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# Efficacy of Physical Therapy in the Management of Reproductive Disorders

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## Abstract

Several textbooks and anecdotal reports exist on the management of reproductive disorders by physical therapy (PHT). However, the recommendations from these sources are often not supported by recent empirical outcome evidence. Thus, there is a need for a comprehensive, up-to-date appraisal of the effectiveness of PHT in the management of reproductive disorders. An exhaustive review of the relevant articles published between 1988 and 2019 was undertaken on the primary electronic databases. The search produced 352 “hits,” but only 47 of them met the stated purpose of the review and subsequently classified into nine disease domains. The overwhelming majority (91%) of the 47 articles reviewed found the PHT modalities being investigated to be effective. The credibility of the work ranges from “poor” (for the case reports) to “strong” (for the meta-analysis). The pubococcygeus contraction exercise training (PCET), aka Kegel’s exercise, was the most studied modality, followed by aerobic exercise. Although substantial evidence suggests that PCET and transvaginal electrical stimulation are effective for reducing the symptoms of stress urinary incontinence (UI), the data on adjunctive techniques (EMG biofeedback, and vaginal cones) are less consistent. There is presently no reliable evidence to support the use of PCET in combination with EMG biofeedback and electrical stimulation to relieve overactive bladder and improve sexual function in men. The conflicting findings are because many of the published studies are heterogeneous in methodology with variant time frame follow-up; therefore, making firm conclusion difficult. There is a need for more randomized controlled trials (RCT) with adequate sample sizes and the use of sensitive, reproducible, and valid outcome measures. In conclusion, systematic reviews and meta-analyses are needed to bolster the rationale for recommending PHT in the management of chronic pelvic diseases in women. Similarly, RCT is required to support the recommendation for using PCET, electric stimulation, and EMG biofeedback to treat ejaculatory/orgasmic dysfunction, prostatitis, UI and erectile dysfunction in men. The information in this chapter will be useful to physical therapist students, frontline clinicians, and healthcare policymakers.

**Keywords:** reproductive disorders, obstetrics and gynecology, physical therapy, intervention, efficacy

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## 1. Introduction

Reproductive health is within the purview of obstetrics and gynecology; the clinical specialty that deals with pregnancy, child delivery, and the care of the female reproductive system (breast, vagina, uterus, and ovaries), including the management of the dysfunction of the male prostate and the external structures such as the penis, scrotum, and testicles. Several textbooks [1, 2] and expert opinions [3–12] on the reproductive disorders that are amenable to physical therapy (PHT) intervention have been published previously. However, the recommendations from these sources are often based on clinical opinions and speculations that are not supported by empirically based research. Thus, there is presently a need for a credible reference source that evaluates the literature and provides up to date information on the efficacy of PHT in the management of reproductive disorders in obstetrics and gynecology.

## 2. Review methodology

An exhaustive search of the pertinent literature on the PUBMED, CINAHL and PsycINFO electronic databases was conducted using the primary keywords: reproductive disorders, PHT, intervention, and efficacy. Subsequently, secondary keywords (urinary and fecal incontinence, chronic pelvic inflammatory diseases, postpartum depression, gestational diabetes mellitus, vestibulodynia, dyspareunia, persistent genital arousal disorder, sexual dysfunction, post-mastectomy complications) were selected individually and used in combination with the primary keywords. Following the literature searches, a total of 352 “hits” emerged. The abstract of each literature search output was assessed for their relevance to the review stated goal. Only 47 of the articles met the purpose of the literature review and were classified into nine disease domains, and the pertinent information on each of them presented in **Table 1**. Subsequently, the full articles were read and evaluated for their weaknesses and strengths [13].

**Figure 1** illustrates the credibility rating criteria used to evaluate the 47 articles reviewed. The meta-analysis investigation has the highest credibility and is at the top of the pyramid, while the pre-experimental (case report/series) design has the lowest credibility and is at the bottom of the pyramid. The other research designs (quasi-experimental, randomized controlled trial and systematic review) are in between the apex and base of the pyramid.

In this review, the external validity of the findings from case reports/series are considered “poor,” or “limited” and quasi-experimental (cross-sectional) designs ranked as “fair”, because a cause and effect conclusion cannot be inferred from these two designs as they fail to control for extraneous factors such as history, repeated testing, maturation, selection bias, experimental mortality, instrumentation, and statistical regression [13]. The credibility of the findings from true experimental designs (also known as randomized controlled trials—RCT) is

S./No.	Authors	Year	Physical therapy modalities evaluated <sup>1,2,3,4,5,6,7,8,9,10,11,12</sup>	Gender <sup>13</sup>	Study designs <sup>14</sup>	Outcomes <sup>15</sup>	Finding's credibility
<b>Chronic pelvic inflammatory disease (PID)/salpingo-oophoritis (5 studies—11%)</b>							
1	Balogun and Okonofua	1988	SWD	F	Case report	+	Poor
2	Evseeva et al.	2006	SWD	F	Quasi-experimental	+	Fair
3	Lamina and Hanif	2008	SWD	F	Case series	+	Poor
4	Lamina et al.	2008	SWD	F	RCT	+	Moderate
5	Sonali et al.	2015	SWD/PCET/ADL		RCT	+	Moderate
<b>Urinary and fecal (anal) incontinence (10 studies—22%)</b>							
6	Harvey	2003	PCET	F	Systematic review	—	Substantial
7	McLennan et al.	2006	Knowledge PCET	F	Quasi-experimental	—	Fair
8	Vasconcelos et al.	2006	PCET/EMGB	F	RCT	+	Moderate
9	Kari Bø	2012	PCET	F	Systematic review	+	Substantial
10	Terlikowski et al.	2013	ES/EGMB	F	RCT	+	Moderate
11	Park et al.	2013	PCET	F	Meta-analysis	+	Strong
12	Homsí et al.	2015	PCET	F	Systematic review	+	Substantial
13	Adams et al.	2015	PCET	F	Quasi-experimental	+	Fair
14	Castellani et al.	2016	PCET/ES/EMGB	F	RCT	+	Moderate
15	García-Sánchez et al.	2016	PCET	F	Systematic review		Substantial
16	Liu et al.	2018	ES/EMGB/PCET	F	RCT	+	Moderate
<b>Sexual dysfunction (4 studies—9%)</b>							
17	Brotto et al.	2010	PCET	F	Systematic review	?	Substantial
18	Juraskova et al.	2013	PFRE <sup>4</sup>	F	Quasi-experimental	+	Fair
19	Cohen et al.	2016	PCET	M	Systematic review	+	Substantial
<b>Vestibulodynia and dyspareunia (7 studies—15%)</b>							
20	Bergeron et al.	2002	Manual therapy (stretching), EMGB, ES, PCET <sup>11</sup>	F	Retrospective	+	Fair
21	Murina et al.	2008	TENS	F	RCT	+	Moderate

S./No.	Authors	Year	Physical therapy modalities evaluated <sup>1,2,3,4,5,6,7,8,9,10,11,12</sup>	Gender <sup>13</sup>	Study designs <sup>14</sup>	Outcomes <sup>15</sup>	Finding's credibility
22	Dionisi et al.	2008	EMGB/TENS/ES	F	Quasi-experimental	+	Fair
23	Dionisi and Senatori	2011	PCET/TENS/©DMFSE	F	Quasi-experimental	+	Fair
24	Salvatore et al.	2014	Fractional CO <sub>2</sub> laser therapy <sup>7</sup>	F	Quasi-experimental	+	Fair
25	Davis et al.	2013	PFRE/EMGB <sup>4</sup>	F	Quasi-experimental	+	Fair
26	Brotto et al.	2015	PCET	F	Quasi-experimental	+	Fair
<b>Post-partum depression and obesity prevention (7 studies—15%)</b>							
27	Dennis	2004	Relaxation/massage therapy <sup>9</sup>	NS	Systematic review	—	Substantial
28	Dinas et al.	2011	Aerobic exercise <sup>10</sup>	NS	Systematic review	+	Substantial
29	Josefsson et al.	2014	Aerobic exercise <sup>10</sup>	F	Meta-analysis	+	Strong
30	Kvam et al.	2016	Aerobic exercise <sup>10</sup>	F	Meta-analysis	+	Strong
31	Saligheh et al.	2017	Aerobic exercise <sup>10</sup>	F	Systematic review	+	Substantial
32	Wu et al.	2017	Aerobic exercise <sup>10</sup>	F	Systematic review	+	Substantial
33	Soucy et al.	2017	Aerobic exercise <sup>10</sup>	F	RCT	+	Moderate
<b>Survivors of breast cancer (2 studies—4%)</b>							
34	Juvet et al.	2009	Multimodal—Aerobic exercise <sup>10</sup>	F	Systematic review	+	Substantial
35	Cox et al.	2015	Aerobic exercise <sup>10</sup>	F	Quasi-experimental	+	Fair
<b>Infertility due to adhesive disease (2 studies—4%)</b>							
36	Rice et al.	2015	Manual physical therapy <sup>11</sup>	F	Quasi-experimental	+	Fair
37	Okhowat et al.	2015	Deep relaxation massage <sup>12</sup>	F	Quasi-experimental	+	Fair
<b>Gestational diabetes mellitus prevention (2 studies—4%)</b>							
38	Harrison et al.	2016	Aerobic exercise <sup>10</sup>	F	RCT	+	Moderate
39	Wang et al.	2017	Aerobic exercise <sup>10</sup>	F	RCT	+	Moderate
<b>Mastectomy complications: lymphedema, pain and dermatologic adverse events (7 studies—15%)</b>							
40	Seav et al.	2015	Aerobic exercise <sup>10</sup> /PCET	F	Systematic review	—	Substantial
41	Schmidt et al.	2017	Aerobic exercise <sup>10</sup>	F	RCT	+	Moderate

S./No.	Authors	Year	Physical therapy modalities evaluated <sup>1,2,3,4,5,6,7,8,9,10,11,12</sup>	Gender <sup>13</sup>	Study designs <sup>14</sup>	Outcomes <sup>15</sup>	Finding's credibility
42	Lee	2018	Scrambler therapy <sup>16</sup>	F	Case report	+	Poor
43	Zasadzka et al.	2018	Bandaging & decongestive Rx <sup>17</sup>	M/F	Quasi-experimental	+	Fair
44	Dalenc et al.	2018	Hydrotherapy <sup>18</sup>	F	Quasi-experimental	+	Fair
45	Yeung and Senciw	2018	Hydrotherapy (aquatic vs. land) <sup>18</sup>	F	Systematic review	?	Substantial
46	Duyur et al.	2019	Decongestive therapy <sup>17</sup>	F	Quasi-experimental	+	Fair
47	Panchik et al.	2019	Multimodal— aerobic exercise <sup>10</sup>	F	Meta-analysis	+	Strong

<sup>1</sup>SWD = shortwave diathermy.

<sup>2</sup>EMGB = EMG biofeedback.

<sup>3</sup>PCET = PC exercise (Kegel's) training.

<sup>4</sup>PFRE = pelvic floor muscle relaxation exercise.

<sup>5</sup>ES = electrical stimulation.

<sup>6</sup>TENS = transcutaneous electrical nerve stimulation.

<sup>7</sup>LASER = fractional carbon dioxide laser therapy.

<sup>8</sup>MFSE = Daily myofascial stretching exercises.

<sup>9</sup>Relaxation/massage therapy.

<sup>10</sup>Aerobic exercise.

<sup>11</sup>Manual physical therapy.

<sup>12</sup>Deep relaxation massage.

<sup>13</sup>Gender: F = female, M = male, NR = not reported.

<sup>14</sup>RCT = randomized controlled trial (RCT).

<sup>15</sup>Outcome: + = Effective, - = not effective, ? = unclear.

<sup>16</sup>Scrambler therapy.

<sup>17</sup>Compression bandaging and complex decongestive therapy.

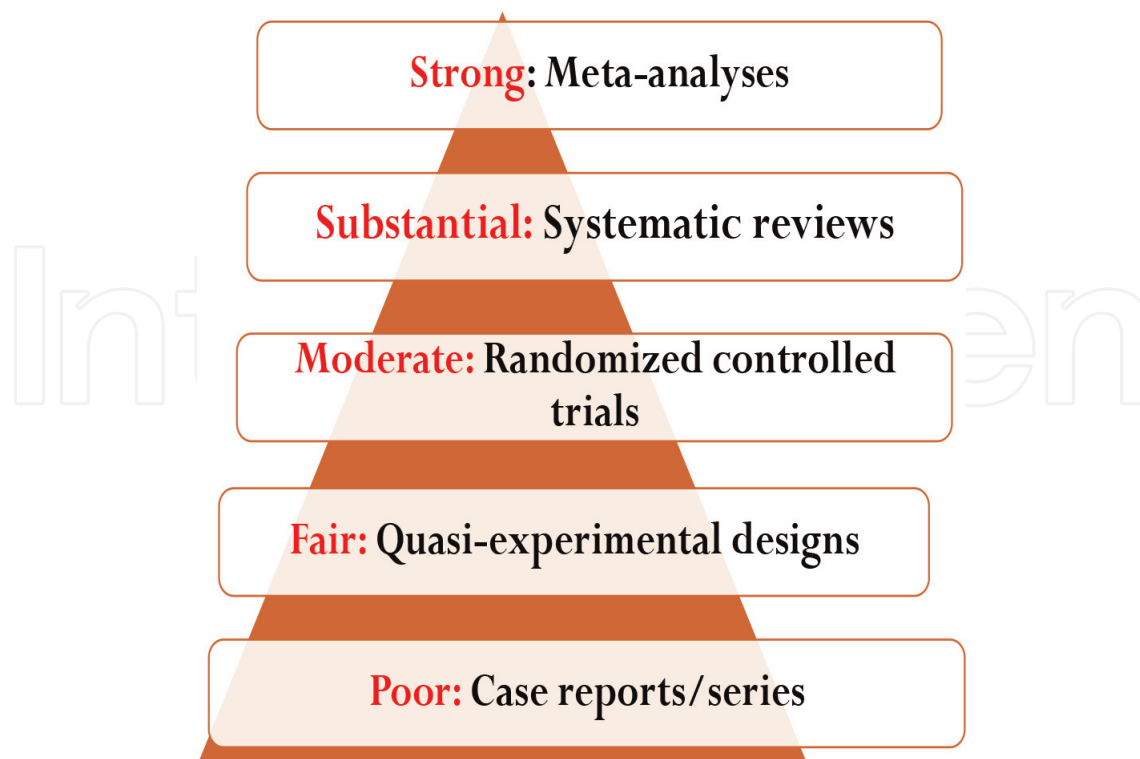
<sup>18</sup>Hydrotherapy.

**Table 1.** The relevant information on the efficacy of physical therapy in the management of reproductive disorders.

considered “moderate”; systematic reviews and meta-analyses as “substantial” and “strong,” respectively. The outcomes from RCT, systematic reviews and meta-analyses eliminate selection and confounding factor biases. Therefore, a cause and effect conclusion can be drawn from them [13].

### 3. Results

All the 47 full length articles reviewed appeared in peer-reviewed journals between 1988 and 2019, and the salient points extracted from them are shown in **Table 1**. Most of the published articles reviewed was a quasi-experimental design. The data for 90% of them were collected from females, less than 4% were from males, and the rest did not specify the gender of the study participants. The most popular area of PHT research in obstetrics and gynecology is urinary and fecal (anal) incontinence (22%), followed by mastectomy complications (sexual



**Figure 1.** Research credibility pyramid.

dysfunction, lymphedema, pain, and dermatologic adverse events) which accounts for 17%. Vestibulodynia and dyspareunia, post-partum depression, and obesity prevention each accounted for 15% of the PHT research. Chronic pelvic inflammatory disease/salpingo-oophoritis represents 11% and sexual dysfunction was 7% of the published research. The least studied area of women's health PHT (4% each) was the physical/psychological well-being of survivors of breast cancer, including infertility, adhesive disease and gestational diabetes mellitus prevention (**Table 1**).

For historiographic and consistency purposes, the review in each of the nine disease domains was organized in sequential order starting from the oldest to the most recent publications. The aim and major findings for each of the 47 investigations are presented below.

### **3.1. Chronic pelvic inflammatory disease/salpingo-oophoritis**

In 1988, Balogun and Okonofua documented the effectiveness of shortwave diathermy (SWD) while treating a 39-year-old black woman with an eight-year history of chronic PID that is non-responsive to conventional antibiotic therapy [14]. SWD is a deep-heating thermal agent that its use has declined in several countries because of its large size and heavy weight but is enjoying a rebirth due to modern technology that now produced a more compact and light-weight product that can be transported easily within the clinic and use in the home setting. A modified "cross-fire" technique at a thermal dosage level was administered (for each half of the crossfire technique treatment) for 20 and 30 min. At baseline, the patient rated her pain perception on a 10-point visual analog pain scale at the beginning of every treatment session.

After eight sessions of SWD treatment, she was utterly pain-free and remained so for 6 months at follow up.

In three case series, Lamina and Hanif [15] replicated the clinical protocol described earlier by Balogun and Okonofua. Two of the patients in this study had their pain score on the visual analog scale reduced from an average of 6.5 to 0 and remain at 0 levels without any medication 4 months later. The third patient had her pain perception reduced from 6 to 4; and on follow up pain score stay at level three while still on antibiotic treatment.

In a quasi-experimental study, Evseeva et al. investigated the effect of a “low-frequency electrostatic field” for treating chronic salpingo-oophoritis. Sixty-three females with the disorder participated in the study; 52 of them received intensive treatment with the electrotherapy device, while the remaining 11 study participants received a sham treatment. They found the participants who received the “low-frequency electrostatic field” treatment observed significant and long-term pain relief for up to 18 months [16].

In a follow-up RCT, Lamina, Hanif and Gagarawa investigated the effect of SWD in the management of the chronic PID [17]. Thirty-two patients diagnosed with the disorder were assigned randomly to three (SWD, control, and analgesic) groups. The SWD group (n = 13) received antibiotics (oral ofloxacin 400 mg twice daily and metronidazole 400 mg twice a day, placebo (sham analgesic) tablets and SWD treatment for 15–20 min on alternate days of the week. The analgesic group (n = 14) received antibiotics, analgesics (nonsteroidal anti-inflammatory drugs—oral ibuprofen 400 mg twice daily, and sham SWD, while the control group (n = 13) received the same dosage of antibiotics, sham SWD, and placebo tablets. The treatment lasted 30 days, and pain perception was monitored pre-and-post-treatment. The baseline (pretest) pain scores among the groups differ significantly ( $F = 4.96$ ,  $p < 0.05$ ). The pre-and-post-treatment difference observed in the severity of pain was statistically significant ( $p < 0.05$ ) among the groups. The mean pain score of the SWD group compared to the control and analgesics groups was significantly reduced.

In 2015, Sonali et al. investigated the efficacy of SWD in the management of pain associated with chronic PID [18]. They randomly assigned 30 women between 18 and 40 years diagnosed with PID into two groups. The women in group one were treated with medication (antibiotics and analgesics), pubococcygeus contraction exercise training (PCET), aka Kegel’s exercise, activities of daily living instruction and SWD. The women in group two received medications, PCET, and activities of daily living instruction, but no SWD. The pre-and-post-intervention visual analog scale and pain disability index were monitored. The result of the investigation showed significant improvement in both outcome measures among the women in group one treated with SWD. The authors concluded that their findings provide a rational basis for recommending SWD instead of analgesics, which often has side effects, during the management of the debilitating pain associated with PID.

In a recent randomized controlled trial, Saif et al. evaluated the effectiveness of SWD and pharmacological agents in the management of the chronic PID [19]. The authors randomly allocated 60 women diagnosed with PID for more than 6 months into three groups; 20 women in each group. The women in group one received both medical (oral doxycycline 100 mg twice



daily and metronidazole 500 mg twice daily for 14 days) treatment and SWD. Those in group two received only SWD treatment, and the third group received only medical treatment. The SWD treatment using the crossfire technique was administered for 20 min (split into two sessions of 10 min per session) every alternate day for a total of 15 sessions. At baseline, the gynecologist clinically examined the women, took a cervix biopsy for laboratory analysis and ultrasonography to detect any underlying pathology. Also, the pain level was measured using a 10-point visual analog scale. Post-treatment, after 14 days of treatment for group 1, and the 5th week session for groups 2 and 3, pain score on the 10-point visual analog scale, laboratory (end cervix swab) specimen was taken to examine the number of WBCs, and ultrasonography was also conducted to detect any improvement in previous pathology, self-report of itching, and discharge. A statistically significant ( $p < .01$ ) improvement in itching and discharge was observed among the women in group one when compared to the women in group three; and insignificant differences was obtained between women in groups two and three ( $p > .05$ ). Compared to the baseline, the result revealed a statistically significant difference ( $p < .01$ ) in the visual analog scale pain rating score in the three groups following treatment. No significant difference was observed in the pain rating score when group one was compared with the other two groups ( $p > .05$ ) and insignificant differences was also observed between groups two and three ( $p > .05$ ). There was a statistically significant ( $p < .01$ ) reduction in the number of pus cells in the cervix swab specimen and reduction of fluid in the Douglas pouch for the women in group one compared to the baseline and the other groups. The authors concluded that the most beneficial therapeutic effect is when SWD was used in combination with medical treatment (analgesics and antibiotics).

### 3.2. Urinary and fecal (anal) incontinence

Harvey investigated the effectiveness of PCET in the prevention of urinary/anal incontinence and prolapse [20]. The major electronic databases were reviewed to identify studies that used prenatal and postpartum PCET. The review yielded 12 investigations on the role of prenatal PCET, which included three RCT which compared PCET for the prevention of UI to controls. Similarly, the authors identified 12 studies that evaluated postpartum PCET for prevention of UI, of which 4 were RCT designs. The author also reviewed five researches that evaluated postpartum PCET for the prevention of anal incontinence; four of the investigations were RCT designs. The analyses revealed that prenatal PCET used in combination with biofeedback does not significantly produce short-term (3 months) decrease in postpartum UI or pelvic floor strength. However, postpartum PCET implemented with vaginal device to provide resistance or feedback, appear to decrease postpartum UI and increase strength. Ongoing reminder and motivational instructions to perform PCET are not effective strategies in preventing postpartum UI. The authors concluded that postpartum PCET does not consistently reduce the incidence of anal incontinence.

A quasi-experimental (cross-sectional) research by McLennan et al. evaluated the knowledge of pregnant women about pelvic floor complications during pregnancy and delivery [21]. A total of 232 women with a mean age of 27 years and the overwhelming majority (85%) had at least grade 12 education participated in the study. A day after delivery, the women completed

a 52-item questionnaire that assesses their knowledge of the information provided during routine antenatal care. The research questionnaire intermixed the pelvic floor and general questions. Forty-six percent of the women in the investigation reported that they did not receive any information on PCET; 51% denied receiving information on episiotomy; 47% on UI; 81% fecal incontinence; 73% change in vaginal caliber; and 85% did not receive any information on neuropathy. Education of pregnant women on all these issues occur less frequently ( $p < .05$ ) than counseling on general pregnancy topics. The authors concluded that instruction of pregnant women about pelvic floor risks is very much lacking and advocated the development of educational materials on the issue.

A prospective study by Vasconcelos et al. randomly allocated 56 women (6–15 years old) with dysfunctional elimination syndrome who are nonresponsive to previous therapies into two groups [22]. Both groups received avoiding and drinking schedule, and instruction on adequate toilet posture reinforced through the maintenance of voiding diaries, and PCET intervention but different training sessions and treatment duration. Group one consists of 26 women who received 24 training sessions over 3 months, and Group two which comprised of 30 women also received 16 training sessions of EMG biofeedback therapy offered over 2 months period. Outcome measures (millivoltage recordings of the pelvic floor muscles (PFM) and postvoiding residual urine monitored by dynamic ultrasonography) were monitored at pre-intervention, 1, 6, and 12 months post-intervention time frames. Renal ultrasonography and dynamic ultrasonography were conducted in both groups before and 6 months after the intervention. The data analysis revealed the improvement of urinary continence following training in both groups. Only the patients in group two who received biofeedback training showed a significant decrease in postvoiding residual urine. The authors concluded that their results show that both PCET and biofeedback training modulated episodic UI and urinary tract infection and recommended follow up studies to identify the optimal training parameters, treatment frequency, and duration.

In 2012, Kari Bø analyzed the results of RCT published in English language in the Cochrane reviews. The study reviewed investigated the effectiveness of using PCET to treat stress UI, pelvic organ prolapses, and sexual dysfunction [23]. The author reported Level 1 evidence that PCET is useful in the treatment of stress UI with short-term cure rates between 35 and 80%. Five RCT showed a significant effect of PCET on either pelvic organ prolapse stage, symptoms or PC muscle morphology. The authors found that supervised and more intensive training is more effective than unsupervised training and no adverse effects were reported. None of the RCT addressed the impact of PCET on sexual dysfunction. Based on the findings in the study, the author recommended that PCET should be the first option treatment to manage stress UI and pelvic organ prolapse. The authors cautioned that PCET needs proper instruction and close follow-up for the intervention to be effective.

Using a double-blind, placebo-controlled, randomized design, Terlikowski et al. compared the efficacy of PHT (electrical stimulation and EMG biofeedback) in the treatment of urodynamic stress UI in premenopausal women [24]. The investigators allocated 102 women with stress UI into two groups. Group one ( $n = 68$ ) received the PHT treatment ( $n = 68$ ), and group two received a sham or placebo ( $n = 34$ ) treatment. Both groups had their treatment administered two times

per day for 8 weeks. Urinary leakage measured by the standard pad test, voiding diary, urodynamic analysis, and the Incontinence Quality of Life Questionnaire were monitored at three-time frames; before treatment (at baseline), after the intervention (at 8th week) and at 16th weeks follow-up. At the end of the 8th week, the mean urinary leakage was significantly ( $p < .0001$ ) lower in group one (PHT) than the placebo group ( $19.5 \pm 13.6$  vs.  $39.8 \pm 28.5$ ). The mean urinary leakage was significantly ( $p < .0001$ ) reduced in group one (PHT) compared to the placebo group at the end of 8th and 16th weeks ( $8.2 \pm 14.8$  vs.  $14.6 \pm 18.9$  and  $6.1 \pm 11.4$  vs.  $18.2 \pm 20.8$ ), respectively. Similarly, there was a statistically significant ( $p < .0001$ ) improvement in muscle strength, as measured by the Oxford scale, in group one (PHT) compared to the placebo group after 8 and 16 weeks ( $4.2$  vs.  $2.6$  and  $4.1$  vs.  $2.7$ ), respectively. The urodynamic data for the two groups were not statistically different ( $p > .05$ ) at baseline and after treatment. The mean Incontinence Quality of Life Questionnaire score at the end of 8th week, for group one (PHT) compared to the placebo group, was  $78.2 \pm 17.9$  vs.  $55.9 \pm 14.2$  ( $p < .0004$ ), respectively, and at the end of the 16th week was  $80.8 \pm 24.1$  vs.  $50.6 \pm 14.9$  ( $p < .0001$ ), respectively. The authors concluded that the combination of electrical stimulation and EMG biofeedback modalities is efficacious in the treatment of premenopausal women's stress UI.

A meta-analysis by Park et al. evaluated published RCT of low-risk obstetric women who received PCET during pregnancy and after delivery to determine whether the training could prevent urinary and fecal incontinence [25]. The authors analyzed articles with high methodological quality published between 1966 and 2012 in the major electronic databases that met the study criteria ( $n = 14$ ). The meta-analysis of the 14 investigations reviewed included 6454 women, and the result revealed that PCET significantly reduced the development of urinary and fecal incontinence from pregnancy to postpartum.

In 2015, Homsy et al. reviewed the literature on the effects of PFM training on women sexual function using the six major electronic databases for RCT published between 1997 and 2014 [26]. Eight of the RCT met the study criteria, and 1341 women were included in the review. The studies methodological scores range between four and seven and most of them reported a significant improvement in sexual function score after PCET between control and intervention groups. Most of the investigations reviewed found an increase of at least one sexual variable among women with pelvic floor dysfunction, and one study found an improvement in sexual function in women with postpartum selected independently of their continence status.

In a quasi-experimental cohort study, Adams et al. investigated the effectiveness of PCET as primary treatment of women urinary urgency and frequency symptoms [27]. The women ( $n = 36$  out of 57) who met the study inclusion criteria completed 10 weeks of PCET once or twice per week for 10 weeks and symptom assessed by a Pelvic Floor Distress Inventory and Global Patient Impression of Improvement survey, voiding diaries, and subjective measures. At baseline, the women median Pelvic Floor Distress Inventory score was 79.2 (IQR, 53.1–122.9), and decreased to 50.0 (IQR, 25.0–88.5;  $p < 0.001$ ) following PCET; both the urinary and prolapse symptom subscale score on the Pelvic Floor Distress Inventory decreased significantly (from a median of 10.0 voids per day to 8.0 ( $p < 0.001$ )). About 63% of the women reported that they were “much better” or “very much better” on the Patient Global Impression of Improvement survey. The authors concluded that PCET supplemented with myofascial

release techniques improves urinary symptoms in the absence of medications and more invasive therapies. The high dropout rates suggest that motivation and logistic factors are needed to ensure the utilization and success of PCET.

A RCT by Castellani et al. compared the relative effectiveness of the combination of PHT (PCET, electrical stimulation, and EMG biofeedback) with medication (intravaginal estriol) to treat the stress UI of postmenopausal women [28]. Sixty-two women diagnosed with the disorder were allocated randomly into two groups. Group one received PHT, and group two received PHT in addition to medication (1 mg intravaginal estriol) for 6 months. Baseline outcome measures were taken at the beginning of the study and 6 months at the end of the study. Pelvic examination, urodynamics, and 24-hour pad tests were also monitored. Urinary incontinence was assessed using the Short Form of the International Consultation on Incontinence questionnaire, and the women's quality of life measured by the Short Form of the Incontinence Impact Questionnaire. At the end of the study, three of the 62 women enrolled in the study dropped out. In Group one, the mean urine leakage decreased from  $42.3 \pm 20.2$  g/die to  $31.5 \pm 14.2$  g/die. And in Group two, the mean urine leakage also decreased from  $48.3 \pm 19.8$  g/die to  $22.3 \pm 10.1$  g/die. The symptoms scores and incontinence status in Group two were significantly better than Group one. The authors concluded that the combination of intravaginal estriol and PHT intervention is a safe and efficient first-line treatment in postmenopausal women with stress UI.

In 2016, García-Sánchez et al. analyzed published work on the effectiveness of PCET in the management of UI [29]. They reviewed the major electronic databases published in Spanish and English over a 10-year period that met the study criteria. Overall, nine full articles and one abstract were reviewed; three of the articles were on UI in female athletes and six on UI in women in general. The nine studies reported an improvement in the disease. The authors concluded that PCET is effective in the management of stress UI.

In a RCT, Liu et al. investigated the efficacy of different treatment methods on stress UI among perimenopausal women [30]. They allocated 72 menopausal women with stress UI into three groups with 24 women in each group. Group one received electrical stimulation treatment combined with biofeedback. Group two received PCET and the women in group three did not receive any treatment (control group). The outcome measures tracked at baseline and after 60-days include clinical parameters of urination, PFM strengths, urine dynamics indexes and Quality of Life Survey scores. Although the women in both groups showed statistically significant ( $p < 0.01$ ) improvement in their UI, PFM strength, leakage times, frequency of urination, urine dynamics index and Quality of Life Survey scores ( $P < 0.05$ ) after 60 days treatment, but the women in group one showed the most significant improvement. The women in the control group showed no significant difference ( $p > 0.05$ ) between the baseline and the post-training 60-day time frame. The authors concluded that both electrical stimulation treatment combined with biofeedback, and PCET could prevent stress UI in perimenopausal women.

### **3.3. Sexual dysfunction**

In 2010, Brotto et al. reviewed the literature over a 7 year period on women's sexual dysfunctions, their diagnostic issues, pathophysiology, assessment, and treatment [31]. They examined

the primary research databases, conference proceedings, and lay articles in the press using the keywords of hypoactive sexual desire disorder, female sexual arousal disorder, female orgasmic disorder, and persistent genital arousal disorder. Following the review, the authors recommended assessment of women's sexual dysfunctions using the biopsychosocial clinical interview of the woman and partner (if possible); followed by a physical and psychophysiological examination, patient self-report questionnaires to supplement the interview information and laboratory investigations. At the time when the study was being implemented in the USA, some promising drugs for treating women's sexual dysfunction were undergoing clinical trials. Empirical evidence demonstrating the efficacy of PHT and psychological therapies for women's sexual dysfunction is presently limited. Thus, there is the need for RCT to evaluate the effectiveness of the different treatments recommended to treat women's sexual dysfunction.

A quasi-experimental study by Juraskova et al. evaluated the acceptability, feasibility, and efficacy of using olive oil, vaginal exercise, and moisturize (OVEM)—a polycarbophil-based vaginal moisturizer—to treat sexual dysfunction associated with breast cancer treatment [32]. Twenty-five women with dyspareunia received PHT (PFM relaxation exercises) twice/day for 4 weeks to prevent/manage PFM overactivity. The women were also instructed to apply the OVEM thrice per week to decrease vaginal dryness, use olive oil as a lubricant during sexual intercourse, and complete a weekly compliance diary. During the study, dyspareunia, sexual functioning, quality of life, distress, and PFM functioning were monitored. The outcome measures were tracked at the beginning of the study and the end of the training (fourth week) and at 12 and 26 weeks follow-ups. Each week during the study, the women completed a self-report questionnaire, and the physical therapist recorded objective measures of PFM functioning. The study found significant improvement in dyspareunia, sexual function, and quality of life of the women over time ( $p < 0.001$ ) following the OVEM intervention. The PFM relaxation training also improved dyspareunia, sexual function, and quality of life of the women ( $p < 0.001$ ). The maximum improvements occurred at week 12 follow-up time frame. Most of the women in the study rated PHT (92%), vaginal moisturizer (88%), and olive oil (73%) as helpful and acceptable. Paradoxically, six of the women (11%) had vaginal stenosis during the initial screening, which further confirms the underreporting of sexual problems following breast cancer. The authors concluded that the novel OVEM intervention is acceptable, feasible in a clinical setting and effective in improving dyspareunia and sexual function following breast cancer.

In a systematic review, Seav et al. in 2015 compared the findings of RCT and observational studies on the sexual functioning of women who survived breast cancer [33]. The authors identified 1414 investigations, but only 34 of them met the defined study criteria that used vaginal lubricants (moisturizers, estrogens, dehydroepiandrosterone, testosterone, vibrators, dilators), systemic medications (androgens, anti-depressants, flibanserin, ospemifene), PHT (physical activity, pelvic floor training), counseling and educational interventions on sexual functioning of women with breast cancer. The findings revealed that vaginal moisturizers were effective in improving vaginal dryness, dyspareunia, and sexual satisfaction; educational and counseling interventions showed improvement in various aspects of sexual health. Physical activity, transdermal testosterone or hot flash interventions did not consistently improve the sexual health of the women.

In 2016, Cohen et al., in a systematic review study, evaluated the effect of PCET in the management of male sexual dysfunctions, including erectile dysfunction, ejaculatory/orgasmic dysfunction, prostatitis and chronic pelvic pain syndrome [34]. The authors concluded that PCET is of potential therapeutic benefit for men who suffer from these conditions.

### 3.4. Vestibulodynia and dyspareunia

In 2002, Bergeron et al. conducted a retrospective study on the effectiveness of PHT (in the form of manual techniques such as stretching, electromyographic biofeedback, electrical stimulation, and PCET home exercises) in improving sexual function and relieving painful intercourse associated with vulvar vestibulitis [35]. Thirty-five women diagnosed with vulvar vestibulitis who received PHT for an average of seven sessions were interviewed on the phone to determine whether PHT or other subsequent treatments had any effect on their pain perception during intercourse and sexual functioning. The length of treatment follow up ranged from 2 to 44 months with a mean of 16 months. Following PHT intervention, 51% of the women in the study showed complete or significant improvement; 20% of them experienced a moderate increase, and 29% observed little to no improvement. The PHT intervention resulted in a significant decrease in pain perception both during intercourse and gynecological examinations; including a substantial increase in the frequency of sex and levels of sexual desire and arousal. The women with favorable outcomes were significantly less educated than those with unfavorable results. The overall findings revealed that dyspareunia associated with vulvar vestibulitis could potentially be managed successfully by PHT.

A double-arm randomized placebo-controlled study by Murina et al. investigated the efficacy of transcutaneous electrical nerve stimulation (TENS) in the treatment of vestibulodynia [36]. Forty women with vestibulodynia were randomly allocated into two groups—active TENS group and sham (placebo) group and each group were treated twice a week for a total of 20 treatment sessions—the treatment with TENS or sham was delivered through a vaginal probe. The outcome measures tracked at baseline, at the end of treatment and 3 months follow up were visual analog scale, the short form of the McGill-Mailsack Pain Questionnaire, the Female Sexual Function Index Questionnaire and the Marinoff Scale for dyspareunia. The baseline visual analog scale and McGill-Melzack Pain Questionnaire scores ( $6.2 \pm 1.9$  and  $19.5 \pm 11.9$ ) significantly decreased (improved) in the TENS group ( $2.1 \pm 2.7$ ,  $p = 0.01$ ) compared to the placebo group ( $8.5 \pm 10.7$ ,  $p = 0.001$ ), respectively. Similarly, the Marinoff dyspareunia scale and the Female Sexual Function Index improved significantly. However, no improvement occurred in the placebo group. The authors concluded that TENS is a simple, effective, safe short-term (3 months) treatment for vestibulodynia.

A quasi-experimental study by Dionisi et al. evaluated the safety, tolerability, and efficacy of a multimodal PHT intervention in the treatment of vulvar pain and vulvar discomfort in women with vulvodinia [37]. One hundred and forty-five women diagnosed with vulvodinia were treated weekly for a total of 10 sessions with EMG biofeedback, TENS, in association with functional electrical stimulation using an intravaginal probe for the treatment, and home program stretching exercise of the PFM. An improvement (decrease) in vulvar pain occurred in 76% of the cases. The authors concluded that the relaxation of the PFM with biofeedback

and electroanalgesia is safe and effective in modulating the vulvar pain and dyspareunia in women with vulvodynia.

Another quasi-experimental study conducted by Dionisi and Senatori determined the safety and effectiveness of using intravaginal electrodes TENS for the treatment of vulvar pain and dyspareunia during the postpartum period following perineal trauma caused by episiotomy [38]. Forty-five women with a diagnosis of postpartum dyspareunia from perineal trauma after a vaginal delivery training on how to use the PFM. Also, they were educated on the role of PFM in continuing dyspareunia. Subsequently, they received weekly intravaginal TENS treatment in an outpatient clinic in addition to daily home program myofascial stretching and PCET. Outcome measurements obtained before training (baseline), at the end of the 5th week and 8 months post-training includes the cotton swab test, the Visual Analog Scale, the Marinoff Dyspareunia Scale, and the Anovulvar Distance. The overwhelming majority (85%) of the sample reported an improvement of dyspareunia after five sessions of TENS, and 95% of the women had full remission of the symptoms. All the women were utterly pain-free 8 months following the treatment. The authors concluded that intravaginally applied TENS and pelvic floor relaxation exercises is safe and effective in the relief of vulvar pain and dyspareunia after spontaneous delivery in women with postpartum perineal trauma due to episiorrhaphy.

In 2014, Salvatore et al. conducted a quasi-experimental study to evaluate the efficacy and feasibility of treating vulvovaginal atrophy in postmenopausal women using a fractional carbon dioxide laser therapy [39]. Fifty women (mean age = 59.6; SD = 5.8 years) diagnosed with vulvovaginal atrophy symptoms and who are dissatisfied with previous local estrogen therapies were treated with laser therapy for three sessions over 12 weeks. The women's subjective pain was monitored using the visual analog scale and objectively using the Vaginal Health Index Score inventory; quality of life measured with the SF-12 Standardized Questionnaire at baseline and 12 weeks later. Compared to the baseline measurements, the vulvovaginal atrophy symptoms (vaginal dryness, vaginal burning, vaginal itching, dyspareunia, dysuria), the Vaginal Health Index Score (mean = 13.1; SD = 2.5 at baseline vs. mean = 23.1; SD = 1.9), the physical and mental scores and qualities of life of the women following the laser treatment improved significantly ( $p < 0.001$ ) at the end of the 12-weeks. Eighty-four percent of the women were satisfied with the laser treatment. However, the women reported minimal discomfort at the first fractional carbon dioxide laser application due to the insertion and the movements of the probe. Subsequent treatment from the second application in week four was straightforward to perform in all the women, and no other untoward adverse event recorded during the study. The authors concluded that randomized RCT are needed to confirm the long-term benefits of fractional carbon dioxide laser therapy on vaginal morphology.

A quasi-experimental study by Davis et al. evaluated the changes in pain, depressive symptoms, and sexual outcomes in women with vestibulodynia following PHT (PFM relaxation exercise, EMG biofeedback), sex/psychotherapy, and medical intervention and controls [40]. Two hundred and thirty-nine women with provoked vestibulodynia completed a questionnaire at baseline and 2 years follow up. The questionnaire subscales measured the visual analog scale of genital pain, Global Measure of Sexual Satisfaction, Female Sexual Function

Index, Beck Depression Inventory, Dyadic Adjustment Scale, and sexual intercourse attempts over the past month. The results overall revealed significant improvement on pain ratings, sexual satisfaction and function, and depressive symptoms 2 years post-test. Most of the women received PHT, sex/psychotherapy, and medical treatment; 41% of them did not receive any treatment but improved significantly on pain ratings. None of the single treatment types provided better outcome on any of the outcome measures monitored except depressive symptoms on which women who had surgery were more likely to improve. This study did not demonstrate the superiority of any one treatment over the other and the improvements in the symptoms of vestibulodynia was attributed to natural progression.

A quasi-experimental study by Brotto et al. investigated the efficacy of a multimodal treatment consisting of psychological skills training, PCET and medication management of provoked vestibulodynia [41]. Women ( $n = 132$ ) with provoked vestibulodynia received the hospital-based treatment for 10-weeks. Of the 132 women, 116 (mean = 28; SD = 7.1 years) provided complete data following the 10 weeks treatment, and 84 women had full data 3–4 months post-test period. At baseline, 38% of the women avoided intimacy, 41% avoided sexual while 50% choose to focus on their partner's sexual arousal and satisfaction. Post-treatment, 54% of the women reported significant improvements in dyspareunia with strong significant effects for the reduction in dyspareunia, sex-related distress, increase sexual arousal and overall sexual functioning ( $p < 0.001$ ). Statistically significant improvements in sexual desire, lubrication, orgasmic function, and sexual satisfaction were observed ( $p < 0.05$ ). Two to three-months post-treatment, all the improvements were still retained. The authors concluded that their study provided strong evidence for the use of multidisciplinary approach in the management of the dyspareunia and sexual dysfunctions experienced by women with provoked vestibulodynia.

### **3.5. Post-partum depression and obesity prevention**

In 2004, Dennis systematically reviewed the major electronic databases from 1966 to 2003 to evaluate the treatment of postpartum depression by non-pharmacological methods [42]. Published studies ( $n = 21$ ) on interpersonal psychotherapy, cognitive-behavioral therapy, peer and partner support, nondirective counseling, relaxation/massage therapy, infant sleep interventions, infant-mother relationship therapy, and maternal exercise that met the set inclusion criteria were analyzed. The author concluded that he could not ascertain the relative effectiveness of most of the non-pharmacological treatments because of weak and disparate experimental design issues.

Dinas et al. reviewed the publications that investigated the effects of aerobic exercise therapy on acute and chronic depression [43]. The screening criteria used covered several topics such as the "treatment of depression, the link between  $\beta$ -endorphin and exercise, the efficacy of exercise and physical activity as treatments for depression, properties of exercise stimuli used in intervention programs, as well as the efficacy of exercise and physical activity for treating depression in diseased individuals." The result of the analysis revealed that aerobic exercise has salutary effects on depression symptoms; the effects are comparable to those obtained using antidepressant treatments.



A meta-analysis study by Josefsson et al. compared the relative effectiveness of aerobic exercise with no intervention, placebo, and usual care conditions in reducing symptoms of depression among clinically defined adults with depression [44]. After reviewing the major electronic databases, the authors identified 89 articles, but only 15 of them met the inclusion criteria, and 13 reported relevant information needed to calculate effect sizes. The main result showed a significantly large overall effect that favored aerobic exercise intervention. The effect size was even more significant when only designs that had used no intervention or placebo conditions were analyzed. Nevertheless, the effect size was reduced to a moderate level when only the research with high methodological quality were included in the analysis. The authors recommended aerobic exercise therapy for patients with mild to moderate depression who are motivated, and physically healthy to participate in such a program.

Kvam et al. conducted a meta-analysis of RCT published until November 2014 that examined the effectiveness of aerobic exercise in the treatment of unipolar depression, both as an independent and as a combination intervention to antidepressant medication [45]. A total of 23 articles with 977 participants, met the study criteria. The analyses revealed that aerobic exercise had a moderate to a large significant effect on depression score compared to control conditions ( $g = -0.68$ ), but the change was small and not significant at follow-up ( $g = -0.22$ ). Compared to the control group, the aerobic exercise group had a large and significant effect size ( $g = -1.24$ ), and exercise training had a moderate and significant effect compared to usual conventional care ( $g = -0.48$ ). The impact of aerobic exercise was small and not significant when compared to psychological treatment or antidepressant medication ( $g = -0.22$  and  $-0.08$ , respectively). When aerobic exercise was implemented as an adjunct to antidepressant medication, they yielded a moderate effect ( $g = -0.50$ ) that trended toward statistical significance. The authors concluded that aerobic exercise is an effective treatment for the management of depression, and it is as viable as an adjunct treatment in combination with antidepressants.

A systematic review study by Saligheh et al. evaluated the effectiveness of aerobic exercise on postnatal depression and weight loss. Following data searches of the six major electronic databases, nine of the studies met the stated inclusion criteria [46]. The articles reviewed implemented different exercise therapy modalities (commonly walking), and they incorporated different support strategies to enhance adherence. Two (22%) of the nine studies identified changes in both postnatal depression and weight loss outcomes with small effect sizes. Four of the research (44%) reported a decrease in postnatal depression with variable effect sizes, while three of them (33%) reported no effect. The exercise therapy most likely to reduce postnatal depression and weight loss are those that employ one on one weekly supervision at moderate intensity level and adhered to specific intervention guidelines for over 12 weeks and supplemented by psychosocial strategies such as educational information, advice on exercise therapy, and counseling.

Wu et al. analyzed the English language publications that investigated the effects of physical activity on depressive symptoms in Parkinson disease in the major electronic databases from January 2006 to June 2017 [47]. The authors analyzed 11 of the 769 abstracts that met the eligibility screening criteria and awarded better quality scores ranging from 3 to 8 by the raters.

The research included 342 patients that underwent 17 different kinds of physical activity programs. The results revealed that aerobic exercise training significantly improved the cumulative Parkinson's Disease Rating, Beck Depression Inventory, and the Quality of Life subscale scores. Qigong exercise improved the overall Unified Parkinson's Disease Rating Scale score and decreased incidences of multiple non-motor symptoms and depression. Tai Chi exercises enhanced the postural stability and Quality of Life of the patients.

In 2017, Soucy et al. conducted a RCT to determine the effectiveness of behavioral and aerobic exercise interventions for treating depression [48]. Fifty-nine women with a diagnosis of mild-to-moderate symptoms of depression were assigned randomly to either a behavioral therapy (n = 20), aerobic exercise (n = 19) or a wait-listed control group (n = 20). At pretest, mid-test, immediate post-intervention, and at two-month follow-up time frames, all the women recorded their symptoms. The results revealed that both behavioral and aerobic exercise interventions were significantly more effective in reducing depressive symptoms compared to the control group. The aerobic exercise therapy program significantly involved less treatment time compared to the behavioral therapy program (half the amount of time). The authors concluded that both physical activity at the low-intensity level and behavioral therapy effectively reduce depressive symptoms.

### **3.6. Survivors of breast cancer in cancer rehabilitation**

A systematic review by Juvet et al. evaluated the efficacy of single treatments and the combination of therapies (e.g., rehabilitation programs) on the physical performance and psychological well-being of women following breast cancer treatment [49]. A total of 46 RCT of moderate or high quality were reviewed; seven of the articles were on PHT, 11 examined different types of physical activity, 18 assessed different psychosocial interventions, two of the research were on nutrition, five examined complementary interventions, and three were on a complex rehabilitation program. The research on physical activity showed improved quality of life and decrease fatigue. Three of the investigation revealed that early physical activity was not associated with aggravated lymphedema. Four of the studies showed that cognitive behavior therapy intervention also improved overall quality of life. Based on the findings, the combination of therapies effect cannot be delineated clearly. The authors concluded that there is limited documentation in favor of the efficacy of different rehabilitation interventions for women with breast cancer.

A study by Cox et al. investigated the temporal relationships between several social-cognitive theory constructs and aerobic exercise (physical activity) among women with endometrial cancer receiving aerobic exercise training at four different time frames (T1–T4) [50]. The sedentary women (n = 98) who were at least 6 months posttreatment after endometrial cancer underwent physical activity intervention. The findings revealed that physiological somatic sensations at T2 decreased, self-efficacy at T3 increased, which led to an increase in physical activity at the T4 time frame. The authors posited that self-efficacy is a significant mediator between physiological somatic sensations and physical activity. They concluded that physiological somatic sensations are an important construct that can be used to promote increased physical activity; self-efficacy mediates the relationship between physiological somatic sensations and physical activity, but the timing of the relationship warrants follow-up investigation.

### 3.7. Infertility due to adhesive disease

A quasi-experimental (retrospective) study by Rice et al. investigated the effectiveness of manual PHT in the management of infertile women with an underlying adhesive disease [51]. The study reviewed the records of 1392 women with diagnoses of infertility, including occluded fallopian tubes, hormonal dysfunction, endometriosis, and those undergoing in vitro fertilization treated at a private PHT practice. All the women had whole-body, patient-centered treatments using manual PHT that focused on restoring mobility and motility to structures affecting reproductive function. Study outcomes measured tubal patency, hormone levels, and pregnancy. The findings revealed a 61% rate of clearing occluded fallopian tubes and a 57% rate of pregnancy. The women with endometriosis had a 43% pregnancy rate. Among women with hormonal dysfunction, the success rate was 49% for lowering elevated levels of follicle stimulating hormone, with a 39% pregnancy rate; and 54% of the women with polycystic ovarian syndrome became pregnant. A 57% pregnancy rate occurred among women who underwent in vitro fertilization after the manual PHT. The authors concluded that manual therapy is an “effective, conservative treatment for women diagnosed as infertile due to mechanical causes, independent of the specific etiology.”

Another quasi-experimental (retrospective) study by Okhowat et al. assessed the effectiveness of a deep relaxation massage therapy on invitro fertilization cryo-cycles [52]. Women (n = 267) who received vitrified and warmed blastocysts transfer before embryo transfer participated in the study. The intervention group received a 30-min deep relaxation massage with an oscillating (vibrating) device applied before embryo transfer while the control group did not. The women in the massage therapy group significantly had higher pregnancy rates (58.9% vs. 41.7%,  $p < .05$ ), ongoing pregnancies (53.6% vs. 33.2%,  $p < .01$ ), and birth rates (32.0% vs. 20.3%,  $p < .05$ ) than those in the control group. The women’s ages, hormonal substitution protocols, endometrium structures and buildups, quality of transferred embryos, or quality of transfers were not significantly different between the two groups, and no adverse effects occurred in the women who received massage therapy. The authors concluded that receiving massage therapy before blastocyst transfer in a cryo-cycle improves embryo implantation and recommended the use of massage therapy as adjunctive treatment in assisted reproductive technology. The positive outcome was attributed to the reduction in stress level and in uterine contractions, and improvement of blood flow in the abdominal region.

### 3.8. Gestational diabetes mellitus prevention

A RCT by Harrison et al. investigated the optimal gestational weight gain during early pregnancy among women with higher risk pregnancies [53]. The authors assigned pregnant women (n = 228) at risk of developing gestational diabetes mellitus but receiving standard maternal care to a control (written health information only) or an aerobic exercise program. At 12–15 and 26–28-weeks’ gestation period, the women’s anthropometric (weight and height), physical activity level (pedometer and International Physical Activity Questionnaire score), risk perception and gestational diabetes mellitus status were monitored. The age and body mass index of the control and intervention groups were similar. At 28 weeks, the gestational weight gain for the control and intervention groups ( $6.9 \pm 3.3$  vs.  $6.0 \pm 2.8$  kg) was significantly

( $p < 0.05$ ) different. When the baseline body mass index was stratified, the overweight women in the control group significantly ( $p < 0.05$ ) gained more weight than the overweight women in the intervention group ( $7.8 \pm 3.4$  vs.  $6.0 \pm 2.2$  kg); yet in women who are obese, the gestational weight gain was similar in both the control and intervention groups. The physical activity levels declined by the 28 weeks gestation ( $p < 0.01$ ); while the intervention group maintained a 20% higher step count ( $p < 0.05$ ) when compared to the control group ( $5203 \pm 3368$  vs.  $4140 \pm 2420$  steps/day). Overall, the gestational diabetes mellitus prevalence rate was 22.8%, with a trend toward fewer cases in the intervention group ( $p > .05$ ). The authors concluded that a low-intensity aerobic exercise program combined with antenatal care promotes healthy gestational weight gain and modulates physical activity decline during early pregnancy. Efficacy in limiting weight gain was highest among women who are overweight and in high-risk women who are ethnically diverse.

A recent RCT by Wang et al. investigated the effects of aerobic exercise on the incidence of gestational diabetes mellitus among pregnant women who are overweight or obese [54]. Singleton women ( $n = 300$ ) at 10 weeks' gestational age with a pre-pregnancy body mass index of  $26.8 \pm 2.75$  kg/m<sup>2</sup> were assigned randomly to either aerobic exercise or a control group. The women in the exercise group ( $n = 150$ ) were trained on a cycling ergometer three times per week (at least 30 min/session with a rating of perceived exertion intensity between 12 and 14), while the women in the control group ( $n = 150$ ) continued their routine daily activities until 37 weeks of gestation. The women in both groups had standard prenatal care. The women in the exercise group had a significantly lower incidence of gestational diabetes mellitus (22% vs. 41%;  $p < .001$ ), fewer gestational weight gain by 25 gestational weeks ( $4.1 \pm 3.0$  vs.  $5.9 \pm 2.58$  kg;  $p < .001$ ) and at the end of pregnancy ( $8.4 \pm 3.65$  vs.  $10.5 \pm 3.33$  kg;  $p < .001$ ), and reduced insulin resistance levels ( $2.9 \pm 1.27$  vs.  $3.4 \pm 2.00$ ;  $p < .05$ ) at 25 gestational weeks. The aerobic exercise program did not increase the risk of preterm birth nor reduced the mean gestational age at birth.

### **3.9. Mastectomy complications: lymphedema, pain, and dermatologic adverse events**

A RCT by Schmidt et al. investigated the safety and effectiveness of arm crank ergometry in women with lymphedema after axillary lymph node dissection [55]. The women were trained for 12 weeks on the arm crank ergometer twice weekly, and their bioelectrical impedance, arm circumference, muscular strength, quality of life and fatigue were measured and compared with women who received the usual care. The lean body mass and skeletal muscle mass increased and the body fat decreased significantly in the women who trained on the arm crank ergometer. In both groups, the armpit circumference increased substantially during the training period; the increase was higher in the usual care group than the arm crank ergometer group. Similarly, the circumferential measurements obtained in the other regions of the arm decreased significantly in both groups. In both groups, the muscular strength of the upper extremity increased dramatically, with a higher gain obtained in the arm crank ergometer group. The physical functioning, general fatigue and physical fatigue of the women in the arm crank ergometer group improved significantly. In both groups, the investigators found a trend toward improvement in the quality of life, but the gain is not statistically significant. Based on the results, the authors recommended arm crank ergometer training for women with

breast cancer following axillary lymph node dissection with the therapeutic goal to improve upper extremity muscle strength, quality of life and reduced arm symptoms.

In 2018, Lee evaluated the effect of Scrambler Therapy (an electrotherapy device use for pain modulation) on the symptoms experienced following breast cancer surgery [56]. A 39-year-old woman after mastectomy had pain and lymphedema of the right upper extremity. She was treated with scrambler therapy for 45 min once a day for 10 days. After 10 sessions of the treatment, the patient pain perception reduced by 6 points on a visual analog pain scale. The patient arm circumference and bioimpedance measurements remained unchanged after 10 treatment sessions. The author concluded that Scrambler Therapy “reduced pain without increased lymphedema.”

A quasi-experimental study by Zasadzka et al. in 2018 compared the relative effectiveness of multi-layer compression bandaging and complex decongestive therapy in the treatment of lymphedema [57]. Elderly patients (85 women and 18 men) over 60 years of age with unilateral lower limb lymphedema were recruited and allocated into two groups and treated with complex decongestive therapy (n = 50) and multi-layer compression bandaging (n = 53). The patients’ body mass index, and the circumference of the edematous extremities were measured pre-and post-treatment. After 15 treatment sessions, both groups showed a reduction in swelling with a similar decrease in limb volume and circumference, but the multi-layer compression bandaging demonstrated higher efficacy in reducing the limb circumference. The findings in this study suggests that compression bandaging is a treatment of choice in low technology clinical environment because of its low cost and accessibility.

Another quasi-experimental study by Dalenc et al. investigated the effectiveness of hydrotherapy in the management of persistent/long-lasting dermatologic adverse events associated with post-treatment adjuvant therapy and its impact on the quality of life of women with breast cancer [58]. Women with breast cancer but in complete remission after combined standardized (neo) adjuvant chemo, surgical and radiotherapies were assigned into two groups 1–5 weeks post-radiotherapy. The women in the control group (n = 33) received best supportive care while those in the treatment group (n = 35) received three-weeks of hydrotherapy. The women’s quality of life, clinical grading of dermatologic adverse events, cancer-related quality of life, dermatologic quality of life and general psychological well-being were monitored. In both groups, significant dermatologic adverse events occurred at the beginning, but the women quality of life (breast,  $p < .0001$ ), systemic therapy side effects ( $p < .01$ ), arm symptoms ( $p < .01$ ), body image ( $p < .05$ ), dermatologic adverse events grading, dermatologic quality of life ( $p < .001$ ) and psychological well-being ( $p < .01$ ) showed significantly greater improvement in the treatment group when compared to the control group. Xerosis (88% of the women at the beginning) completely healed in all the women in the hydrotherapy treatment group. The authors concluded that specific hydrotherapy is an effective supportive care indicated in the management of dermatologic adverse events occurring after early breast cancer therapies.

A systematic review study by Yeung and Semciw evaluated the benefits of hydro (aquatic) therapy in the management of lymphedema by reviewing five electronic databases for RCT which compared aquatic therapy with other lymphedema interventions [59]. In all, six studies met the study criteria; four of them were of moderate quality (average PEDro score 6.5/10) and two of the investigation provided data for inclusion in the meta-analysis. The result revealed there were no

significant short-term differences in lymphedema status (measured by lymphedema relative volume) between the women who completed aqua lymphatic therapy compared to land-based standard care (standardized mean difference: 0.14; 95% CI:  $-0.37$  to  $0.64$ ,  $I^2 = 0\%$ ,  $p > .59$ ). The authors found low-quality evidence of no significant difference in upper limb physical function (land-based standard care  $-0.27$ , 95% CI:  $-0.78$  to  $0.23$ ,  $I^2 = 0\%$ ,  $p > .29$ ) between the aqua-lymphatic therapy and standard care. No adverse events were reported in both groups. The authors concluded that aqua lymphatic therapy is not significantly better than standard land-based care in the treatment of the swelling and physical function statuses of women with upper limb lymphedema. To facilitate adherence to treatment, patient preference should guide the choice of treatment.

A recent quasi-experimental study by Duyur et al. compared the long-term effectiveness of complex decongestive therapy used in the treatment of lymphedema [60]. Women with unilateral breast cancer-related lymphedema, (29 women in group one was obese, and 30 women in group two had normal weight or overweight) received manual lymphatic drainage, intermittent pneumatic compression pump, multilayer compression bandaging, lymphedema exercises, and skin care for 1 hour a day, 5 days a week for 3 weeks. The women limb volume was measured before, after and 1 year following complex decongestive therapy. The initial lymphedema volume was  $866.3 \pm 389.3$  mL for the women in group one and  $661.8 \pm 470.6$  mL for the women in group two ( $p < 0.05$ ). The lymphedema severity percentage of the excess volume was  $33.4 \pm 15.7$  for the women in group one and  $31.9 \pm 19.6$  for the women in group two; which was moderate lymphedema. After 15 sessions of therapy, the lymphedema volume of the women in group one decreased to  $771.5 \pm 389.1$  mL ( $p < 0.05$ ), and those in group two also decreased to  $468.4 \pm 417.4$  mL ( $p < 0.0001$ ). Similarly, the percentage of the excess volume of the women in and in group one decreased to  $28.5 \pm 16.8$  ( $p < 0.01$ ), and those in group two declined to  $22.1 \pm 16.9$  ( $p < 0.0001$ ). One-year post-intervention, the volume of the extremities for the women in group one attained the baseline values, but the women in group two maintain the post-treatment volumes of their extremity values. Obesity is a factor known to modulate the efficacy of complex decongestive therapy. Thus, the primary goal in the treatment of breast cancer-related lymphedema is to begin treatment early before the fat accumulation and fibrosis.

Another recent meta-analyses study by Panchik et al. examined the available published research on the effectiveness of aerobic exercise to treat women with, or at risk for breast cancer-related lymphedema [61]. The relevant published articles ( $n = 807$ ) were retrieved from the major electronic databases, but only 26 of them met the study criteria. The results revealed that conventional aerobic, stretching and resistance exercises, including unconventional exercise approaches such as Yoga, Qigong, and Pilates are safe and effective in the management of the symptoms of the women at risk for and those with breast cancer-related lymphedema. The different forms of exercise improved the women quality of life, body mass index, muscle strength, and mental health and the pain and lymphatic swelling decreased.

#### 4. Discussion

This article provided a comprehensive up to date summary of the outcome research that evaluated the efficacy of PHT in the management of reproductive disorders. The findings

summarized in **Table 1** revealed that men's reproductive disorders are understudied. The overwhelming majority (91%) of the 47 studies reviewed found the various PHT modalities evaluated to be effective. The credibility of the articles ranges from "poor" (for the case reports) to "strong" (for the meta-analysis). The PCET used to treat urinary and fecal (anal) incontinence, was the most studied PHT modality, followed by aerobic exercise used for post-partum depression, obesity, gestational diabetes mellitus, and mastectomy complication prevention (**Table 1**). The relevant investigation reviewed indicated that proper instruction and close supervision of the patient are critical for PCET to be effective. At least three systematic reviews and one meta-analysis found PCET to be safe and effective in the management of urinary and fecal incontinence. Based on this strong supporting evidence, it is justified to recommend PCET as a first-line treatment option for the management of voiding dysfunction.

Several of the research reviewed concluded that proper instruction and close supervision of PCET is crucial for the treatment to be effective. The patients who did not improve tend to perform PCET at a low intensity based on their strength. On the other extreme, patients who over work the PFM cause muscle soreness and a decrease in muscle performance; the incontinence may worsen. Therefore, learning the correct protocol [62] is essential for PCET to be effective. Also, the physical therapist must educate the patient to avoid food and drinks that may irritate the bladder and how to change the behaviors that make the symptoms worse by decreasing urinary urge and frequency.

Although the preponderance of the evidence suggests that PCET and transvaginal electrical stimulation are useful for reducing the symptoms of stress UI, data on other adjunctive techniques (EMG biofeedback, and vaginal cones) are less consistent. There is presently no reliable evidence to support the use of PCET in combination with EMG biofeedback and electrical stimulation to relieve overactive bladder and improve sexual function in men. The conflicting findings are because many of the existing studies are heterogeneous in methodology and time frame follow-up; thus, making firm conclusion difficult.

The outcomes of the RCT that evaluated the efficacy of electrical stimulation in the management of stress UI are conflicting [24, 28, 30]. Consequently, there is a need to conduct more RCT with adequate sample sizes and the use of sensitive, reproducible, and valid outcome measures. The optimum electrical parameters for pelvic floor stimulation have not been established currently, but the frequency range of 20–50 Hz is often recommended. The protocol is to apply the electrical stimulation transvaginal for 15–30 min every day at the maximum tolerable intensity for between 4 and 12 weeks.

The use of aerobic exercise to treat post-partum depression, followed by obesity, is the most studied PHT modality followed by the prevention of gestational diabetes mellitus; breast cancer survivor's mental health, sexual dysfunction, lymphedema, pain, and dermatologic adverse events. The evidence for using aerobic exercise as adjunctive treatment in the management of post-partum depression, obesity, and prevention of gestational diabetes is equally convincing; based on positive outcomes from four systematic reviews, two meta-analyses and one RCT [42–47]. The evidence for the use of PHT in the treatment of the mental health, sexual dysfunction, lymphedema, pain, and dermatologic adverse events among women with breast cancer warrant additional systematic reviews and meta-analysis investigations.

Three published RCT [17–19] revealed that when SWD is combined with medication (analgesics and antibiotics), the bimodal treatment is beneficial in the management of PID. Additional RCT with larger sample size, followed by systematic review and meta-analysis investigations are needed to bolster the recommendation to use SWD to treat chronic PID and salpingo-oophoritis.

Two quasi-experimental design study revealed that manual and massage physical modalities hold promise in the management of infertility due to adhesive disease [50, 51]. RCT are urgently needed to substantiate the recommendation. Similarly, the findings from a quasi-experimental study that used fractional carbon dioxide laser therapy to treat vulvovaginal atrophy in postmenopausal women showed great promise [37]. This potentially useful modality is presently underutilized in the treatment of reproductive disorders. Also, the use of TENS in the management of vestibulodynia lacks strong empirical evidence [34–36]. Follow up, RCT are needed to confirm the long-term benefits of fractional carbon dioxide laser therapy on vaginal morphology and for using TENS to treat vulvar pain.

## 5. Conclusion

This article provided a comprehensive up-to-date review of the relevant studies that evaluated the efficacy of PHT interventions in the management of reproductive disorders. The preponderance of the published research found PHT modalities to be effective. The findings suggest that systematic reviews and meta-analyses are needed to bolster the rationale for recommending PHT in the management of chronic pelvic diseases in women. Similarly, RCT are required to support the recommendation for using PCET, electric stimulation, and EMG biofeedback to treat ejaculatory/orgasmic dysfunction, prostatitis, UI and erectile dysfunction in men. The information in this chapter will be useful to physical therapist students, frontline clinicians, and healthcare policymakers.

## Conflict of interest

No conflict of interest to declare.

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