mixed and vigorous sessions tend to have more positive effects on pain and well-being while the mixed and vigorous sessions tend to have more effect on fatigue. Post-intervention data were not analysed because of the small sample size but were presented.

Conclusion: Stretching, mobility, mixed and vigorous perceived sessions, seemed relevant for reducing pain and fatigue. The results from the first pilot study which investigated the impact of PA on the most important symptoms of endometriosis, distinguishing different types of PA are discussed.

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Keywords: adapted physical activity, pelvic pain, fatigue, wellbeing, interval training, stretching, psychosocial variables

INTRODUCTION

Endometriosis is a chronic disease characterized by the growth of endometrial tissue outside the uterine cavity and afflicts approximately 5–10% of women of reproductive age. However, the prevalence may be underestimated because of diagnostic difficulty (Shafrir et al., 2018). Chronic pain and more specifically pelvic pain, is one of the most common symptoms of endometriosis, preventing the physical functioning necessary for daily life (e.g., leisure, social, learning and/or professional activities). In addition, this chronic pain leads to fatigue, which is also seen as an obstacle to daily life (Fourquet et al., 2011; Mastrangelo & Turnbull, 2022; Peterson et al., 2023). Pain and fatigue negatively affect quality of life (QoL, Fourquet et al., 2011; Soliman et al., 2017). Women who suffer from endometriosis also report higher risk of depression, anxiety (Gambadauro et al., 2019; Mińko et al., 2021), social restriction (Peterson et al., 2023; Mastrangelo & Turnbull, 2022) and poor body image (Volker & Mills, 2022) compared to women who do not suffer from this disease. Furthermore, pain and psychological distress in women who suffer from endometriosis are also more associated with sedentary behaviours and a reduction in physical activity (PA) than in healthy women (Sachs et al., 2023). Thus, studies have shown a link between PA, on one hand, and pain, depression (Sachs et al.,2023) and coping

strategies, on the other hand (Minko et al.,2021). In summary, endometriosis affects the physical, mental health and consequently many domains of life.

To deal with their symptoms, women with endometriosis commonly use hormonal and/or painkiller treatments as well as and complementary treatments or self-management strategies such as heat, rest, meditation or breathing exercises (Armour et al., 2019). Systematic reviews (Bonocher et al., 2014; Hansen et al., 2021; Tennfjord et al., 2021; Mardon et al., 2023; Evans et al., 2019; Samami et al., 2023) and one meta-analysis (Mira et al., 2018) showed that intervention based on PA seemed to be good ways to alleviate pain and improve mental health. However, due to the inconsistency of the results, risks of bias, and protocol heterogeneity between studies, beneficial effects could not be reliably determined. Otherwise, these reviews did not all use "PA" and "exercise" in the search terms, leading to the examination of all type of physical practices which prevented to distinguishing the actual role of PA and exercise (Evans et al., 2019; Samami et al. 2023). A recent narrative review detailed trials carried out on PA and endometriosis and concluded that body awareness techniques such as yoga and relaxation should be incorporated into PA programs (Tourny et al., 2023). In fact, exercises programs in the studies varied and could combine stretching, aerobic, postural exercises, muscle strengthening, psychological intervention or disciplines such as yoga and relaxation. In a qualitative study, yoga seemed to be a good practice to control pain by awareness, breathing exercise and psychosocial support (Gonçalves et al., 2016). Two studies, one pre-post intervention (Ravins et al., 2023) and one randomised controlled trial (Gonçalves et al., 2017) investigated the effect of yoga, showed improvements in QoL and pain. An ongoing trial is seeking to establish the efficacy of yoga, cognitive behavioural therapy, and education, on QoL and biopsychosocial outcomes (Mikocka-Walus et al., 2021). Jacobson's relaxation group had also significantly improved anxiety, depression and QoL compared with a control group (Zhao et al., 2012). In two pre-post intervention studies, exercises based on stretching, postural and breathing exercises with or without psychological intervention showed reduction in pain levels between 12 and 24 sessions (Awad et al., 2017), a reduction of stress , increased vitality and physical functioning (Petrelluzzi et al., 2012). Aerobic exercise reduced Danazol treatment side effects and testosterone levels at 24 weeks compared to a group that received Danazol treatment alone (Carpenter et al., 1995) and compensated for the loss of bone mineral density in the femoral neck after stopping GnRH treatment compared with a control group (Bergström et al., 2005). Eight weeks of combined exercises (i.e., lumbo-abdomino-pelvic exercises, aerobics, muscle strengthening, stretching) improved QoL just after the intervention and one-year post intervention when compared to the

control group. This group also showed a reduction in the intensity of dyspareunia, catastrophic thoughts and an increase in pelvic, lumbar and distal pressure pain thresholds (Artacho-Cordón et al., 2023; Salinas-Asensio et al., 2022). One study showed that acute PA had similar pain score changes whether supervised by videoconferencing or in virtual reality (dance, tennis, etc.), but had less increase in pain scores and lower perceived pelvic pain than the control group (Lutfi et al., 2023). In sum, PA and mind-body interventions appeared relevant for relieving pain and improving QoL, while aerobic exercise seemed to attenuate treatment-related adverse effects, particularly physiological ones. These results are in line with the previously cited reviews.

Otherwise, in experimental animal studies, exercise and aerobic PA have shown an anti-inflammatory effect: reduction in macrophage infiltration, oestrogen receptor beta (Appleyard et al., 2021; Méndez-Casillas et al., 2022), inflammatory cytokines (Mendez-Casillas et al., 2020), oxidative stress, endometrial tissue proliferation and increased cell apoptosis (Montenegro et al., 2019) which could explain these results on pain. Previous studies have also shown that exercise can reduce the size of endometriosis lesions, particularly with moderate and intense exercise (3-5 sessions per week) in animal models (Hernandez et al., 2015; Montenegro et al., 2019). These studies have shown that the biological and metabolic mechanisms that cause or amplify endometriosis symptoms can be slowed by aerobic PA. These results indicate that these types of PA could help reduce pain via the anti-inflammatory effect. To our knowledge, no study has investigated these variables in women. Nevertheless, beneficial effects of PA on chronic diseases and chronic pain in general are well-known (Borisovskaya et al., 2020; Couto et al., 2022; Larsson et al., 2015). Despite existence of various types of PA in the literature, there is no consensus on which are most effective in managing endometriosis symptoms, making it impossible to recommend one specific type over another.

Despite the potential benefits of PA and that low physical levels is positively linked to dysmenorrhea and altered mental health (Koppan et al., 2010; Mińko et al., 2021; Sachs et al., 2023), women with endometriosis do not engage in or maintain this approach: they are less active than healthy women. The low uptake of strategies based on PA when suffer from endometriosis may be due to the symptoms in general (e.g., pain, fatigue), and the lack of recommendations and education from healthcare professionals (Mardon et al., 2023). Another explanation is that women with endometriosis had lower pain thresholds than healthy women. In healthy women, the threshold increased after exercise (and returned to baseline after 20 minutes), but in women with endometriosis, this threshold was not modulated by exercise (Poli-

Neto et al., 2020). These results showed that exercise might be experienced as less pleasurable and have fewer antalgic effects for women with endometriosis. In the same vein, adverse events were common with exercise (34.2%), yoga and Pilates (15.9%), stretching (14.8%); in particular in increasing pelvic pain (especially cramping pain), frequency of 'flare ups', and fatigue compared to meditation/breathing (3.4%). Nevertheless, exercise was considered more effective than meditation, stretching and yoga in reducing pain, despite being less widely used (Armour et al., 2019). The intensity of the activities was not indicated. Adapted physical activity (APA) interventions therefore appear relevant for women with endometriosis. It is based on adapting exercise to individual differences and is supervised by physical activity professionals to support beneficiaries' motivation and education in this field. Otherwise, the frequency of exercise (e.g., regular or not) influences the effects of exercise on endometriosis-related pain on the day following exercise. Women who exercise regularly (at least 3 times a week) experience less pain the day after exercise, while those who exercise less or not at all tend to have higher pain levels and greater increases in pain the day after exercise (Ensari et al., 2022). It can be assumed that exercise must go through a period of adaptation and/or be regular to have benefits, and that periods of interruption or one-off exercise can be deleterious. It is worth noticing that most exercise programs are developed face-to-face. A pilot study showed that supervised (interval training) or unsupervised (simulation games) remote acute exercise can reduce pain (Lutfi et al., 2023) suggesting that it is relevant to look at distance programs. These types of programs are worth studying given that the most common barriers related to PA are commuting, the lake of time, motivation, interest and health (European Commission et al., 2022). PA practice from home has increased in France with teleworking and covid conditions. Almost a quarter of French people practice from home because it gives them more freedom (less time and weather constraints) (Jörg & CRÉDOC, 2023). It is relevant to investigate PA programs that do not involve commuting and thus save time and prevent the increase of fatigue or pain, such as programs proposed via videoconference. Such programs have already proved their worth for other chronic diseases (Bennell et al., 2022; Galiano-Castillo et al., 2016; Yang et al., 2023).

To go further previous studies, the first aim of the present pilot study was to investigate the effect of a 3-month APA program delivered via videoconferencing on perceived pain and fatigue and well-being. The second aim was to identify the most effective types and intensity of PA. Based on the literature, we hypothesize that a mixed APA program based on stretching, aerobic, and/or strengthening activities could help improve well-being, reduce pain and fatigue related to endometriosis. We do not have hypothesis about the most effective intensity.

METHOD

Recruitment

Ten patients with endometriosis were recruited in France from the Hospice Civils de Lyon Hospital, among whom 6 participated to the program (see Table 1 for socio-demographic data and endometriosis history and Figure 1 for final sample). Participants used their own new technology devices (e.g., notebook, PC, tablet, laptop) to take part in the APA program via videoconferencing.

The inclusion criteria were: diagnosis of endometriosis (by physical exam, MRI), age over 18 years and sexually active, having moderate to significant functional difficulties, pain, and fatigue (between 4 and 10 / 10 points on visual analogue scale), sufficient French language skills, free access to the internet with a stable internet connection on a device which allow to see movement and be seen (webcam). The exclusion criteria were: having a disabling disease other than endometriosis with the same major symptoms (cancer, arthritis, ...), body mass index $\geq$ 40, no major difficulties related to the disease (i.e., no impact on daily life), participation in another program which propose education and/or PA program while enrolled the present program and surgery or Medically Assisted Procreation scheduled within 9 months.

Consent

The consent form containing written information about the study (e.g., objective, duration, data collection during and after the program, randomization process) was e-mailed to participants after they had discussed the program via a scheduled 30-minute individual videoconference (this will also insure technology and internet access). This interview provided an opportunity to present the study in detail and answer any questions the participants may have. There were no deadlines for returning the signed written consent form, to avoid pressure and allow the information to be read.

APA Protocol

Participants were invited to take part in 60-minute supervised APA sessions in a small group setting once a week, first, and then twice a week from half of the program (i.e., 1.5 months). The

program lasted 3 months, and participants were allowed to continue their habitual PA and engage more in PA on their own. Initial PA levels were measured with International Physical Activity Questionnaire (IPAQ- see additional questionnaire section for details). The program contained different types of structured activities classified into 4 groups:

- 36 “mobility and stretching " sessions, which include slow movements to stretch muscles throughout the body, promote joint mobility and relaxation (also including yoga-inspired movements),
- 17 “muscle strengthening" sessions, which engaged skeletal muscles to strengthen and develop muscular endurance (including movements based on Pilates and yoga sequences engaging muscular endurance and strength),
- 20 “interval-based cardio fitness" sessions, which consisted of various repeated movements interspersed with short rest periods to increase heart rate and promote aerobic work, and
- 14 "mixed" sessions, combining muscle strengthening and cardio in the form of alternating exercise and rest periods.

The sessions were designed by the APA teacher to be of low, moderate or vigorous intensity. Each session included (a) a warm-up period, (b) exercise depending on the type of session, and (c) a cool-down period consisting of stretching and/or relaxation. The perceived intensity of the sessions was also assessed using the Borg 6-20 scale where 6 represents “no exertion at all” and 20 “maximal exertion” (Borg, 1982). 8-10 : activity not cause noticeable change in breath rate and can be sustained for at least 60 minutes, 11-13: activity able to be conducted whilst maintaining a conversation uninterrupted or intensity can be sustained 30-60 minutes, 14-16: activity in which a conversation generally cannot be maintained uninterrupted or intensity that may last up to about 30 minutes, >17 an intensity that generally cannot be sustained for longer than about 10 minutes (Norton et al., 2010)

Outcome

Primary outcome

Fatigue, well-being, and pain variables assessed using VAS (0-10) before and after each session. The VAS is usually used for pain, is an 11-point scale ranging from 0 through 10 where 0 represents “No pain” and 10 represents “Worst imaginable pain”. (Ferreira-Valente et al., 2011). This VAS was extended for fatigue and wellness where 0 representing “No fatigue” and “Worst wellness” and 10 “Worst imaginable fatigue” and “best imaginable wellness”.

Additional questionnaire

Participants were asked to complete a questionnaire before and after the program, which included the following dimensions:

Quality of life: Endometriosis-related QoL was assessed using the French version of the Endometriosis Health Profile-30 (Chauvet et al., 2017). The core questionnaire comprises 30 items grouped into five scales: "Pain" (11 items), "Control and powerlessness" (6 items), "Emotional well-being" (6 items), "Social support" (4 items), and "Self-Image" (3 items). It can be completed with a 23-item facultative questionnaire with six subscales (treatment, relationship with children, work life, sexual intercourse, medical profession, and infertility). Items are rated on a Likert scale ranging from 0 (Never) to 5 (Always). A score ranging from 0 to 100 is calculated (for each scale, a raw score is calculated by summing the items in each scale. The score for each scale is equal to the total of the raw scores calculated by the maximum possible gross score for the scale, multiplied by 100), with a lower score indicating better the QoL.

- Physical activity levels: IPAQ (Craig et al., 2003) were designed for adults aged 18–65 years old and the short version (9 items) measures the number of days per week, and the time (hours and minutes) spent in walking, vigorous PA, moderate PA and sedentary activity. Then, total weekly PA can be estimated by calculating MET-minutes per week (duration x frequency per week x MET intensity), which were summed across activity domains (Craig et al., 2003). According to IPAQ guidelines (Sjöström et al., 2005), IPAQ outcome was be defined as the proportion of patients who achieved the internationally recommended level of PA, i.e., at least 150 minutes per week of moderate to vigorous PA.

- Motivation: Self-determination theory of motivation for PA was assessed using the French validated version of Motivation toward Physical Activity in health context scale (Boiché et al., 2019). The 18 items are assessed within a seven-point Likert scale from 1 (does not correspond at all) to 7 (corresponds very strongly). The types of motivation evaluated are intrinsic, integrated, identified, introjected, external regulation and amotivation (3 items each). It is possible to calculate a self-determined motivation score by adding summing the scores for intrinsic motivation and integrated and identified regulation; and a non-self-determined motivation score by summing the scores for introjected, external and amotivation motivation. It is also possible to calculate an overall score by subtracting the non-self-determined motivation score from the self-determined motivation score.

- Self-concept: Self-concept (Guérin et al., 2003) about health (8 items), adiposity (6 items), sport skills (6 items), physical appearance (6 items), global physical satisfaction (6 items) and global self-esteem (8 items) was measured using 5-point Likert scale from 1 (wrong) to 5 (true).

Statistical Analysis

To understand the effect of PA on perceived fatigue, the difference in perceived fatigue before and after each PA session was analysed (i.e., "delta fatigue" variable). Elementary non-parametric statistics were calculated: mean, median, standard deviation, 95% confidence interval and range. The same procedure was performed for well-being and pain.

To classify the perceived difference in fatigue, well-being, and pain during each session, these ordinal variables were transformed into 3-modality variables: (1) reduction of fatigue, pain and increase of well-being represented by the value 1, (2) absence of effect with the value 0, and (3) increase of fatigue, pain and decrease of well-being with the value -1. Using these transformations, allowed to test the fit of each patient's statistical series to the 3-modality uniform distribution using a Chi-square goodness-of-fit test. Fits to the distributions were used because our sample is small and correlations may exist between sessions, so it cannot be assumed that each session is independent of the others. Thus, the autocorrelation coefficients of the time series of sessions performed by each participant were examined to determine whether there was a cumulative effect of the sessions (Figure 2). For all goodness-of-fit tests, the number of sessions had to be greater than or equal to 15 (Cochran's rule).

Finally, the effects of different types and intensity of PA on fatigue, well-being and pain were presented by representing graphically conditional distributions (i.e., mosaic-type diagrams, Figures 3-5). These diagrams represent the probability of having an effect knowing that a particular activity has been performed.

Results

Descriptive analysis

Among the 10 women recruited for the program and completed the pre-intervention questionnaire, six achieved the APA program and four participants completed the post-intervention questionnaires (Table 1 and Figure 1)

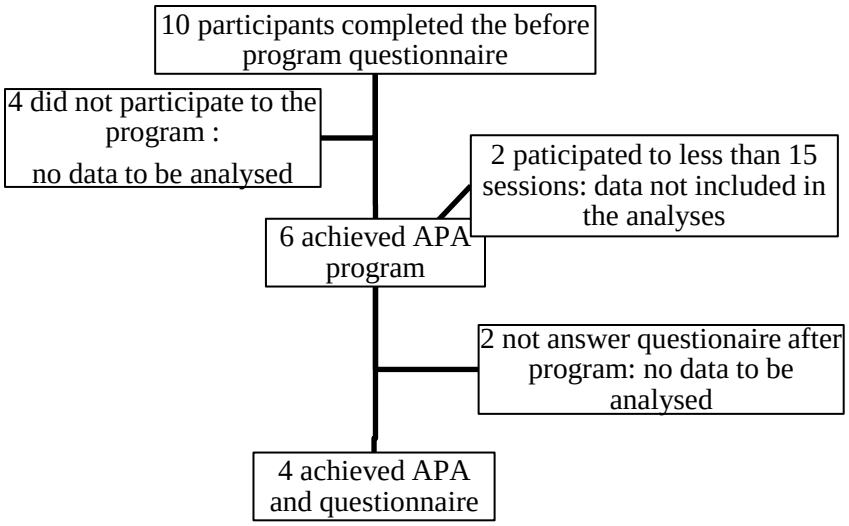

Figure 1

Fluency of participants

Table 1

Socio-demographic variables and related to endometriosis history at baseline

	All participant N=10	APA participant[1] N=6	No APA[2] N=4
Socio-demographic			
Age (years)			
Mean (± SD)	38.6 (±3,9)	39.2 (±4,40)	37.8 (±3,6)
Median (min-max)	37 (35-45)	38 (35-45)	36.5 (35-43)
Marital status, N (%)			
Married / In a relationship	7 (70%)	3 (50%)	4 (100%)
Single	3 (30%)	3 (50%)	-
Child, N (%)			
0	4 (40%)	2 (33%)	2 (50%)
1	3 (30%)	3 (50%)	-
2	3 (30%)	1 (17%)	2 (50%)
University level (years), N (%)			
0	2 (20%)	-	2 (50%)
1-3	2 (20%)	2 (33%)	-
4 or more	6 (60%)	4 (67%)	2 (50%)
Occupation, N (%)			
Work	7 (70%)	4 (67%)	2 (50%)
Seeking jobs	1 (10%)	1 (17%)	1 (25%)
Student	2 (20%)	1 (17%)	1 (25%)
Variables related to endometriosis			
Menarche (years)			
Mean (± SD)	12,8(±2,0)	12,7 (±1,5)	13 (±2,8)
Median (min-max)	13 (11-17)	13 (11-15)	11 (11-17)
First perceived pain (years)			
First menstruation, N (%)	3 (30%)	2 (33%)	1 (25%)
Mean (± SD)	17,7 (±6,0)	19,3 (±6,7)	14,3 (±3,2)*
Median (min-max)	15 (12-26)	20 (12-26)	13 (12-18)*
Medical errancy (years)			
Mean (± SD)	14(±4)	12,8 (±4,3)	16,3 (±2,3)*
Median (min-max)	15 (7-19)	13 (7-18)	15 (15-19)*
Painkiller frequency, N (%)			
Daily	3 (30%)	3 (50%)	-
During menstruation	1 (10%)	1 (17%)	-
During pain	3 (30%)	2 (33%)	1 (25%)

*Note. [1] six out of 10 participants achieved the APA program, [2] four out of 10 participants did not take part in the APA program., *N=3*

Data from the pre-test questionnaire completed before the program about Global pain, QoL, motivation for PA, and self-concept are presented in Table 2. Post test data are not analysed because of the small sample size but results are presented in supplementary material. IPAQ questionnaire results were available in (Table 1 and Table 2 additional material).

Table 2

Questionnaire results between groups at baseline

Mean (± SD)	All participant N=10	APA N=6	No APA N=4
Global pain			
Now	2.7 (±1.8)	2.7 (±1.8)	2.8 (±2.9)
Mean in a week	4.9 (±2.3)	5.2 (±2.8)	4.5 (±1.7)
Mean during crisis	7.2 (±2.3)	7.5 (±2.4)	6.8 (±2.2)
EHP – 30			
Pain	66.7 (±10.7)	65.5 (±10.7)	68.6 (±12.0)
Control and powerlessness	77.0 (±15.5)	77.8 (±16.6)	75.8 (±16.2)
Emotional well-being	61.7 (±12.5)	62.2 (±15.4)	60.8 (±8.3)
Social support	66.5 (±15.1)	71.7 (±16.9)	58.8 (±8.5)
Self-image	35.5 (±9.6)	35.0 (±10.5)	36.3 (±9.5)
EMAPS			
Intrinsic motivation	3.8 (±1.5)	3.3 (±1.7)	4.5 (±0.6)
Integrate motivation	3.2 (±1.7)	3.4 (±1.7)	2.9 (±1.8)
Identified motivation	5.2 (±1.5)	4.8 (±1.7)	5.8 (±1.3)
Introspection motivation	3.7 (±1.5)	3.7 (±1.7)	3.7 (±1.4)
External regulation	1.3 (±0.4)	1.3 (±0.5)	1.2 (±0.3)
Amotivation	1.4 (±0.7)	1.4 (±0.6)	1.5 (±1.0)
Autonomous Motivation	4.1 (±1.4)	3.8 (±1.6)	4.4 (±0.9)
Controlled motivation	2.5 (±0.7)	2.5 (±0.7)	2.4 (±0.7)
Self-concept			
Health	3.5 (±1.2)	3.5 (±1.0)	3.7 (±1.6)
Adiposity	3.5 (±1.8)	3.4 (±2.2)	3.5 (±1.3)
Physical function	2.1 (±1.2)	2.5 (±1.4)	1.5 (±0.6)
Physical satisfaction	2.7 (±1.4)	3.2 (±1.6)	2.0 (±0.8)
Self esteem	4.6 (±0.9)	4.9 (±1.0)	4.2 (±0.4)

Perceived fatigue, well-being results and pain results.

Parametric statistics of perceived fatigue, wellness and pain are presented in Table 3-5. At least half of the patients showed a strong disparity within the three tables, due to the small amount of data. In 50% of cases, high variances and wide range of values were observed for the different sessions performed by each participant. Consequently, confidence intervals were not significant for 3 out of 6 participants for perceived fatigue (Table 3), 2 out 6 participants for well-being (Table 4), and for 4 out of 6 participants for perceived pain (Table 5)

Table 3

Parametric statistics of fatigue differences between before and after sessions for the six participants

	Mean	(SD)	CI		Median	Range
Delta fatigue						
P1	0,54	(1,13)	[-0,14 ;	1,22]	1	[-2 ; 2]
P2	-1,13	(2,03)	[-2,21 ;	-0,04]	0	[-5 ; 2]
P3	-1,07	(1,62)	[-1,97 ;	-0,17]	-1	[-6 ; 1]
P4	0,00	(2,94)	[-1,51 ;	1,51]	0	[-5 ; 5]
P5	-0,11	(0,81)	[-0,50 ;	0,28]	0	[-2 ; 1]
P6	-1,00	(1,63)	[-2,51 ;	0,51]	-1	[-4 ; 0]

Note. CI = Confidence Interval

Table 4

Parametric statistics of wellness differences between before and after sessions for the six participants

	Mean	(SD)	CI		Median	Range
Delta wellness						
P1	-0,46	(2,37)	[-1,89 ;	0,97]	0	[-8 ; 2]
P2	1,31	(1,92)	[0,29 ;	2,34]	0	[0 ; 5]
P3	1,67	(0,62)	[1,32 ;	2,01]	2	[1 ; 3]
P4	0,00	(2,94)	[-1,51 ;	1,51]	0	[-5 ; 5]
P5	0,11	(0,81)	[-0,28 ;	0,50]	0	[-1 ; 2]
P6	1,00	(1,63)	[-0,51 ;	2,51]	1	[-1 ; 4]

Note. CI = Confidence Interval

Table 5

Parametric statistics of pain differences between before and after sessions for the six participants

	Mean	(±SD)	CI		Median	Range
Delta pain						
P1	-0,62	(0,65)	[-1,01 ;	-0,22]	-1	[-2 ; 0]
P2	-1,69	(2,12)	[-2,82 ;	-0,56]	-1,5	[-7 ; 1]
P3	-0,67	(0,72)	[-1,07 ;	-0,27]	-1	[-2 ; 1]
P4	0,18	(1,63)	[-0,66 ;	1,01]	1	[-3 ; 2]
P5	-0,26	(0,56)	[-0,53 ;	0,01]	0	[-2 ; 0]
P6	-1,14	(1,07)	[-2,13 ;	-0,15]	-1	[-3 ; 0]

Note. CI = Confidence Interval

The results of chi-square tests of fit to the uniform distribution are presented in Table 6. A p-value <.05 means that score differences between the beginning and end of the session are significant and that the intervention has had an effect. It was not possible to conclude that PA influenced perceived fatigue and wellbeing (Table 6). Differences in perceived pain scores were significant between the beginning and end of PA sessions for 3 out of 4 participants: perceived pain decreased (Table 6).

Table 6

Uniform chi-square test for delta pain, fatigue, and wellness score per participant

	Pain		Fatigue		Wellness	
	F	p	F	p	F	p
P1	NA	NA	NA	NA	NA	NA
P2	6,1250	0,0468*	3,1250	0,2096	9,5000	0,0087*
P3	8,4000	0,0150*	6,4000	0,0408*	30,0000	0,0000*
P4	5,7647	0,0560*	3,6471	0,1615	3,6471	0,1615
P5	19,0526	0,0001*	3,2632	0,1956	3,2632	0,1956
P6	NA	NA	NA	NA	NA	NA

Note. NA = incomplete data (<15 sessions) ; F = stastistic value ; p = p-value

** p-value < .05*

The autocorrelations for each series of values of the delta pain variable were calculated (each series represents one patient). Between sessions, there was no significant correlation, and the latter were weak ($r < 0.5$). We did not go further than the correlation between one session and the fifth session after it, because each correlation is carried out with the first session as a reference and session n. If there is no correlation from the fifth session onwards (n=5), there will be even less in the sixth (n=6) and so on (Figure 2).

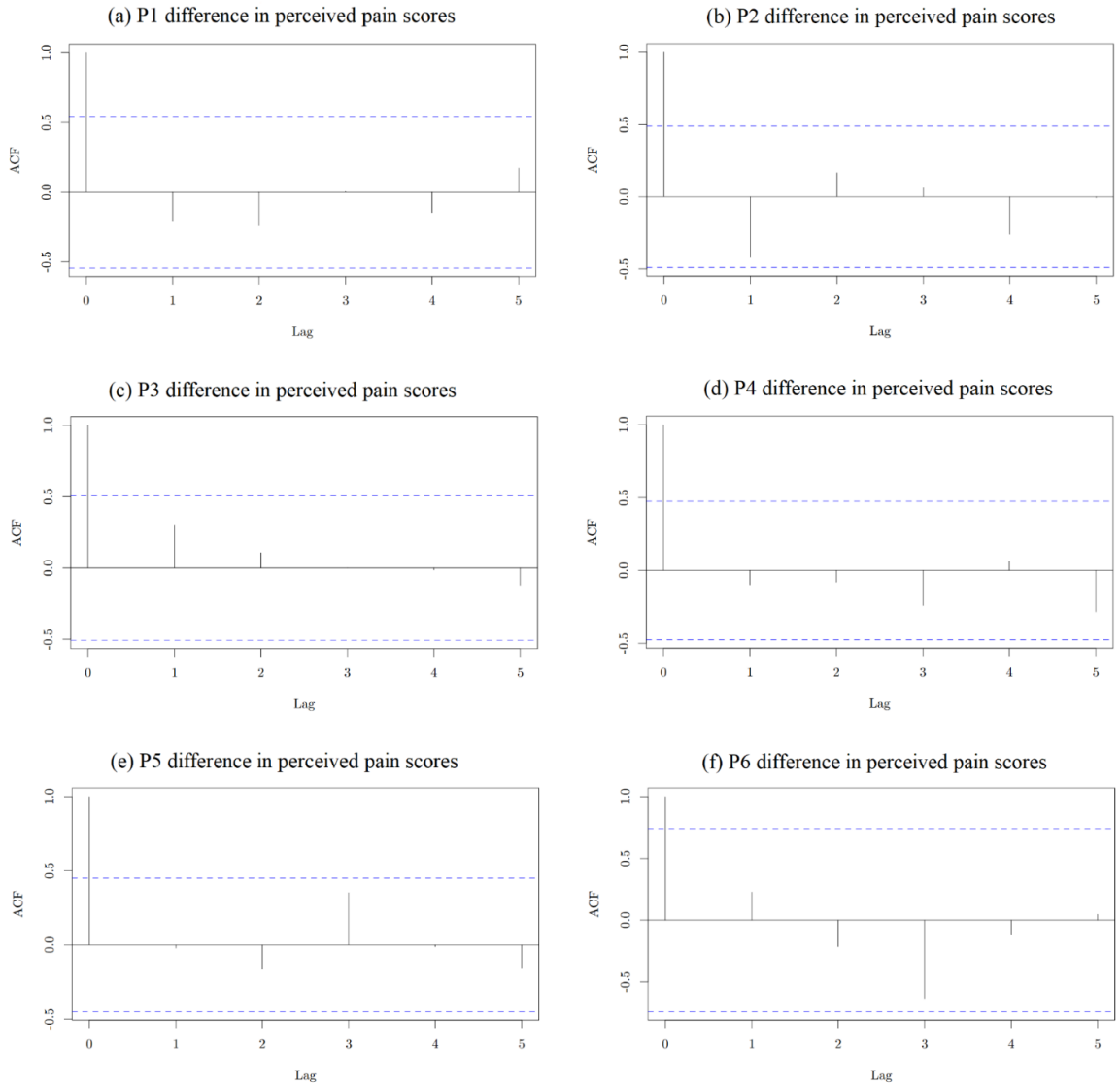

Figure 2

Autocorrelation coefficient of PA sessions for each patient between each session (up to the fifth)

Graphical analysis of perceived measures results

Mixed activities seem to have a greater effect on perceived fatigue, while muscle strengthening has no overall effect on fatigue. Stretching and interval aerobic activities have both positive and negative effects on fatigue (Figure 3). To complete these results, PA sessions considered to be vigorous seem to have a positive effect on fatigue, moderate perceived intensity seems to have both positive and negative effect, and low perceived intensity seems to have no effect (Figure 4).

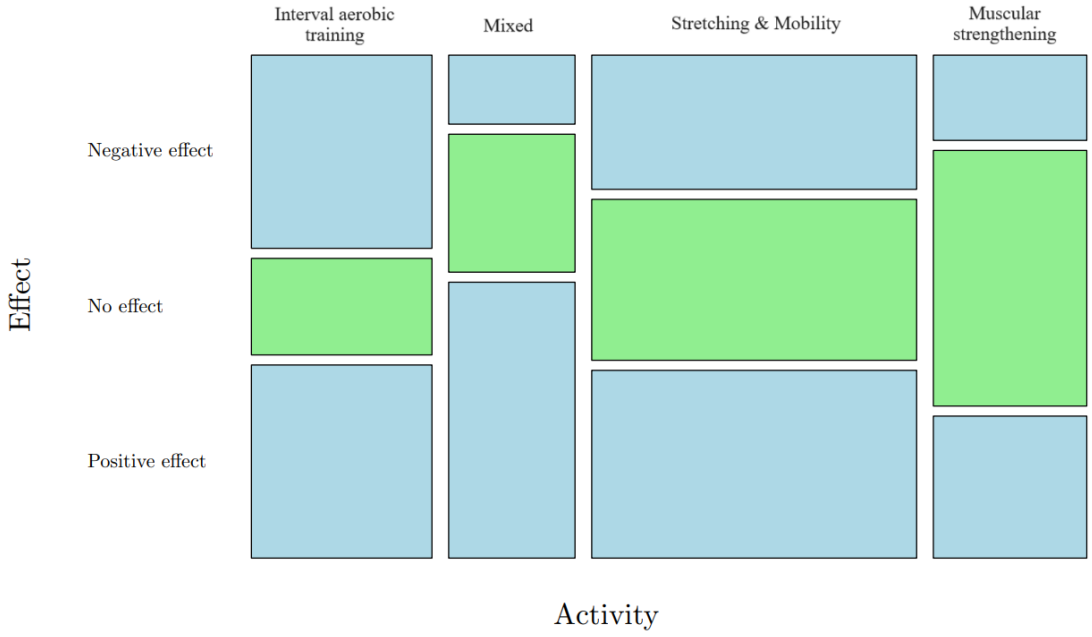

Figure 3

Conditional laws comparing the difference in fatigue according to the type of PA followed.

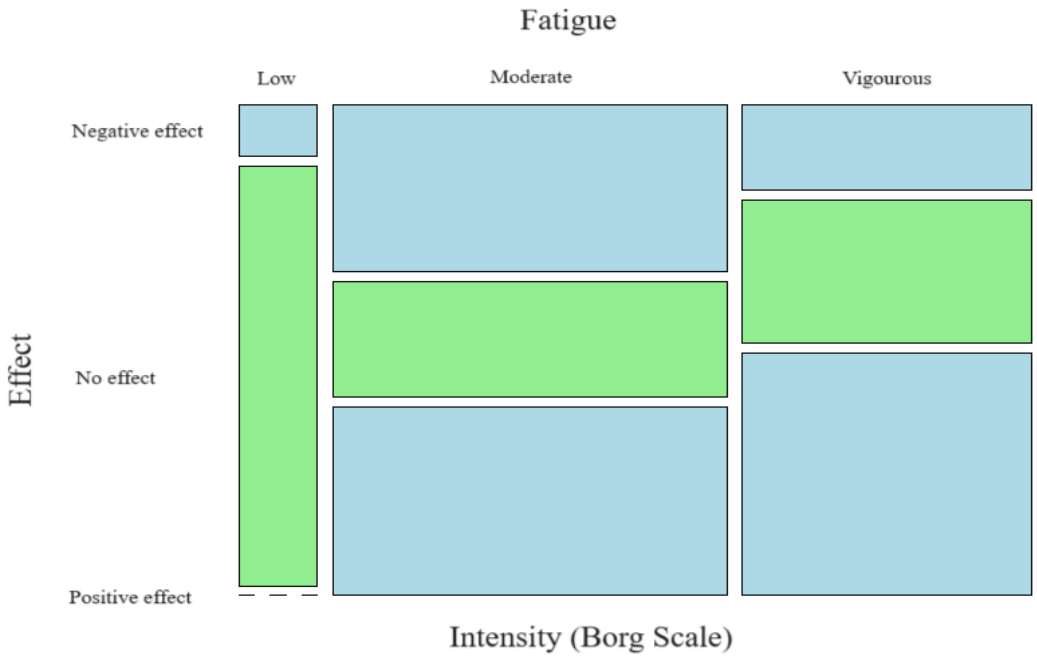

Figure 4

Conditional laws comparing the difference in fatigue according to the perceive intensity of PA sessions followed.

As far as well-being is concerned, stretching and mixed activities have the most positive effects, while muscle strengthening still has no effect overall. For interval aerobic activities have many negative as positive effects (Figure 5). As with fatigue, vigorous PA seems to have more of a positive effect, moderate activity seems to have both positive and negative effect, and low perceived intensity seems to have no effect (Figure 6).

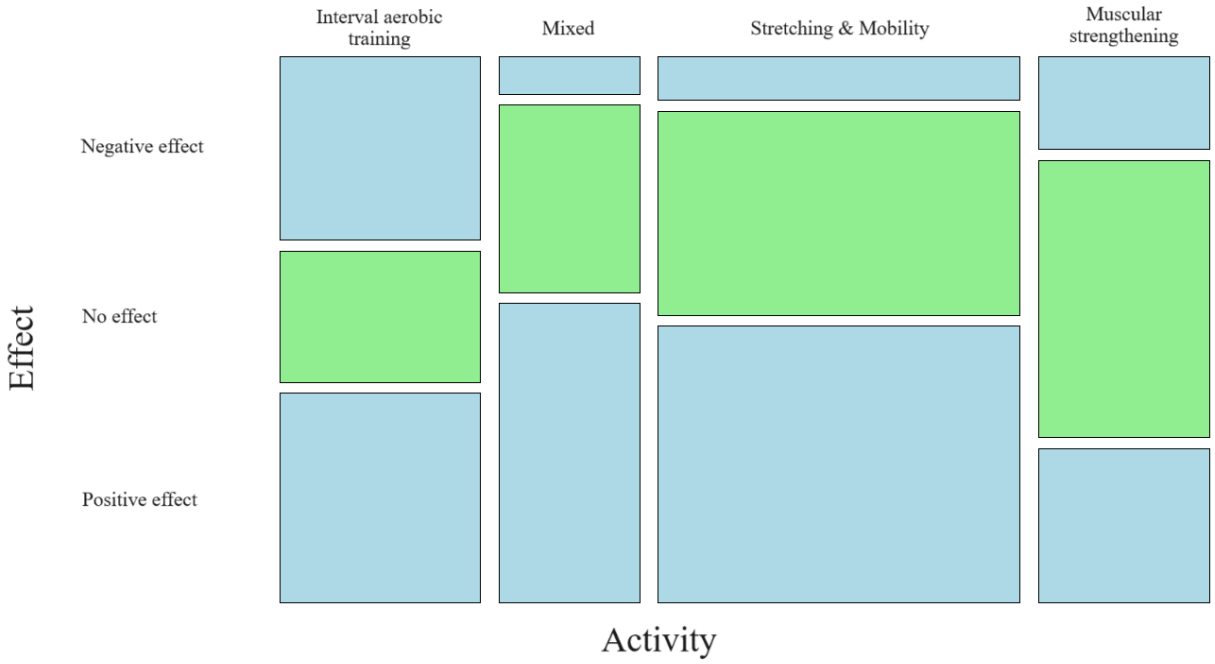

Figure 5

Conditional laws comparing the difference in wellbeing according to the type of PA followed.

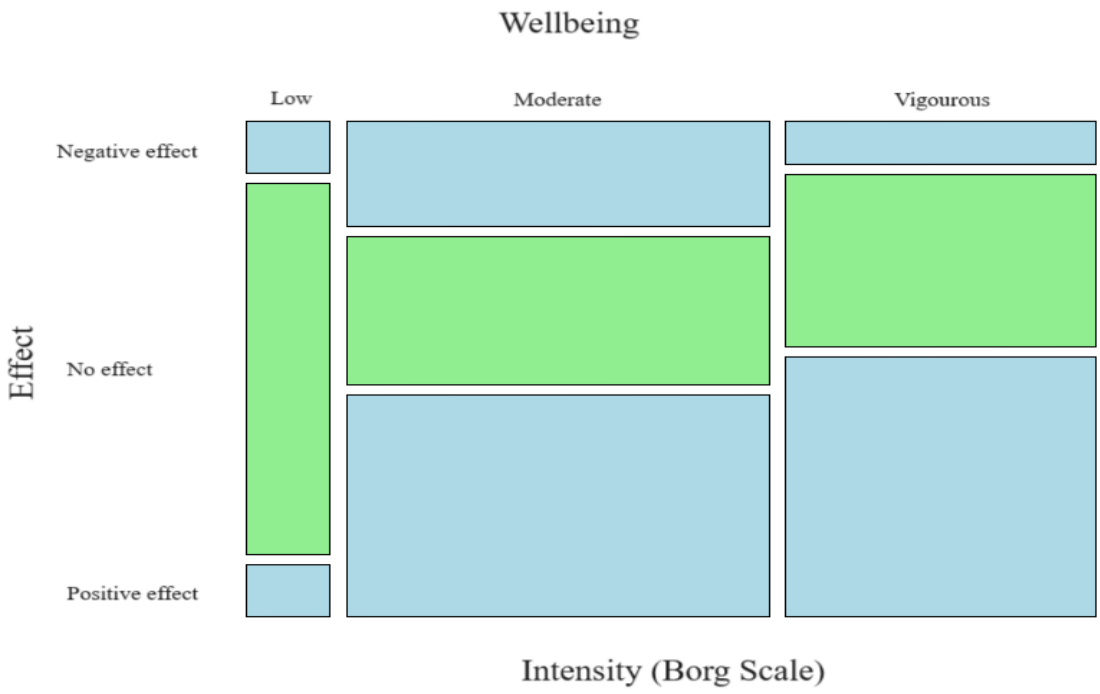

Figure 6

Conditional laws comparing the difference in wellbeing according to the perceive intensity of PA sessions followed.

When examining the effect according to the type of PA proposed, stretching seems to have the most beneficial effect on perceived pain, followed by mixed sessions. Muscle-strengthening activities seem to have no overall effect on pain. Interval aerobic activities seem to be as much of a neutral effect as a combined positive and negative effects (Figure 7). As fatigue and well-being, vigorous PA seems to have more of a positive effect, moderate activity seems to have both positive and negative effect, and low perceived intensity seems to have no effect (Figure 8).

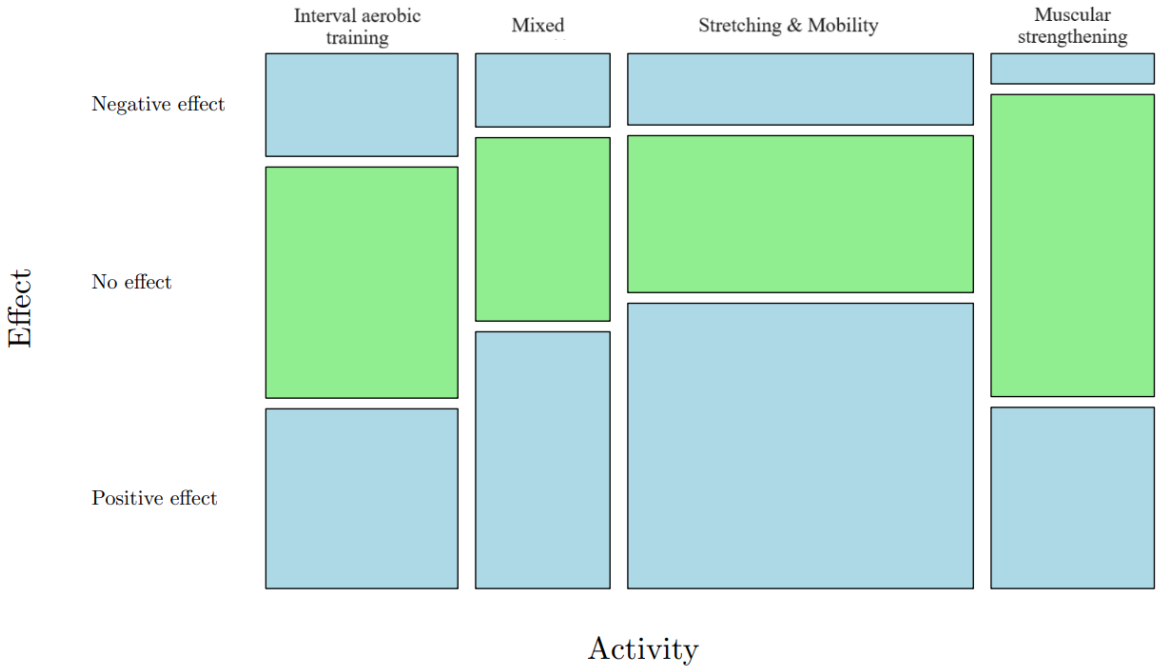

Figure 7

Conditional laws comparing the difference in pain according to the type of PA sessions followed.

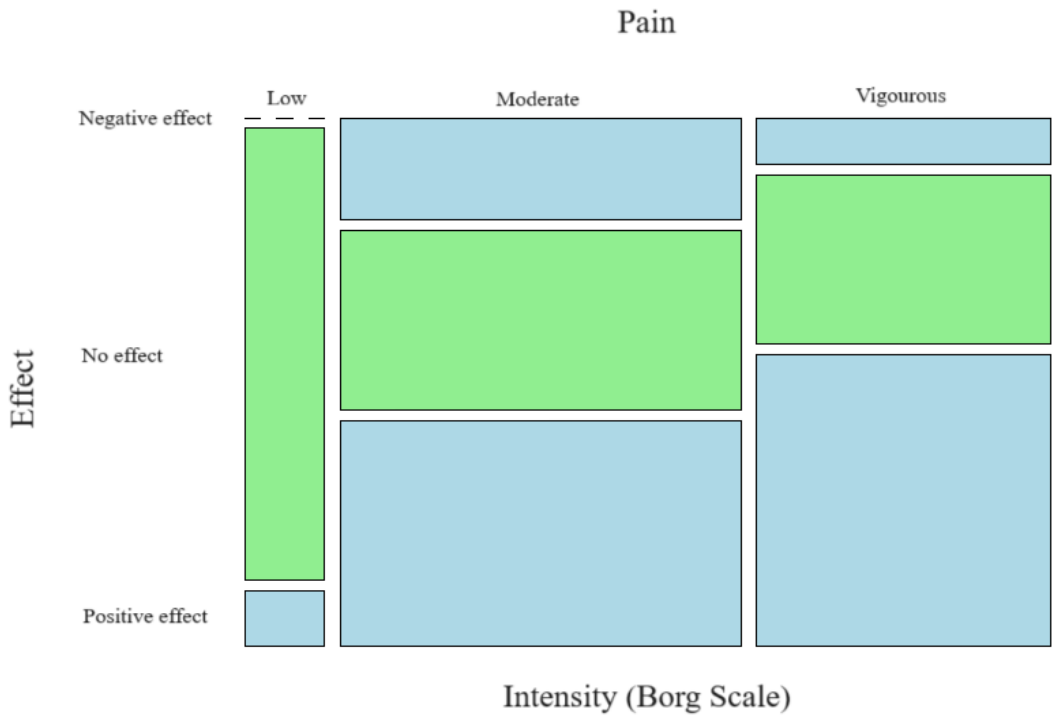

Figure 8

Conditional laws comparing the difference in pain according to perceive intensity of PA sessions followed.

According to the distribution, low perceived intensity activities are muscular strengthening sessions, moderate perceived intensity activities are mainly stretching & mobility sessions and vigorous intensity is shared between the activities (Figure 9). Overall, most sessions were perceived as moderate intensity (Figure 10). The majority of stretching sessions were perceived as being of moderate intensity. Most aerobic interval training sessions and mixed sessions were perceived as vigorous intensity. Most muscle-strengthening sessions were perceived as being both light and moderate intensity (Figure 10). Each type of PA in the APA sessions was planned to be proposed with different level of intensity. The low intensity stretching sessions were perceived as moderate intensity by the participants (Figure 2 additional material).

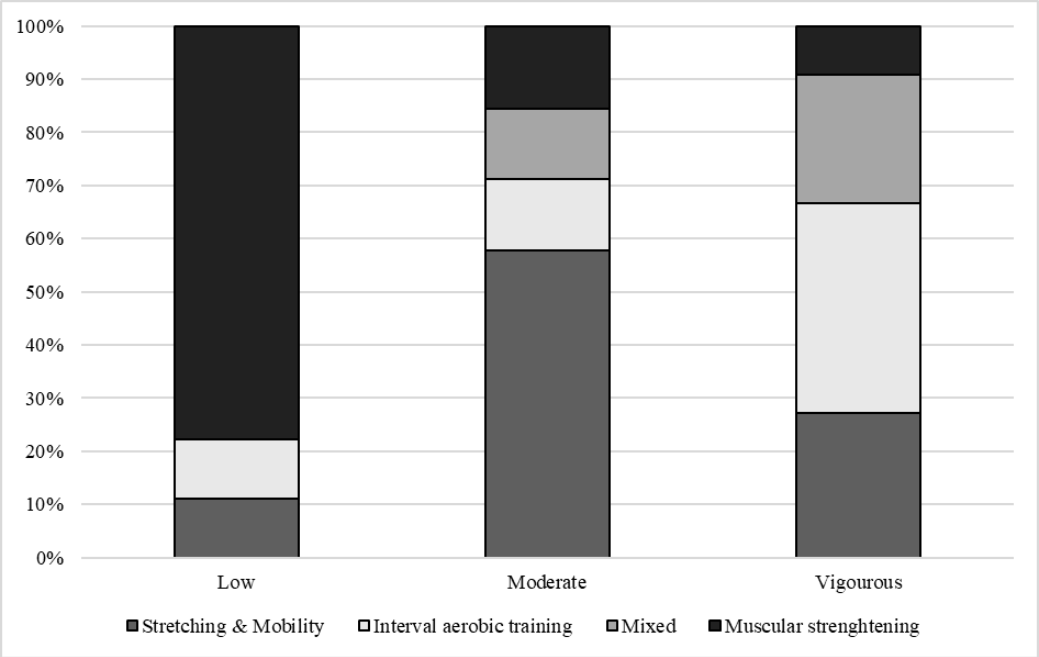

Figure 9

Distribution of session type by perceived intensity

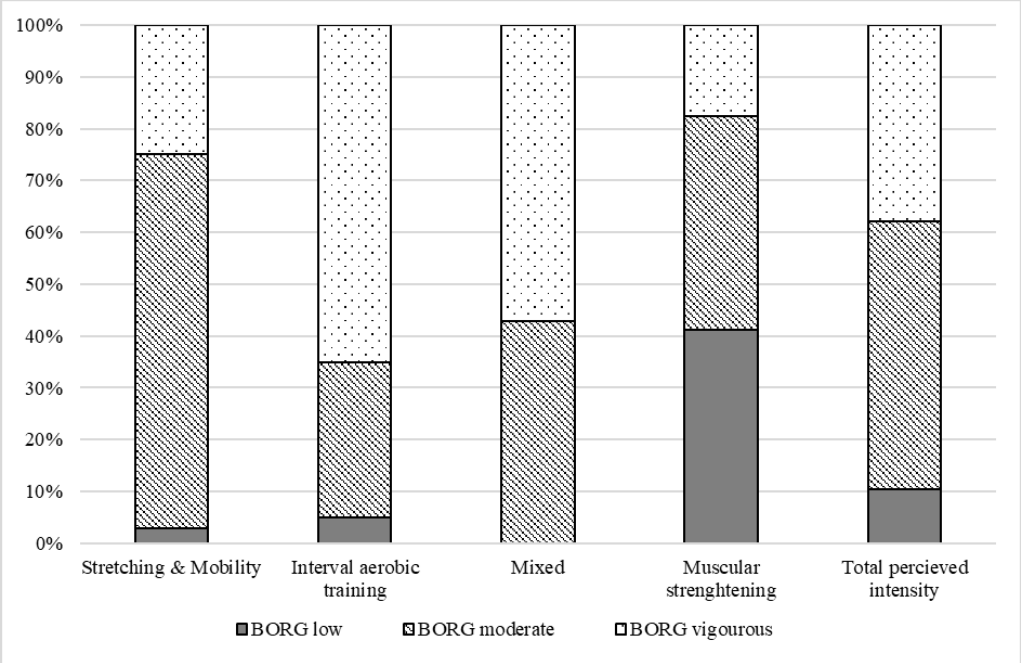

Figure 10

Distribution of perceived intensity by session type

Discussion

Investigating data from 6 participants, the aim of the pilot study was to assess the effect of an APA program delivered via videoconferencing on perceived pain, fatigue and well-being. The second aim was to identify the most effective types and intensity of PA. Results are discussed below.

Fatigue and well-being

Results showed no significant difference in perceived fatigue and well-being. Other studies assessed fatigue with QoL items and found post-intervention improvements. Petrelluzzi et al. (2012) found an improvement in vitality item of SF-36 QoL intragroup between pre- and post-intervention. Zhao et al. (2012) showed an improvement in the same item intragroup for control and relaxation group, and intergroup for relaxation group between pre- and post-intervention. Although fatigue is a symptom associated with endometriosis, few studies have measured this in PA interventions. Concerning well-being, studies found no improvement in the mental health domain of the QoL SF-36 intragroup between pre- and post-intervention (Petrelluzzi et al., 2012; Zhao et al., 2012). However, compared to control group, various exercise programs found an improvement of catastrophic thoughts (Artacho-Cordón et al., 2023), stress reduction (Petrelluzzi et al., 2012; Zhao et al., 2012), improve of emotional wellbeing (Gonçalves et al., 2017) or mental health (Zhao et al., 2012) in QoL. Only Zhao et al. (2012) found a improvements of stress, anxiety and depression pre- post-intervention intragroup.

Our results only concern the difference between the beginning and the end of an acute PA session of any type, whereas previous studies compared the results between a control group and a group that received a structured programme lasting several weeks. The studies on the effect of acute exercise in endometriosis have not assessed fatigue and well-being (Lutfi et al., 2023; Poli-Neto et al., 2020). Perhaps a single session of PA is not enough to improve the perception of fatigue and well-being. It has been shown graphically that mixed sessions are more efficient at reducing fatigue and that mixed and stretching sessions are more efficient at improving well-being. It's difficult to draw conclusions for interval training, which shows as many negative effects as positive, suggesting individual variability and the need for individualisation. Surprisingly, it was the sessions perceived as vigorous that were the most beneficial on fatigue and well-being. If we look at the breakdown of session type according to intensity, moderate-

intensity sessions were predominantly stretching sessions, while all types of activity could be perceived as vigorous sessions, with a predominance of interval training. Therefore, perceived intensities would be important. The sessions may be more effective if they are perceived as vigorous or moderate for stretching and mixed sessions, and moderate for aerobic interval training sessions, depending on the profiles of participants. Starting scores or recruitment bias may have influenced the perception of effort or investment in the session. For instance, individuals who are not used to practice PA could have found any exercise as moderate to vigorous even if the intensity planned was lower or they could have left the program because they perceived it too hard compared to the participants who completed the entire program.

Pain

Sixty minutes of PA seems efficient to reduce pain immediately after the session. Our results are in line with another previous study which showed that a single exercise session supervised by videoconferencing or virtual reality game was effective to in reducing pain (Lutfi et al., 2023). But these results were not consistent with those of Poli-Neto et al. (2020) which showed no modulation of pain thresholds after acute strength exercise in women with endometriosis. However, our graphical observations showed that muscle strengthening, and perceived light-intensity activity tended to have less effect. Taken together, these results suggest that the modalities of the exercise program (i.e., type and intensity of exercise) may be important in reducing pain related to endometriosis.

Indeed, mixed programs (i.e., a combination of aerobic activity, strengthening or stretching) showed reductions in perceived pain (VAS-scale; (Artacho-Cordón et al., 2023; Awad et al., 2017) and increase in pressure pain thresholds (Artacho-Cordón et al., 2023). Relaxation program associated with hormonal therapy showed a reduction in body pain (SF-36) for intragroup and intergroup compared to control (Zhao et al., 2012). Additionally, Yoga program also found significant reduction in pain score (EHP-30) compared to control (Gonçalves et al., 2017). However, a multimodal program based on psychological intervention and physical therapy including posture exercise, stretching and breathing exercise, self-massage, TENS, etc. in a single session of 2.5 hours per week, did not found an effect on body pain (SF-36; Petrelluzzi et al., 2012). Another mixed program (i.e., walking and flexibility exercise), did not find additional effect on pain with danazol treatment, however, the tool used was not detailed (only presented as "subjective assessment"; Carpenter et al., 1995). This highlights the need for a well-defined

exercise protocol (i.e., with FITT criteria; ACSM, 2017) and standardised pain measurement tools (i.e., EHP-30, SF-36 pain item, VAS-scale).

Overall, various types and durations of PA do not appear to be harmful for women with endometriosis and seem to help reduce pain. Previous studies are in line with our graphic observations and showed that stretching and mixed sessions were more efficient to reduce pain. Similarly for fatigue and well-being, sessions which proposed perceived vigorous intensity seem to be the most effective in reducing pain. However, the majority of stretching sessions were perceived as being of moderate intensity, and these seemed to have equivalent positive effects compared with the other neutral and negative effects. This could therefore mean a priori that stretching sessions perceived as intense are the most effective in reducing endometriosis-related pain. Concerning aerobic interval sessions, our results were inconsistent, potentially resulting very different effects on participants. Physio-EndEA program (Artacho-Cordón et al., 2023; Salinas-Asensio et al., 2022) with a strong aerobic component, but progressed from 20 to 40 minutes over the 8 weeks observed positive effects on pain thresholds measured by pressure algometry. And in view of the positive results of the mixed sessions, and the neutral effect of the muscle-strengthening and low sessions, it could be suggested that session duration and intensity were ones of the determining factors of beneficial effect for aerobic sessions. The results of a meta-analysis on the hypoalgesic effect (measured with pain threshold) of exercise in healthy adults (Tomschi et al., 2024) showed that, regardless of duration, high-intensity exercise had a greater effect than moderate-intensity exercise and that light-intensity exercise had very little effect, corroborating our results. Authors have also questioned the hypoalgesic effect of exercise in relation to the types of PA and showed inconsistent results. Wewege & Jones (2021) showed that resistance training had little effect compared with aerobic exercise, whereas Naugle et al. (2012) showed that all exercises could have an effect, with a greater effect for resistance exercise. This suggests that exercise intensity is probably one of the most important variables to modulate for inducing an acute reduction in pain.

Our autocorrelations showed no cumulative effect of sessions on perceived pain, perhaps the volume and intensity of exercise per week was insufficient to see any effect, or perhaps there was a very long-term effect (longer than 3 months). In this sense, (Ensari et al., 2022) were the first to show that habitual exercise is likely to influence perceived endometriosis pain the day after exercise (McGill and 3-point severity scale) : people who exercised regularly at least three times a week were more likely to experience favourable pain outcome after exercising the day before. To sum up, the frequency, duration, type and intensity of exercise programs are likely to

influence the perceived pain associated with endometriosis in the long term. Additionally the onset of pain can be random or cyclical, it would seem appropriate to use recurrent pain measurements, pre and post session, especially in a context of PA support and for PA supervisors, or daily as proposed by (Gonçalves et al., 2017) and (Ensari et al., 2022).

Highlighting the socio-psychological variables associated with PA

Only 6 women participated the program, and the association between reduced PA, pain intensity and depression is well known, and may explain why women with endometriosis are less physically active (Sachs et al., 2023). However, in our descriptive analysis (add material), the level of pain was similar between groups. Additionally, intrinsic motivation and identified motivation were higher in the NO APA group compared to APA group. However, the latter had poorer physical function, physical satisfaction and social support compared to APA group. The No APA group may have found enough resources to practice PA by their own or in usual sport clubs whereas the individuals who participate to the program need more guidance, step by step and personalized approach. Self-determined motivation could be not enough to get involved in an APA program and adhere to it. The perception of physical ability and social support as much as various psycho-social determinants, and perceived pain, are involved in the commitment to PA. Regarding to the reduced perception of physical capacity in the NO APA group, authors have observed that self-efficacy is reduced in people suffering from chronic pain (Alappattu et al., 2015) and that if patients feel they can do little to control their symptoms, they will make only minimal efforts (Turk & Okifuji, 2002). Lack of commitment to exercise may be due as much to the pain itself as to fear of its occurrence, leading to fear of movement and avoidance strategies (Phelps et al., 2021; Turk & Okifuji, 2002). This suggests that even when people are not in pain, they may be resistant to certain activities in anticipation of pain. Therefore, it would have been relevant to assess kinesiophobia and self-efficacy in addition to perceived physical ability.
Having the knowledge of the ability to practice PA without anticipated negative consequences can reduce fear of pain, increase perceived self-efficacy and enhance perseverance. Thus, exposure to positive PA experiences can ameliorate pain while attenuating avoidance (Phelps et al., 2021; Turk & Okifuji, 2002). Recently, authors have also demonstrated the benefits of exercise through neuroscience and pain circuitry (Senba & Kami, 2023). In chronic pain sufferers, central neurological dysfunction leads to chronification of pain, even when the painful stimulus is absent. Exercise can improve fear and avoidance through better regulation of thoughts and behaviour, and activation of the reward circuit. Recently, authors found that in chronic pain sufferers, the brain sees pain as a task, preventing it from switching to a resting mode, which

further impairs the sufferer's quality of life. Different types of exercise, such as walking, help to improve the brain's condition. Individuals benefit more from exercise if they make it a habit and a way of life without needing to think about it (Senba & Kami, 2023). This way of thinking echoes the work of (Mińko et al., 2021), whose results showed that PA is associated with coping strategies such as distraction (diverting attention from a stressor by other thoughts), active coping (the process of suppressing or mitigating the effects of the stressor), planning (planning to deal with the problem), and acceptance of the situation. One can also speculate that the distraction process could be one of the factors explaining the short-term pain reduction mechanism of acute exercise.

Strengths and limitations

The principal strength of the present study is the analysis of PA as acute exercise, which has rarely been investigated. The present study tried to clarify whether different modalities of PA could have an impact on fatigue, well-being and pain related to endometriosis. Even though this study provides a total of 87 independent sessions of PA for the graphic analysis, and the descriptive data at baseline are similar to other studies, this study is not without limitation. The sample size is small and more data are needed, but the results suggest aerobic exercise and perceived exertion should be investigated. Given the influence of psychosocial factors on PA and chronic pain, interventions should be carried out to support self-efficacy, social support and reduce fear avoidance. Also, it should be borne in mind that only a small sample of 6 people participated, meaning that even though our results are interesting should be taken with caution. For instance, the vigorous intensity perceived was shown as beneficial but was actually moderate intensity session and not all participant perceived the positive effects highlighted. Otherwise, as previously shown women who suffer from endometriosis are not very active, intense sessions from the beginning of an APA program could repel them. Physical and mental dimensions in measurements for fatigue and well-being, could make results more accurate. The other studies cited used specific questionnaires related to psychological states like Hospital Anxiety and Depression Scale (HADS) (Salinas-Asensio et al., 2022) and Perceived Stress Questionnaire (PSQ) (Petrelluzzi et al., 2012) or QoL like EHP-30 (Artacho-Cordón et al., 2023; Gonçalves et al., 2017; Salinas-Asensio et al., 2022) and SF-36 questionnaire (Petrelluzzi et al., 2012) to assess these variables before and after the intervention. While such questionnaires were also used (EHP-30, borg scale and VAS, see method for detail), analysis was not performed given the small sample size, which would not allow us to draw any further conclusions.

Conclusion

A session of PA could reduce perceived pain in endometriosis context. This improvement can be explained by various psychological and physiological mechanisms which need further investigation. The present study showed that stretching, mixed sessions and vigorous perceived intensity seemed to have a positive effect on pain. Results vary from person to person, so individualization is essential in practice. Based on this pilot study it is possible to advise practitioners and PA supervisors to be aware of individual variation, PA history, pain and psychosocial factors to be able to match the content of the session according to frequence, intensity, type and duration of exercises to individuals. Finally, results from the present study would help to improve the program and propose the enhanced version to a larger sample.

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Conflict of interest disclosure

The authors declare that they have no financial conflicts of interest in relation to the content of the article. The authors declare the following non-financial conflict of interest

Data and Supplementary Material Accessibility

Supplementary materials are available on https://osf.io/67dj3/

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