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Review

Effects of Rehabilitation Approaches on Children with Hemophilia: Systematic Review

Hemofili Hastası Çocuklarda Rehabilitasyon Yaklaşımlarının Etkileri: Sistematik Bir Derleme

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ABSTRACT

Hemophilia presents with symptoms such as pain, limited joint range of motion, and reduced functionality and diminished quality of life. The World Federation of Hemophilia recommends core treatment programs, including preventive, curative, rehabilitative, and palliative care, to improve quality of life. The aim of this study is to examine the effectiveness of physiotherapy approaches in children with hemophilia. In this systematic review, studies published in English were identified through searches of the Cochrane Central Register of Controlled Trials, MEDLINE, and physiotherapy evidence databases (PEDro). The quality of the included studies was assessed using the PEDro scale. Of 60 screened articles, nine randomized controlled trials met the inclusion criteria. According to PEDro scores, four studies were of good quality, whereas five were of low quality. A total of 295 participants aged 8-16 years were included: 175 had moderate hemophilia and 120 had mild-to-moderate hemophilia. The primary outcome measures were pain, functional capacity, and muscle strength; secondary outcomes included joint range of motion, swelling, and balance and gait parameters. Evidence suggested that, in addition to conventional physiotherapy, laser therapy and therapeutic resistive exercise significantly reduced pain and improved range of motion, muscle strength, and functional capacity. This review supports the integration of these modalities into physiotherapy programs for children with hemophilia.

Keywords: Haemophilia, physiotherapy, exercise, pediatric hemophilia, laser therapy

ÖZ

Hemofili ağrı, eklem hareket açıklığında kısıtlılık, azalmış fonksiyonellik ve yaşam kalitesi gibi semptomlarla kendini gösteren bir hastalıktır. Dünya Hemofili Federasyonu, yaşam kalitesini artırmak amacıyla önleyici, tedavi edici, rehabilite edici ve palyatif bakımı içeren temel tedavi programlarını önermektedir. Bu çalışmanın amacı, çocuklarda hemofiliye yönelik fizyoterapi yaklaşımlarının etkinliğini incelemektir. Bu sistematik derlemede, İngilizce yayımlanmış çalışmalar Cochrane Kontrollü Çalışmalar Merkezi Kayıtları, MEDLINE ve fizyoterapi kanıt veri tabanında (PEDro) taranmıştır. Dahil edilen çalışmaların kalitesi PEDro ölçeği kullanılarak değerlendirilmiştir. Tarama sonucunda 60 makale arasından, kriterleri karşılayan 9 randomize kontrollü çalışma derlemeye dahil edilmiştir. PEDro puanlamasına göre bu çalışmalardan 4'ü iyi, 5'i düşük kalitededir. Derlemeye 8 ile 16 yaş arasında toplam 295 katılımcı dahil edilmiştir; bunların 175'i orta düzeyde hemofiliye, 120'si ise hafif ile orta düzeyde hemofiliye sahiptir. Birincil sonuç ölçütleri; ağrı, fonksiyonel kapasite ve kas kuvveti olarak belirlenmiştir; ikincil ölçütler ise eklem hareket açıklığı, ödem ve denge/yürüme parametrelerini içermektedir. Bulgular, konvansiyonel fizyoterapiye ek olarak uygulanan lazer tedavisi ve dirençli egzersizlerin ağrı, hareket açıklığı, kas kuvveti ve fonksiyonel kapasite üzerinde anlamlı iyileşmeler sağladığını göstermektedir. Bu derleme, bu modalitelerin hemofili tanılı çocuklar için fizyoterapi programlarına entegre edilmesini desteklemektedir.

Anahtar Kelimeler: Hemofili, fizyoterapi, egzersiz, pediatrik hemofili, lazer tedavisi

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INTRODUCTION

Hemophilia is an X-linked recessive disorder caused by deficiencies in factor VIII (hemophilia A) or factor IX (hemophilia B), with hemophilia A being four times more common. It primarily affects males due to the inheritance of the X chromosome from the mother, occurring in 1 in 10,000 births overall and 1 in 5,000 male births (1-4).

During early childhood, the presence of frequent bruising, spontaneous bleeding in areas such as joints, muscles, and soft tissues, as well as excessive bleeding following trauma or surgery, may raise suspicion of hemophilia (4). The primary clinical manifestation of hemophilia is prolonged bleeding, which can occur in various parts of the body. Although the disease typically presents in early childhood and persists throughout life, bleeding in severe cases may not become apparent until the child begins physical activities such as walking or running. In mild cases, significant bleeding may not occur until a triggering event, such as trauma or surgery, has occurred (2,4).

The World Federation of Hemophilia (WFH) recommends core treatment programs, including preventive, curative, rehabilitative, and palliative care, to improve patients' quality of life (5). Although evidence-based studies are needed in the treatment of hemophilia, most current research is of low methodological quality. Therefore, it is important to conduct studies that focus on disease-specific needs and that align with models based on the World Health Organization's International Classification of Functioning, Disability and Health (ICF) (5).

Joint problems in patients with hemophilia begin in infancy and commonly affect the ankle, knee, and elbow joints. Symptoms include recurrent hemarthroses, flexion deformities, chronic synovitis, epiphyseal hypertrophy, cartilage damage, and hemophilic arthropathy (6). Hemarthroses lead to a cycle of bleeding and synovitis, causing joint hypertrophy and increased injury risk. Initially, pain may be manageable, but it can progress to irreversible flexion deformities and asymmetric epiphyseal hypertrophy, resulting in valgus deformities and hemophilic arthropathy (6-8). The WFH recommends primary prophylaxis as the best approach, though it can be challenging for children and highlights the need for personalized treatment. Hydrotherapy reduces bleeding frequency, pain, and joint instability. Ultrasound and pulsed shortwave electrotherapy can be beneficial, but may affect the epiphyseal growth plate, prompting debate over their use (9-14). Although a limited number of research articles examine the effectiveness of various intervention strategies, no systematic review has investigated physiotherapy and rehabilitation interventions in the pediatric hemophilia population. Considering that hemophilia is a lifelong condition, it is recommended that interventions begin as early as possible after diagnosis to help children adapt to the treatment process and integrate it into their daily lives as they grow (9-13). The literature lacks studies focusing particularly on the pediatric population due to ongoing debates regarding the benefits and risks of physiotherapy in practice. Therefore, the aim of this systematic review is to examine the effects of physiotherapy approaches in children with hemophilia.

METHODS

Search Strategy

This systematic review was conducted according to the Cochrane Collaboration standard guide (15) and prepared following the PRISMA Statement (16) for randomized studies. The Cochrane Central Register of Controlled Trials, MEDLINE, and physiotherapy evidence databases (PEDro) databases were used. All studies published up to June 2023 were reviewed. Initially, the authors (Beyza Tanrıöğen and Nilgün Yıldız) independently screened all titles, abstracts, and full-text articles for eligibility. Disagreements regarding inclusion were resolved through consensus meetings or by consulting another co-author, Rüstem Mustafaoğlu.

Eligibility Criteria

We included only randomized controlled trials (RCTs) involving pediatric patients with hemophilia that assessed physiotherapy, rehabilitation, or exercise interventions. Studies covering all types and severities of hemophilia (mild, moderate, and severe) were included. Excluded were non-English articles, book chapters, reviews, meta-analyses, non-randomized studies, and studies without physiotherapy or rehabilitation interventions.

Outcome Measures

The included studies were reviewed and classified according to the ICF model for hemophilia (17). The primary outcomes of the study were determined to be pain, functional capacity, and muscle strength. The secondary outcome measures were range of motion (ROM), swelling, and balance and gait parameters.

Data Extraction

In the present review, relevant data from included studies have been extracted by two authors (Beyza Tanrıöğen and Nilgün Yıldız) (Table 1).

Table 1. Summary of the included studies

Author, country, year	Age	N (IG/CG)	Type/ severity	Intervention	Control	Intensity/ duration/session	Outcomes measures	Results
Eid et al. (26), Egypt, 2013	10-14	30 (15-15)	A/moderate	Bicycle ergometer+resistance exercises	Gentle stretching Static muscle contraction aerobic exercise	Bicycle ergometer for 20 min, resistance exercise for 20 min: sand bags 2-6 kg, 3x10, 3 times/week for 3 months	Muscle strength, 6-MWT	Strength improved only in the study group (flexors: t=13.89, p=0.0001; extensors: t=16.26, p=0.0001). Between-group comparisons favored the study group (extensors: t=2.77, p=0.01; flexors: t=2.41, p=0.02). Functional capacity improved more in the study group (t=2.55, p=0.01)
El-Shamy and Abdelaal (25), Egypt, 2016	9-13	30 (15-15)	A	Active HILT+traditional physical therapy	Placebo HILT+traditional physical therapy	Total energy of 1500 J through 3 phases/3 sessions/ week 12 weeks 8 min	Pain-VAS, 6-MWT, gait assesment	Both of the groups had significant difference on pain and function after the intervention (p=0.001). Significant difference between the laser group has reported compared to placebo group.on VAS scores, and functional capacity (p=0.001 and p<0.003, respectively). Gait parameters also improved (p=0.001) in both groups, intervention group showed significantly superior effect (p=0.001)
El-Shamy (23), Egypt, 2017	9-13	30 (15-15)	A/mild to moderate	WBV+conventional physical therapy	Conventional physical therapy	30-40 Hz, 2-4 mm of peak-to-peak vertical plate displacement for 15 minutes/day, 3 days/week, 12 weeks	Quadriceps strength, 6-MWT	Significant difference between the mean values of quadriceps peak torque was observed in study group compared to CG (p<0.001, Cohen's d=6.66) and 6-MWT (p=0.006, Cohen's d=1.08) at baseline and after treatment
Azab et al. (22), Egypt, 2020	10-13	45 (15-15-15)	A/moderate	KT+exercise placebo taping+exercise	Exercise	KT group: 10 cm Kinesio tape vertically from sacrum to T12 vertebra, on both sides of the spine Placebo group: Same as the KT group, applied with 0% tension CG: Exercise was performed 3 times/ week for 30 min. for 12 weeks	Pain-NRS, 6-MWT	On KT group, pain decreased significantly (p=0.001, Cohen's d=1.61) compared to CG, but there was no significant difference compared to placebo group (p=0.19, Cohen's d=0.87). When it is compared to CG ,there was a significant difference in functional capacity in the KT group (p=0.039), but no significant difference was observed between KT and placebo group (p=0.58)
Eid and Aly (20), Egypt, 2015	9-13	30 (15-15)	A/moderate	Traditional physical therapy+LLLT traditional physical therapy+PEMF		Gallium-aluminum-arsenate laser 3 times a week, ASA magnetic field device Frequency: 15 Hz Intensity: 20 gauss Time: 20 min	Pain-VAS, ROM, circumference measurement, 6-MWT	In the 6th week, a significant improvement was observed on pain (p=0.02, MD=-0.67), knee flexion (p=0.001, MD=5.87), knee extention (p=0.02, MD=5.87), swelling (p=0.02, MD=-0.68) and function (p=0.03, MD=26.33)in the laser group compared to the PEMF. After 12 weeks, there was a significant improvement in pain (p=0.001, MD=-1.27), knee flexion (p=0.02, MD=4.67) and knee extention (p=0.001, MD=5.27) in the laser group compared to the PEMF group, while no significant improvement was observed in knee circumference measurements and 6-MWT parameters

Table 1. Continued

Author, country, year	Age	N (IG/CG)	Type/ severity	Intervention	Control	Intensity/ duration/session	Outcomes measures	Results
Elnaggar (21), Egypt, 2019	8-16	40 (20-20)	A/moderate	Active pulsed Nd: YAG laser+exercise	Placebo laser+exercise	Exercise 3 times a week, not exceeding 30 minutes, for 1 month Laser was applied 3 times a week for about 8 minutes for 1 month	Pain-NRS, postural stability-NeuroCom-balance system, weight bearing pattern-Tekscan HR Mat™, barefoot pressure mapping system	Active pulse laser group was compared to the placebo group; pain (p=0.004, η^2=0.26), directional control (p=0.02, η^2=0.16), endpoint excursion (p=0.003, η^2=0.29), center of gravity movement (p=0.003, η^2=0.30) velocity parameters improved more. There was no statistically significant difference between the maximum excursion parameter active laser and placebo groups (p=0.15)
Mohamed and Sherief (24), Egypt, 2014	10-14	30 (15-15)	Mild-moderate	Bicycle ergometer (group A)/treadmill training (group B)	Gentle stretching, isometric muscle contraction, balance and gait training, treadmill training	1 hour/session-3 times/week, for 3 months Group A: 20 minutes of bicycle ergometer Group B: 20 minutes of treadmill training	Balance and gait parameters-Biodex Gait Trainer 2TM	Significant positive differences on balance were obtained in both groups treadmill training (p=0.001, p=0.001, p=0.001) was more beneficial than bycle ergometer (p=0.01, p=0.01, p=0.01) on overall stability, antero-porterior and medio-lateral stability respectively. Gait parameters improved in both groups (p=0.01) but treadmill group showed significantly superior results
Abd-Elmonem et al. (27), Egypt, 2014	8-12	30 (15-15)	Mild-moderate	Treadmill training group: 20 minutes of training additionaly in control group	Therapeutic, ultrasonic modalities (1 MHZ/1.5 W/cm^2 /10 minutes), strengthening and stretching exercises	1 hour/session-5 times/week, for 3 months Treadmill training group: 20 minutes	Muscle strength-biodex isokinetic dynamometer	Both control and intervention groups achieved significant results on knee flexion and extention (p=0.001) muscle strength at different angles, treadmill training group showed superiority significantly (p=0.001)
Zaky and Hassan (28), Egypt, 2013	8-12	30 (15-15)	Moderate	Additional partial weight bearing program	Therapeutic exercise	3 sets/10 repetitons, 3 sessions/week, for 6 weeks	6-MWT, quadriceps muscle strength-Lafayette manual muscle test system	Both groups showed sigificant improvements after the treatment on muscle strength and function (p=0.001). In the comparison between the groups, no significant difference was found in functional walking (p=0.948), but significant differences were obtained between the two groups in the evaluation of muscle strength (p=0.025)

6-MWT: 6-minutes walk test, BMD: Bone mineral density, HILT: High intensity laser therapy, VAS: Visual analogue scale, CG: Control group, KT: Kinesio tape, NRS: Numerical rating scale, LLLT: Low level laser therapy, PEMF: Pulsed electromagnetic field, ROM: Range of motion, WBV: Whole body vibration, ESR: Erythrocyte sedimentation rate, Nd: YAG: Neodymium: yttrium-aluminium-garnet, η^2: Partial eta squared, MD: Mean difference, NRS: Numeric rating scale

Quality Assessment of the Studies

The PEDro scale assesses study quality in physiotherapy and rehabilitation using 11 yes/no items, with a maximum score of 10 points. Scores of 9-10 indicate excellent quality; scores of 6-8 indicate good quality; scores of 4-5 indicate sufficient quality; and scores below 4 indicate low quality (18,19).

RESULTS

Of 60 initially screened papers, 10 duplicates were removed, leaving 50 records, of which 9 studies were deemed eligible and included (Figure 1).

A total of 9 studies were included in the systematic review (Table 1), comprising 295 participants aged between 8 and 16 years. Among them, 205 had hemophilia A and 90 had unspecified hemophilia types. The severity of hemophilia was classified as moderate in 175 participants and as mild-to-moderate in 120 participants.

Study Quality

All included studies were RCTs with defined exclusion criteria. Allocation concealment was reported in 33% of the studies, subject blinding in 11%, evaluator blinding in 33%, and therapist blinding was not reported in any study. Key outcome data were obtained from more than 85% of participants in 33% of the studies. Intention-to-treat analysis was not conducted in any of the studies. However, statistical comparisons and variability measures for key outcomes were provided (Table 2).

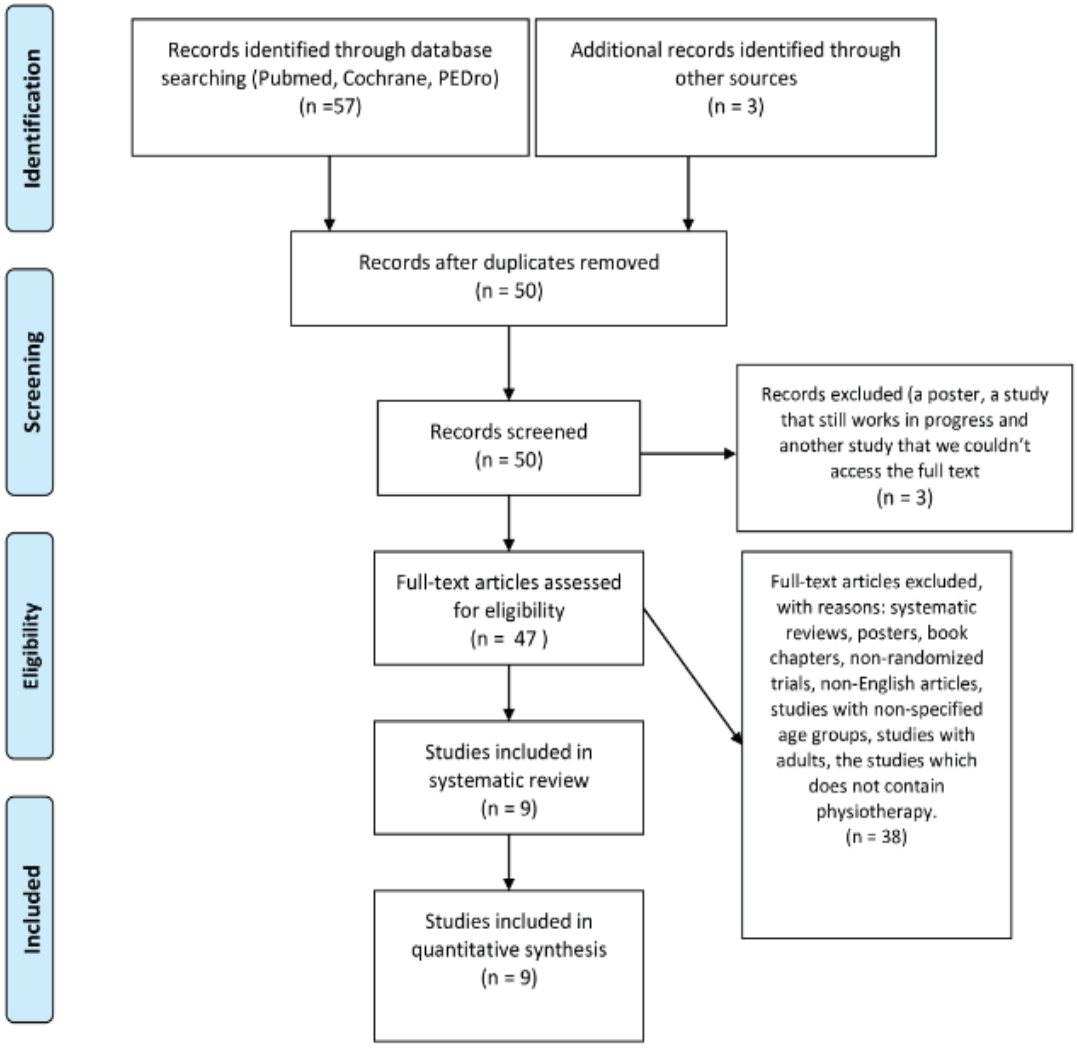

Figure 1. PRISMA flow diagram to demonstrate the process of research and study selection through the review
PRISMA: Preferred reporting items for systematic reviews and meta-analyses, PEDro: Physiotherapy evidence database

Table 2. PEDro scale using to determine the quality of the included studies

Studies	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	PEDro score
Eid and Aly (20)	Y	Y	N	Y	N	N	N	N	N	Y	Y	4
Elnaggar et al. (21)	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Azab et al. (22)	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6
El-Shamy (23)	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	6
Mohamed et al. (24)	Y	Y	N	Y	N	N	N	N	N	Y	Y	4
El-Shamy and Abdelaal (25)	Y	Y	Y	Y	N	N	N	N	N	Y	Y	5
Eid et al. (26)	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	7
Abd-Elmonem et al. (27)	Y	Y	N	Y	N	N	N	N	N	Y	Y	4
Zaky and Hassan (28)	Y	Y	N	Y	N	N	N	N	N	Y	Y	4

According to assessment of PEDro: Physiotherapy evidence databese (the symbols mean), Q: Question, Y: Yes, N: No

Outcome Measures

Four of the nine studies evaluated pain with the visual analog scale (VAS) and numerical rating scale (20-22, 25). Four studies evaluated muscle strength using an isokinetic dynamometer and a Lafayette Manual Muscle Tester (23,26-28).

Six studies evaluated functional capacity using the 6-minutes walk test (6-MWT) (20,22-24,26,28). In two studies, gait parameters were evaluated using the GAITRiteVR system and the Biodex Gait Trainer 2™ (23,25). In one study, ROM was evaluated with a universal goniometer (20). In one study, swelling was assessed with circumference measurements (20).

Evidence of Primary Outcomes

Pain

In the Azab et al. (22) study, researchers applied Kinesio taping (KT) to the patients for 12 weeks. The KT group showed a significant decrease in low back pain compared to the control group ($p<0.01$; Cohen's $d=1.61$). In another study, low-level laser therapy (LLLT) applied for 6 weeks [$p=0.02$; mean difference (MD)=-0.67] and 12 weeks ($p=0.001$; MD=-1.27) showed a significant improvement compared with pulsed electromagnetic field (PEMF) therapy (20). In Elnaggar's (21) study, the neodymium: yttrium-aluminum-garnet (Nd: YAG) laser treatment group experienced greater pain relief than the placebo group ($p=0.004$; $\eta^2=0.26$). Similarly, El-Shamy and Abdelaal (25) reported significant improvements in knee pain, as measured by VAS scores, in the active high-intensity laser therapy (HILT) group than the placebo HILT group ($p=0.001$). Overall, the evidence suggests that laser therapies effectively relieve pain in children with hemophilia, but it remains unclear which type of laser is most effective. KT also demonstrated positive results, although the evidence is currently limited to a single study.

Muscle Strength

When added to routine physical therapy, additional resistance exercises using sandbags and a bicycle ergometer resulted in significant improvements in knee flexor and extensor muscle strength (3 sessions/week for 12 weeks; flexors: $t=13.89$, $p=0.0001$; extensors: $t=16.26$, $p=0.0001$) (26). El-Shamy (23) found that adding whole-body vibration (WBV) to conservative treatment improved peak quadriceps muscle torque after 12 weeks ($p<0.001$; Cohen's $d=6.66$). Another study showed significant gains in quadriceps and hamstring strength after 12 weeks of additional treadmill training, delivered as five sessions per week ($p=0.001$ for both groups and for the between-group comparison) (27). A further study found that partial weight-bearing exercises led to greater improvements in muscle strength compared with static exercises ($p=0.025$), although no difference was observed in walking function ($p=0.948$) (28). Overall, resistance exercises, treadmill walking, WBV, and laser therapy were shown to enhance traditional treatments and to improve lower limb muscle strength.

Functional Capacity

The 6-MWT was the most commonly used outcome measure for assessing functional capacity. In the study by Eid et al. (26), both groups improved following resistance and aerobic training, although the between-group difference was only modest ($t=2.55$, $p=0.01$, favoring the intervention). Similarly, partial weight-bearing exercises led to significant improvements in both groups; however, the difference between them was not significant ($p=0.948$) (28). El-Shamy (23) found a significantly greater improvement in 6-MWT when WBV training was added to physiotherapy compared with physiotherapy alone ($p=0.006$, Cohen's $d=1.08$). In Azab et al.'s (22) study, functional capacity improved significantly in the KT group compared with the control group ($p=0.039$), but not when compared with placebo taping ($p=0.58$).

Laser-based therapies also showed benefits. HILT was significantly superior to placebo in children with hemophilic arthropathy (p=0.001) (25). LLLT showed greater improvement than PEMF at week 6 (p=0.03; MD=26.33), though this was not sustained at week 12 (p>0.05) (20). Overall, both exercise-based and laser interventions improved 6-MWT performance, though the most effective exercise modality remains unclear.

Evidence of Secondary Outcomes

Range of Motion

ROM was evaluated in only one study. Eid and Aly (20) found significant improvements in the LLLT group compared with the PEMF group at 6 weeks (flexion: p=0.001; extension: p=0.02; MD=5.87) and at 12 weeks (flexion: p=0.02, MD=4.67; extension: p=0.001, MD=5.27), with the 12-week program providing the most benefit. LLLT, applied in addition to conventional physiotherapy, effectively improved knee ROM in children with hemophilia.

Swelling

The same study reported a significant reduction in knee circumference in the LLLT group compared with PEMF at both 6 and 12 weeks (MD=-0.68; p=0.02), with no significant difference between the two time points (20). This indicates that laser therapy effectively reduced swelling in the short term.

Balance and Gait Parameters

El-Shamy and Abdelaal (25) assessed gait and balance outcomes and reported improvements in stride length, step length, speed, and cadence after 3 months of HILT (p=0.001). Mohamed and Sherief (24) found that both treadmill and bicycle training enhanced balance, with treadmill training being significantly superior (p=0.001). HILT enhances gait parameters, whereas treadmill training is superior among aerobic modalities because of its gait-specific nature.

DISCUSSION

This systematic review highlights that physiotherapy interventions, including resistance exercises and laser application, are effective for reducing pain intensity and improving muscle strength and functional capacity in children with hemophilia. While KT, WBV, and aerobic exercises also showed positive effects, the number of supporting studies remains limited. Future high-quality studies on these and other treatment methods are needed to provide more comprehensive evidence and enhance the understanding of physiotherapy's effectiveness in pediatric hemophilia.

In a randomized study by Castro-Sánchez et al. (29) investigating pain, KT application to the paraspinal muscles produced a significant reduction in pain compared with the placebo group (n=60, 4 weeks). Consistent with our study, Azab et al. (22) reported a significant reduction in pain in the KT group compared with the control group, whereas the placebo group showed no significant change. These findings support the pain-relieving effect of KT application in patients with hemophilia and low back pain and its addition to the treatment program. Demartis et al. (30) evaluated the effectiveness of HILT in hemophilic individuals with chronic arthropathy and found that HILT produced an analgesic effect shortly after application. This study supported El-Shamy and Abdelaal's (25) findings on HILT for pain, one of the studies we included. Nd: YAG laser therapy applied to the ankle 3 days a week for 4 weeks and LLLT and HILT applied to the knee joint 3 days a week for 12 weeks significantly relieved pain. Additionally, children in the LLLT and HILT groups covered greater distances in the 6-MWT, thereby improving physical fitness. However, it remains unclear whether these interventions are effective in other joints commonly affected by hemophilia (e.g., elbow, knee, and ankle hemarthroses).

All studies included in this review reported significant improvements at the end of the treatment. In these studies, both the intervention and control groups received a conventional physiotherapy program consisting of exercises such as ROM, stretching, strengthening, and progressive exercises tailored to the condition of the child with hemophilia. When additional methods—such as laser therapy, WBV therapy, and KT—were combined with exercise, more notable outcomes were observed. However, studies comparing these approaches to an untreated control group are needed to determine their true effectiveness.

Children with hemophilia experience greater reductions in muscle strength related to physical activity than their healthy peers do. This decreased level of physical activity can affect muscle function (31). Therefore, numerous studies have examined the effects of interventions on muscle strength. In the study by Hilberg et al. (32) involving individuals with hemophilia, a significant increase in isometric muscle strength, measured before and after treatment, was noted in participants who underwent low-resistance strength training. Eid et al. (26) demonstrated that progressive resistance training significantly improved muscle strength in children with hemophilia, supporting its inclusion in treatment programs. Similarly, El-Shamy (23) showed that WBV training can effectively enhance muscle strength when used alongside exercise. Most studies lasted 12 weeks, with one 6-week program, reporting mixed results for stretching

and isometric strengthening. Adding resistance exercises, treadmill walking, WBV, and laser therapy improves treatment effectiveness, but the optimal approach remains unclear due to limited research. Exercise programs should be implemented with caution, despite the absence of reported adverse effects.

Azab et al. (22) found a significant improvement in functional capacity in the KT group compared with the control group, whereas no difference was observed in the placebo group. This may be due to increased proprioceptive input enhancing movement awareness. The effect of laser therapy on functional capacity was evaluated in two studies, KT in one study, WBV in one study, and exercise in two studies. These results suggest that such interventions can be included in rehabilitation programs for children with hemophilia due to their positive effects on functional capacity.

LLLT is a therapeutic modality that reduces pain in patients with musculoskeletal disorders (33). In addition, it reduces swelling and contributes to the healing of soft tissue injuries by affecting the inflammatory process (34). These properties of LLLT have made it a preferred treatment approach for children with hemophilia. An increase in ROM was observed in the studies by Alves et al. (35) and Eid and Aly (20). In the study by Alves et al. (35), this improvement was attributed to the pain-reducing and anti-inflammatory effects of LLLT. Similarly, Eid et al. (26) reported significant increases in knee flexion and extension ROM following LLLT application. These findings suggest that LLLT may be a useful addition to rehabilitation programs for children with hemophilia to support improvements in ROM.

A notable finding in the study by Eid and Aly (20) was a reduction in swelling following application of both LLLT and PEMF. The decrease in swelling observed with these modalities may have contributed to improved physical function in children with hemophilia. These results suggest that LLLT and PEMF can be considered supportive options in rehabilitation programs to help manage swelling and enhance functional outcomes. However, findings from the current study suggest that LLLT offers faster and more effective outcomes compared to PEMF. Furthermore, its cost-effectiveness supports the preference for LLLT as a practical and accessible treatment option.

Improvements in balance and gait parameters have been reported through various interventions in children with hemophilia. Elnaggar (21) reported that pulsed Nd: YAG laser therapy significantly enhanced weight-bearing measures—such as forefoot contact area, hindfoot contact area, and total foot contact area—likely by reducing pain and restoring normal posture. This therapy also improved postural stability, including directional control and center-of-gravity velocity, indicating its potential to enhance balance. Additionally, gait training, included in conventional physical therapy, led to significant improvements in walking parameters (23). These findings support using pulsed Nd: YAG laser therapy and gait training to improve balance and gait in this population.

Overall, the evidence suggests that combining conventional physiotherapy with adjunctive modalities such as laser therapy, KT, WBV, and targeted exercise programs can effectively reduce pain and improve muscle strength, functional capacity, ROM, swelling, balance, and gait in children with hemophilia; however, further high-quality studies are needed to confirm these benefits and optimize intervention protocols.

Previous studies have not reported any adverse effects related to physiotherapy interventions; however, careful attention to exercise intensity remains essential. Although this does not mean that exercises can be performed without caution, under the supervision of a physiotherapist, exercise programs can be safely implemented for patients with hemophilia without causing bleeding or other adverse outcomes.

Study Limitations

This systematic review has several limitations that should be considered when interpreting the findings. Firstly, all included studies were conducted in Egypt, which may limit the generalizability of the results to broader populations and different healthcare settings.

Secondly, the studies included relatively small sample sizes. Although methodological quality was assessed using the PEDro scale, no studies were excluded based on quality due to the limited number of available trials. The heterogeneity in treatment approaches and the absence of standardized physiotherapy protocols and outcome measures also limited the ability to synthesize findings across studies effectively. Additionally, the lack of standardized guidelines for physiotherapy in pediatric hemophilia may have contributed to the variability observed in intervention strategies and measurement tools. Notably, none of the included studies addressed upper extremity hemophilic arthropathy, despite its recognized clinical importance.

Furthermore, the current evidence base does not include studies evaluating innovative rehabilitation modalities such as virtual reality, telerehabilitation, or aquatic therapy, which are gaining prominence in pediatric physiotherapy.

Future research should prioritize the design and implementation of high-quality, multicenter RCT involving

diverse populations, with adequate sample sizes and standardized outcome measures. Investigations should also consider both established and emerging rehabilitation approaches to enhance the evidence base for physiotherapy management in pediatric hemophilia.

CONCLUSION

The systematic review included various interventions such as cycling ergometry, resistance strengthening, treadmill training, WBV, KT, laser application, balance and gait training, and partial weight-bearing exercises. It recommends incorporating laser therapy and therapeutic resistance exercises to conventional physiotherapy to improve pain, ROM, muscle strength, and functional capacity in children with hemophilia. Although the optimal intervention period could not be determined due to the limited number of studies, it was observed that the greater positive effects were observed at 12 weeks compared to 6 weeks. Nevertheless, additional high-quality RCT are required to establish definitive evidence.

FOOTNOTES

Authorship Contributions

Concept: B.T., N.Y., R.M., Design: B.T., N.Y., R.M., Data Collection or Processing: B.T., R.M., Analysis or Interpretation: R.M., Literature Search: B.T., N.Y., R.M., Writing: B.T., N.Y., R.M.

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