Impact of CrossFit® practice on pelvic floor dysfunction: a systematic review

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Summary

Introduction: CrossFit® is an sport modality that involves high-impact and intense exercise, gymnastic movements and weightlifting, whose practice has achieved great popularity in recent years, despite the high prevalence of urinary or fecal incontinence (UI e FI) associated to this practice. Therefore, the objective of this study was to conduct a systematic review of the literature to understand the impact of CrossFit® on pelvic floor dysfunction compared to other exercise modalities.
Material and method: Following PRISMA (Preferred Reported Items for Systematic Reviews and Meta-Analysis) guidelines, a search was conducted in scientific databases. A total of 7 studies out of the 53 obtained were qualitatively evaluated and selected for the systematic review.
Results: Stress UI seemed to be greater in female CrossFit® participants, than in female kickboxing, bootcamp, aerobic exercise and no CrossFit® practitioners, and also in comparison to sedentary women ($P<0.05$). Running was suggested to produced higher FI than CrossFit® ($P<0.001$), while no differences were observed in intra-abdominal pressure and pelvic floor contraction capacity through pelvic examination between female CrossFit® participants and women who practice light exercise, non-CrossFit® practitioners and sedentary women ($P<0.05$).
Conclusion: CrossFit® practice appears to favor IU in a greater extent than other exercise modalities but not FI which seem to be more prevalent with running practice, although differences between exercise modalities were not observed through direct examination of pelvic floor contraction. Further studies are needed to clarify these findings, defining more accurately the assessment instruments, influencing factors and control groups.

Key words:
Urinary incontinence. Fecal incontinence. Exercise training. High-intensity interval training. Pelvic floor disorders.

Impacto de la práctica de CrossFit® en la disfunción del suelo pélvico: una revisión sistemática

Resumen

Introducción: CrossFit® es una modalidad deportiva que engloba ejercicio de alta intensidad e impacto, movimientos gimnásticos y halterofilia, cuya práctica ha alcanzado una gran popularidad en los últimos años, a pesar de la elevada prevalencia de incontinencia urinaria y fecal (IU e IF) a la que se asocia esta práctica. Por ello, el objetivo de este trabajo fue realizar una revision sistemática de la literatura para examinar el impacto del CrossFit® en la disfunción del suelo pélvico comparado con otras modalidades de ejercicio.
Material y método: Siguiendo las directrices PRISMA (Preferred Reported Items for Systematic Reviews and Meta-Analysis) se realizó una búsqueda en bases de datos científicas. De un total de 53 estudios, 7 fueron evaluados cualitativamente y seleccionados para la revisión sistemática.
Resultados: La IU de esfuerzo pareció ser mayor en mujeres que practicaban CrossFit® que en aquellas que practicaban kickboxing, bootcamp, ejercicio aeróbico o que no practicaban CrossFit®, y también mayor que en mujeres sedentarias ($p<0,05$). Correr parecía provocar mayor IF que la práctica de CrossFit® ($p<0,001$), mientras que no se observaron diferencias en la presión intra-abdominal y en la capacidad de contracción del suelo pélvico a través de examen físico entre mujeres que practicaban CrossFit® y aquellas que no practicaban CrossFit® o que practicaban ejercicio ligero o eran sedentarias ($p<0,05$).
Conclusión: La práctica de CrossFit® parece favorecer la IU en mayor medida que otras modalidades de ejercicio, pero no la IF, que pareció ser mayor con la práctica de carrera, aunque no se observaron diferencias entre modalidades de ejercicio mediante el examen directo de la capacidad de contracción del suelo pélvico. Se necesitan más estudios para aclarar estos resultados, definiendo con mayor precisión los instrumentos de evaluación, los factores influyentes y los grupos de control.

Palabras clave:
Incontinencia urinaria. Incontinencia fecal. Entrenamiento físico. Entrenamiento interválico de alta intensidad. Alteraciones del suelo pélvico.

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Introduction

The pelvic floor is a structure formed by muscles, fascia, and ligaments whose main mission is to support other pelvic structures (urinary bladder, urethra, rectum, and anus, and additionally in women uterus and vagina) and fix them to the pelvis, allowing functions of the aforementioned organs such as urination, defecation or intercourse[1] . However, all these structures are especially vulnerable to certain risk factors such as pregnancy, vaginal delivery, multiparity, age, menopause, and all the hormonal changes associated with these processes, as well as vulnerable to certain situations that chronically increase intra-abdominal pressure, such as constipation, chronic bronchitis, obesity or high-impact repetitive exercises[2,3]. All this can trigger an involuntary contraction or relaxation of the pelvic floor muscles known as pelvic floor dysfunction (PFD), which entails a series of anatomical-functional disorders in this region, the most evident being voiding dysfunction or urinary incontinence (UI) and fecal incontinence (FI), followed by other anorectal or pelvic dysfunctions such as obstructive defecation syndrome, pelvic organ prolapse (POP), sexual dysfunction and perineal pain[4]. According to the International Continence Society, UI is the manifestation of any involuntary loss of urine[5] which also represents a social, hygienic and even economic problem. The most frequent types are[6,7]: (1) stress UI, which is the involuntary loss of urine since the sphincter is not able to support it, which is associated with an increase in abdominal pressure, due to underlying physical efforts such as coughing, laughing or running; (2) urgent UI, which is the involuntary loss of urine due to the inability to hold it long enough to go to the bathroom and; (3) mixed UI, which would be the association of involuntary urine loss to both effort and urgency. Regarding FI, this includes, from least to most serious, respectively, any involuntary escape of gases and/or feces through the anal orifice, which can be[3]: (1) passive or unconscious; (2) urgent due to inability to contain defecation; (3) mixed; (4) post-defecation but with normal continence the rest of the time; and (5) during urination. However, there is less agreement on its precise definition and severity criteria than on UI.

Weakness of pelvic floor muscles is one of the possible causes of genitourinary tract problems[6], and the prevalence is higher in women, with ratios of up to 20:1 for IU compared to men. Therefore, men could be more reluctant to report this problem[4]. Despite fluctuating between countries, the percentages of women who have experienced some urine loss range between 25% and 45%, while the percentages of adults who manifest FI range between 0.4% and 18%, increasing up to 24% if gas incontinence is considered[3]. However, the future estimate is not much more encouraging. According to a 2019 study, one in three women will experience UI, while one in two will present POP and one in ten will report FI[8]. On the other hand, it is also estimated that sexual dysfunction will increase from 50% to 83% in women with DSP[8]. Altogether, this implies a clear deterioration in psychological, social and sexual well-being.

Interestingly, in the 1990s a review of the literature suggested a 44% prevalence of UI in physically active women, especially those involved in high-impact sport activities[9,10], predominantly involving jumping or running[2,11,12]. In spite of this, the practice of high-impact exercise has recently become popular among the general population[12], with CrossFit® being one of the high-impact exercise modalities or disciplines that has received great interest and recognition since its formal establishment in 2000[13]. This fitness program initially developed for military training, provides a sense of community, fun, personal satisfaction, and motivation[14] and optimizes physical competence in 10 aspects: cardiorespiratory endurance, muscular endurance, muscular strength, flexibility, power, speed, coordination, agility, balance and precision[15]. CrossFit® sessions combine: (1) exercises with a traditional cardiovascular component and metabolically stimulating impacts such as running, jumping, rowing or climbing rope; (2) exercises based on sports gymnastics skills such as handstands or rings; and (3) weightlifting exercises[13,15]. These three elements make up what is called "Work Of the Day" (WOD), which must be performed with high intensity and speed, repetitively and with limited rest time[13,15].

The presence of women in CrossFit® competitions has grown from approximately 28,000 participants in 2016 to around 75,000 in 2019[15], which according to several studies, has led to a decrease in body dissatisfaction or eating disorders, favoring body positivity and providing women with the possibility of improving their strength and physical perception through sport enjoyment[16]. Some women also highlight the possibility of helping to undo the traditional hegemony of the male gender in terms of cultivating strength and muscularity, which allows them to enhance the functionality of their body and improve their self-concept and confidence in daily life[16]. However, despite the recognized benefits of practicing CrossFit® , it is worth highlighting its potential to produce musculoskeletal injuries, mainly associated with the speed of execution, especially in novice practitioners[15], and the increase of intra-abdominal pressure that is linked to PFD, especially in terms of stress UI. Specifically, in female CrossFit® practitioners, UI prevalence rates between 32.1% and 44.5% were observed, with stress UI being the most common type reported[17,18]. The disorder is greater among women over 35 years of age, with previous pregnancies and vaginal deliveries and the exercises associated with greater stress UI were jumping rope, double under, weightlifting, and box jumping[17]. Nonetheless, although it has recently received more visibility, PFD is a pathology of contemporary appearance and most review studies on the topic focus mainly on UI, so it is necessary to address the entire spectrum of disorders under PFD. Furthermore, the impact of CrossFit® on PFD compared to other exercise modalities remains unclear, as not only high-impact exercise but also significant weightlifting have been linked to high rates of PFD[19] as reflected in a study carried out with powerlifting and weightlifting athletes, where 50%, 80% and 23.3% of women analyzed presented, respectively UI, FI and POP[20]. Therefore, the objective of this study was to conduct a systematic review of the literature to examine the studies evaluating the impact of CrossFit® on PFD based on exercise modality.

Material and method

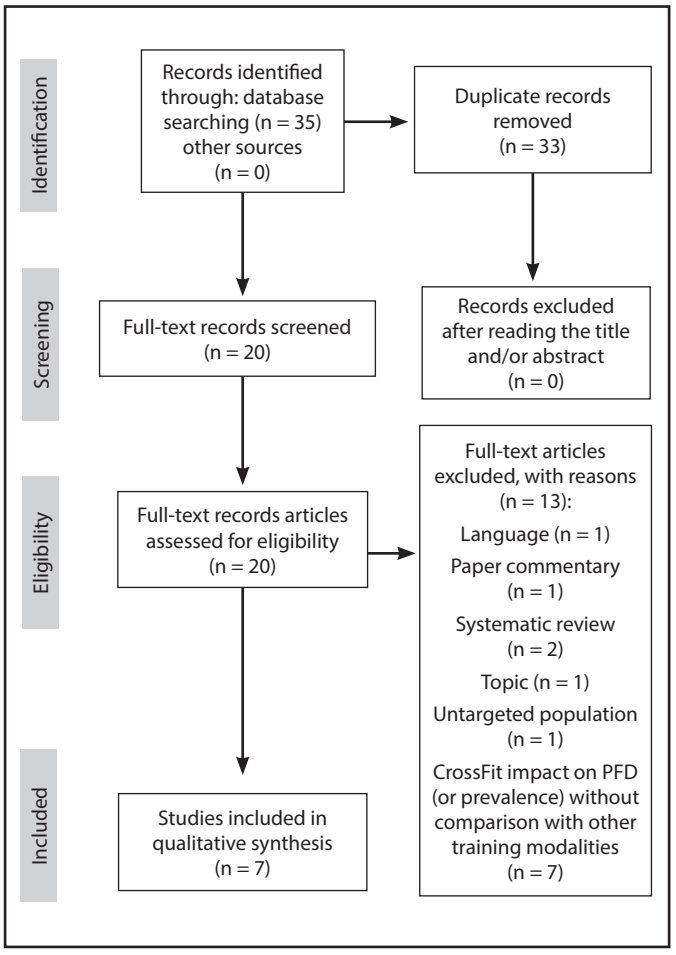
The methodological process carried out was based on the recommendations indicated by the PRISMA (Preferred Reported Items for Systematic Reviews and Meta-Analysis) guidelines[21]. A comprehensive database search was conducted (PubMed, Web of Science, Scopus and Cochrane) up to June 12, 2023, by two authors independently (NRP and

MART). The search strategy was as follows: "pelvic floor" AND "CrossFit®" indicating the combination of these terms in the title, abstract or keywords. To construct the search phrase, the PICO (population, intervention, comparison and outcome) strategy was considered[22], which in the case of this study would have been: females (population), CrossFit® (intervention) vs. other modalities (comparison) and DSP (outcome). However, according to previous literature, the different scenarios that occur in the clinical or social setting mean that the formulation of the question cannot always be adapted to this strategy[23]. In this case, with the initial search phrase, the results obtained were already quite limited, so it was decided, on the one hand, not to include 'females' in the search phrase so that if a study with male participants appeared, it could at least be screened to have a more comprehensive view of pelvic floor pathology. On the other hand, it was also decided not to include different sports disciplines in the search phrase, since this search strategy guaranteed that at least those studies where CrossFit® participants had been evaluated would appear, regardless of whether they were compared with other sport disciplines and even with sedentary participants.

The inclusion criteria were: (1) studies with people in which the impact of CrossFit® on the pelvic floor had been evaluated; and (2) studies accessible in full text in English, published in scientific journals. Opinion articles, conference communications, book chapters or review articles were excluded, as well as those that evaluated the state of the pelvic floor in women during pregnancy and those that studied the prevalence of PFD in CrossFit® without comparing this training modality with others. The search yielded a total of 53 articles (16 in Pubmed, 17 in Web of Science, 20 in Scopus and 0 in Cochrane). After removing the 33 duplicates, 20 potentially eligible articles were obtained and included to consult the full document and evaluate their eligibility. Of these, 13 studies were excluded for the aforementioned reasons: full text found in a language other than English (n = 1), opinion article (n = 1), evaluation of DSP during pregnancy (n = 1), not evaluating the impact of CrossFit® on the pelvic floor but rather the use of an insertable device, although the sample was composed of CrossFit® participants (n = 1), systematic review (n = 2), sPFD prevalence studies in CrossFit® which not compare this training modality to others (n = 7). Therefore, 7 articles were included in the qualitative analysis. The flow chart of the selection process is reflected in Figure 1.

Regarding the tool used for qualitative analysis, it was the following: McMaster University Guidelines and Critical Review Form for Quantitative Studies[24], which has been previously used in recent systematic reviews in the Sports Science field[25] and was considered the most appropriate for evaluating quantitative methods. With it, in each study, issues related to the following aspects were analyzed: 1) clearly stated objective of the study; 2) appropriately reviewed relevant literature; 3) type of design; 4.1) sample described in detail; 4.2) justified sample size; 5.1) reliable outcome measures; 5.2.) valid outcome measures; 6.1) intervention described in detail; 6.2) contamination in the intervention was avoided; 6.3) co-intervention was avoided; 7.1) results reported in statistical terms; 7.2) appropriate analysis; 7.3) clinical relevance was indicated; 7.4) the dropout rate was reported; 8) conclusions consistent with the methodology and results. Each of these 15 items was valued with a "1" if the answer was affirmative and with a "0" if it was negative, giving a value of "low" if the result was less than or equal to 5, "moderate" if the result was between 6 and 10, and "high" if it was greater than 10. From the included studies, the following information was extracted in a previously designed data sheet: authors and year, study design (data obtained through questionnaire or direct measurement) and characteristics of the participants (sex, age, height and weight, training state). Regarding exercise, information related to the activities or exercises performed and training load (sets and repetitions, duration, rest between sets and exercises, intensity...) were extracted, as well as information related to findings about pelvic floor involvement.

Figure 1. Flowchart of the study selection process.



Results

The qualitative analysis of the selected studies is shown in Table 1. The 7 selected studies[12,13,26-30] were included in the qualitative analysis. The characteristics of the studies included in the review are summarized in Tables 2 and 3. The included studies that analyzed the impact of PFD in CrossFit® practitioners compared to other sports disciplines is reflected in Table 2, while a study that compared the PFD between female CrossFit® practitioners and sedentary females is shown in Table 3.

Table 1. Qualitative analysis of the selected studies.

Nº	Authors and year	1. Purpose of the study (0/1)	2. Literature (0/1)	3. Design (0/1)	4. Sample (0/2)	5. Outcome measures (0/2)	6. Interven-tion (0/3)	7. Results (0/4)	8. Conclu-sion (0/1)	Sum of quality criteria (0/15)	Assessment according to score (Poor / Moderate / High)
1	Elks, *et al.,* 2020	1	0	1	2	2	1	3	1	11	High
2	Forner, *et al.,* 2021	1	1	1	1	2	2	3	1	12	High
3	Gephart, *et al.,* 2018	1	0	1	1	2	1	2	1	9	Moderate
4	Khowailed, *et al.,* 2020	1	1	1	1	1	2	3	1	11	High
5	Machado, *et al.,* 2021	1	1	1	2	2	3	3	1	14	High
6	Middlekauf, *et al.,* 2016	1	1	1	1	2	2	3	1	12	High
7	Yang, *et al.,* 2020	1	1	1	1	2	2	2	1	11	High
										11.43	High

Table 2. Results of studies that compare women practicing CrossFit® with women practicing other sports.

Authors and year	Characteristics of the participants and the physical activity practiced	Evaluation instrument and exercise protocol performed (if any)	Main findings
Elks, *et al.*, 2020	**n = 403 women** **n = 303 CrossFit practitioners** 38 (30-45) years BMI: 23.9 (22.4-26.9) kg/m^2 2 (1-3) vaginal deliveries n = 33 ± 10 menopausal **n = 100 non practitioners** 31 (26.5-39.5) years BMI: 23.9 (21.6-26.2) kg/m^2 2 (1-2) vaginal deliveries n = 8 ± 8 menopausal	ISI Questionnaire (Sandvik, *et al.*, 2000): UDI-6 Questionnaire (Barber, *et al.*, 2001). POPDI-6 Questionnaire (Barber, e*t al.,* 2001). UI log during training and competition, and type of exercises.	Higher prevalence and severity of UI in women who participate in CrossFit compared to those who do not: 84% of CrossFit participants (256 ± 84) vs. 48% of non-participants (48 ± 48) (*P* <0.001) reported UI on some occasion. Higher UI severity score in CrossFit participants. 20.8 (8.3-37.5) vs. 12.5 (2.1-27.1) (*P* <0.001). No differences between groups for pelvic prolapse (*P* >0.05). The exercises that reflected higher percentages of urine loss in CrossFit practitioners and in which differences seem to be reflected with respect to the control group were double jumping ropes (65%), rope climbing (50%) and weightlifting (40%).
Forner, *et al.,* 2020	**n = 1379 women** **n = 858 CrossFit practitioners** (Lifting >15 kg of weight in training) 38.5 ± 8.8 years BMI: 25.77 ± 4.48 kg/m^2 n = 452 vaginal deliveries (52.7%) n = 87 ± 10 menopausal **n = 521 runners** (That they did not lift >15 kg of weight in training) 38.4 ± 9.2 years BMI: 24.19 ± 3.91 kg/m^2 n = 295 (56.6%) vaginal deliveries n = 50 ± 10 menopausal	PFDI-20 Questionnaire (Barber, *et al.,* 2005) made up of questionnaires: UDI-6, POPDI-6 y CRADI-8.	The group of runners presented higher scores than the group of CrossFit practitioners in the total PFDI questionnaire (22.9 *vs* 17.7; *P* <0.001), in the POPDI (4.2 *vs* 0; *P* <0.001), and in the CRADI (6.3 *vs* 3.1; *P* <0.001). No differences between groups in the UDI-6 questionnaire (*P* >0.05). Scores were relatively low in both groups.

(continued)

Table 2. Results of studies that compare women practicing CrossFit® with women practicing other sports *(continuation)*.

Gephart, *et al.*, 2018	**n = 10 women** (26–48 years, half of them nulliparous) **n = 5 CrossFit practitioners** (>2 sessions per week, minimum 6 months) **n = 5 non-CrossFit practitioners** (for at least 1 year)	Intravaginal catheter: Goby Laborie wireless system (Laborie Medical Technologies, Mississauga, ON, Canada) to measure intra-abdominal pressure during a CrossFit class with 10 repetitions of the following exercises (weight chosen by each participant): weightless squats, front (front bar) and back (back bar) squats, burpees, deadlifts, kettlebell swings, lunges, pull-ups, push-ups, crunches, thrusters, wall balls, and jumping jacks jump rope with doubles if possible.	There was no difference in intra-abdominal pressure observed between the group of female CrossFit practitioners and the non-practice group. The highest intra-abdominal pressure was generated during jump rope, arm dips, front barbell squats, thrusters, and wall balls (P <0.0001). As the repetitions performed increased, the intra-abdominal pressure increased for the back squat (P = 0.003) while it decreased for the abdominals (P = 0.04).
Khowailed, *et al.*, 2020	**n = 14 women** (18-40 years, 10 of them nulliparous, 3 vaginal delivery) n = 2 training <2 h/week n = 9 training 3-6 h/week n = 3 training >6 h/week **n = 9 CrossFit practitioners** BMI: 22.4 ± 2.3 kg/m^2 **n = 5 Kickboxing or Bootcamp practitioners** BMI: 24.5 ± 2.7 kg/m^2	Questionnaire "The Female Athlete Survey: Urinary Incontinence Survey" (Carls, 2007). This questionnaire includes questions addressed to: a) identify symptoms of SUI during high-impact activities. b) Evaluate the willingness of the participants to try exercises to improve the UI (not included). c) Assess willingness to seek treatment for UI and their awareness of it.	Urine losses were higher in the participants who performed CrossFit than in those who performed Kickboxing or Bootcamp (P = 0.023). 64.2% of the participants reported some loss of urine. 78% of the participants associated urine loss with jumping activities (jump rope, drawer), and with abdominal contraction activities such as sneezing or laughing. 67% of the participants associated urine loss with running.
Middlekauf, *et al.*, 2016	**n = 61 women (26.8 ± 3.79 years), nulliparous** BMI: 24.06 kg/m^2 **n = 32 intense exercise practitioners** (>6 months practicing CrossFit >3 sessions/week) **n = 29 light exercisers** (not participating in any intense or impact strength or conditioning exercise in the previous 6 months) 22.7 ± 3.9 años BMI: 22.8 kg/m^2	Pelvic exam from a registered nurse through: Exam (POP-Q) (Bump, *et al*., 1996), Pelvic floor muscle strength through a perinometer (Peritron 9300 V vaginal perineometer, Laborie, Mississauga, Ontario, Canada), with which 3 MVC of the pelvic floor were measured (contract and relax and the vaginal rest pressure or VRP). 15 minutes before and after performing: a) Intense exercise group: 15 funds, 5 deadlifts at 80% of 3RM, 5 push-presses at 80% of 3RM, 15 burpees, and 20 sit-ups. b) Non-intense exercise group: 20 minutes walking at your preferred intensity and pace.	There were no significant differences between groups in terms of vaginal support. Both vaginal tone and resting vaginal pressure decreased slightly after performing both exercises (P >0.05). Only one participant reported POP. 27.7% of participants in the intense exercise group vs. 8.57% of the non-intense exercise group reported urine loss in relation to physical activity, coughing, sneezing. 68.6% of participants did not perform pelvic floor strengthening exercises, compared to 17.1% who did and 14.28% who were unaware of their existence.
Yang, *et al.*, 2018	**n = 105 CrossFit practitioners** (4-5 sessions/week) 36.9 ± 10.4 years BMI: 24.9 ± 3.7 kg/m^2 36.2% nulliparous. Of the 63.8% with a history of childbirth, 47.6% reported vaginal delivery **n = 44 aerobic exercise practitioners** BMI: 25.6 ± 2.7 kg/m^2 63.6% nulliparous. Of the 36.4% with a history of childbirth, 68.8% reported vaginal delivery	ISSI questionnaire (Terai, *et al.*, 2004).	The incidence of SUI was higher in CrossFit participants (27.8%) than in aerobic exercise participants (0%) (P <0.003). 47.6% of CrossFit participants reported SUI. The exercises with the most pronounced urine loss were jump ropes, both double (47.7%) and simple (41.3%), and box jumps (28.4%). None of the aerobic exercise practitioners reported SUI during the exercise. The most commonly used prevention strategies were emptying the bladder before training, wearing dark pants, and performing Kegel exercises during training.

BMI: Body Mass Index; DSP: Pelvic Floor Dysfunction; POP: Pelvic Organ Prolapse; IF: Fecal incontinence; UI: Urinary incontinence. PFDI: Pelvic Floor Distress Inventory; UDI-6: Urinary Distress Inventory; POPDI-6: Pelvic Organ Prolapse Distress Inventory; CRADI-8: Bowel Dysfunction Scale; ISI: Incontinence Symptoms Index, SUI: Stress Urinary Incontinence; ICIQ-SF: International Consultation on Incontinence Questionnaire – Short Form; POP-Q: POP-Quantification; MVC: Maximal Voluntary Contraction; RM: Maximum Repetition; VRP: vaginal rest pressure; ISSI: Incontinence Symptom Severity Index.

Table 3. Results of studies that compare women practicing CrossFit® with sedentary women.

Authors and year	Characteristics of the participants and physical activity practiced	Evaluation instrument and exercise protocol performed (if any)	Main findings
Machado, *et al.,* 2021	**n = 42 women** (26.6 ± 3.6 years, BMI: 23.7 ± 2.9 kg/m^2) **n = 21 CrossFit practitioners.** (*Minimum* 6 months and 3 sessions/ week à 22 (6-60) months and 4.45 ± 0.8 sessions/week) More menstrual irregularities **n = 21 sedentary women.** (No practice of systematic physical activity for at least 6 months). Increased use of contraceptives	ICIQ-SF Questionnaire (International Consultation on Incontinence Questionnaire – Short Form) (Tamanini, *et al.,* 2004). Assessment (0-5) of a MVC of the pelvic floor by a physiotherapist by means of palpation, following the Modified Oxford Scale (Pereira, *et al.*, 2014). Miotool 400 electromyography (Miotec Equipamentos Biomédicos Ltda, Brazil) with protocol adapted from previous study (Glazer & Hacad, 2012).	Higher prevalence of UI (6 times more) in the group of CrossFit practitioners (P <0.001). 75% of the CrossFit group associated the losses with exercise, specifically in activities that involved jumping (rope, box...) and weightlifting. There were no differences between groups in pelvic floor strength (P >0.05) or electromyographic variables, although MVC from electromyography tended to be higher in the CrossFit group (P = 0.069).

BMI: Body Mass Index; ICIQ-SF: International Consultation on Incontinence Questionnaire–Short Form; MVC: Maximal Voluntary Contraction; UI: Urinary incontinence.

Discussion

The purpose of this study was to conduct a systematic review of the literature to find out if CrossFit® favors PFD to a greater extent than other sports disciplines. Of the seven studies included in the systematic review, six compared the impact of CrossFit® with other disciplines on one or more PFD disorders. However, we will discuss, on the one hand, the studies in which PFD was evaluated using different validated questionnaires and, on the other hand, the studies that evaluate the pelvic floor through direct exploration. In the first group, the results indicate that CrossFit® causes greater stress UI than 1) kickboxing or bootcamp, 2) practicing aerobic exercise and 3) 'no practicing' CrossFit®[12,19,30]. One factor that could influence this result is the higher percentage of vaginal deliveries in the study sample[30], which has been suggested as a risk factor for suffering UI[31-33], although slightly higher UI results (60% *vs*. 40%) have also been observed among participants with a history of vaginal deliveries and nulliparous participants[34]. Another factor previously associated in the literature with greater UI is the higher percentage of postmenopausal participants[19] among CrossFit® practitioners[2,3,13]. Finally, all the reviewed literature indicated greater urine losses in these high-impact exercises: rope jumping, box jumping and running[12-14,19,27-30,32,34]. In contrast to the UI results, female runners were found to have a higher incidence of POP and FI, but not UI, than female CrossFit® practitioners[13], which could suggest that running may be more negative for FI than CrossFit®, although this should be taken with caution to avoid speculation about suggesting that CrossFit® is healthy for the pelvic floor or that running is strictly a cause of anorectal dysfunction[13].

Regarding the studies that evaluated the contraction and relaxation capabilities of the pelvic floor muscles through direct pelvic examination, the results revealed no differences in intra-abdominal pressure and vaginal tone during the same exercises, neither between female CrossFit® and non-CrossFit® practitioners[27], nor between CrossFit® and light exercise practitioners[29]. Interestingly, this lack of differences in PFD between female CrossFit® practitioners and non-practitioners / light exercisers is observed despite the existence of differences between CrossFit® and control groups in BMI or training volume, which are factors traditionally linked to PFD in the literature[3,13,14,19,32,35]. Therefore, it could be thought that this lack of differences between CrossFit® and the control groups in both studies can be attributed to the similarities in terms of the gynecological history of participants' vaginal deliveries, the majority being nulliparous[27,29,] or the fact that, in both studies, more than 30% of participants did not perform pelvic floor strengthening exercises[27,29]. However, the explanation that seems to gain more strength is that the absence of differences between study groups when pelvic floor is evaluated by direct examination instead of using questionnaires is precisely the assessment methodology. This is observed in the only study of the seven that compares female CrossFit® practitioners and sedentary women[28]. This research analyzes both questionnaires and pelvic floor tone by direct examination and electromyography, and revealed a UI up to six times greater in CrossFit® practitioners, but nevertheless, there are no differences in the contraction capacity of the pelvic floor between groups[28]. This could suggest a greater reliability of questionnaires to detect PFD than pelvic examinations, and could explain the greater number of studies that use questionnaires, in addition to the high percentage of women (76%) who, even reporting UI, indicated that they had never received pelvic floor assessment[34]. In fact, despite the presence of eight different questionnaires in the total of seven analyzed studies referring to different PFD symptoms, all of them are based on simple severity scales (none, some, moderate, severe), which seems to guarantee the reliability of the questionnaires as instrument.

Finally, several of the included studies agreed on low percentages of POP, less than 4%, generally observed in all participants[13,14,29,32], although it seems that the prevalence of sexual dysfunction was studied to a much lesser extent. In fact, other research that coincided with the low prevalence of POP yielded an intriguing percentage of 48.7% of participants reporting pain during sexual intercourse[14]. Therefore, sexual dysfunctions should be further explored in future studies, as they may contribute to worsening females' well-being.

Despite addressing a topic of recently increasing attention such as PFD, which seems to underlie a relatively novel and highly practiced

sport modality through a solid methodology, some limitations must be mentioned. There is a great variability in exercise modalities considering the number of studies (7) finally included in the review, which not only impairs the development of a meta-analysis that would provide more robustness, but also the correct interpretation of findings. In fact, of the six studies that compared CrossFit® practitioners with a control group, only two detailed the physical activity carried out by the control group, this activity being running (n = 1) or kickboxing/bootcamp (n = 1). Out of the other six studies, two indicate that the control group was composed of non-CrossFit® practitioners, without specifying whether they performed other types of physical activity, while in two other studies the control group consisted of aerobic exercise practitioners without including details on impact or intensity. Further studies comparing CrossFit® with other exercise modalities should include an accurate description of control group's physical activity practice to reduce heterogeneity and potentially confounding factors. Additionally, other aspects such as the timing of data collection (immediately after training or not), participants' history of vaginal strengthening exercises or the development of strategies to reduce UI before training, such as urinating or reducing water intake, should be carefully described, as they may influence the results[34] and, finally, the consideration of different subtypes of UI and FI may be a key aspect to clarify the findings and facilitate therapists and trainers adjust PFD rehabilitation.

In conclusion, when PFD is assessed through validated questionnaires, CrossFit® seems to cause greater UI than (1) kickboxing and bootcamp, (2) aerobic exercise, (3) not practicing CrossFit® and (4) sedentary lifestyle. In contrast, running seems to trigger more FI than CrossFit®. On the other hand, when the information comes from a direct pelvic examination, no differences are observed between women who practice CrossFit® and 1) women who practice light exercise, 2) women who do not practice CrossFit®, and 3) sedentary women. However, due to methodological differences, the results should be taken with caution and future studies should specify in detail the physical activity practices of the control group, as well as potentially influential factors, such as gynecological history.

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