QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

Cite as: KARWAT, Karolina, GUT, Stanisław, MIARCZYŃSKI, Jakub, WIERCIŃSKA, Nikola, WIDELSKI, Juliusz Aleksander, and WOŹNIAK, Szymon. Lipedema: Pathophysiology, Functional Limitations and Physical Activity Implications – A Narrative Review. Quality in Sport. 2026;62:73269. https://doi.org/10.12775/QS.2026.62.73269

ARTICLE TIMELINE
Received: 11.06.2026. Revised: 30.06.2026. Accepted: 04.07.2026. Published: 11.07.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

Lipedema: Pathophysiology, Functional Limitations and Physical Activity Implications – A Narrative Review

Karolina Karwat[1]

ORCID ID: 0009-0003-0442-6164

karolina.k.1357@gmail.com

Stanisław Gut[2]

ORCID ID: 0009-0006-3968-6507

stangut2001@gmail.com

Jakub Miarczyński[1]

ORCID ID: 0009-0004-5746-4786

jakub.miarczynski1@gmail.com

Nikola Wiercińska[2]

ORCID ID: 0009-0009-0266-2562

nwiercinska2@gmail.com

Juliusz Aleksander Widelski[2]
ORCID ID: 0009-0004-5939-1322
juliuszwidelski@gmail.com

Szymon Woźniak[2]
ORCID ID: 0009-0004-4081-0064
szymon.wozniak5@gmail.com

[1]Ludwik Rydygier Collegium Medicum in Bydgoszcz Nicolaus Copernicus University in Toruń, Jagiellońska 13/15, 85-067 Bydgoszcz
[2] Medical University of Warsaw, Żwirki i Wigury 62, 02-091 Warszawa
* Correspondence: karolina.k.1357@gmail.com

Abstract:

Introduction: Lipedema is a chronic adipose tissue disorder characterized by disproportionate accumulation of subcutaneous fat, primarily affecting the lower extremities. The condition occurs almost exclusively in women and is associated with pain, tissue sensitivity, easy bruising, and progressive functional limitations. These symptoms can impair mobility and negatively affect quality of life.

Beyond its characteristic fat distribution, lipedema is increasingly recognized as a complex disorder involving adipose tissue dysfunction, vascular alterations, and impaired physical function. As symptoms progress, many individuals experience reduced participation in physical activity, which may contribute to further declines in mobility and overall health.

Exercise is considered an important component of conservative management; however, evidence regarding its role in lipedema remains limited. Therefore, the aim of this narrative review was to summarize current knowledge on lipedema pathophysiology and its impact on physical activity and exercise capacity, and to evaluate the role of exercise in disease management.

Materials and methods: An analysis of scientific articles available in PubMed, Scopus, and Google Scholar was conducted using the following keywords: “lipedema,” “physical activity,” “exercise,” “adipose tissue,” “inflammation,” “microcirculation,” and “functional limitations.” Peer-reviewed studies relevant to lipedema pathophysiology, clinical presentation, and exercise-based management were included.

Results: Lipedema is a chronic adipose tissue disorder characterized by abnormal subcutaneous fat accumulation, fibrosis, and extracellular matrix remodeling, which distinguish it from obesity and contribute to progressive lower limb enlargement and functional impairment [4,15]. Current evidence also indicates the presence of chronic low-grade inflammation and microvascular dysfunction, which are likely contributors to pain, tissue hypersensitivity, and reduced tolerance to mechanical loading [3,4,10]. These pathophysiological alterations provide a plausible biological basis for the functional limitations observed in affected individuals.

Across studies, pain and discomfort consistently emerge as the primary barriers to physical activity participation, leading to reduced mobility, avoidance of exercise, and progressive physical deconditioning [10,24,33]. Preliminary evidence suggests that appropriately adapted low-impact exercise may improve functional outcomes and symptom burden; however, available data remain limited and largely derived from observational or pilot studies [4,10,24]. Collectively, the literature supports an integrated model in which adipose tissue dysfunction, pain, and reduced physical activity interact to negatively influence functional capacity in lipedema.

Keywords: Lipedema; Exercise; Physical Activity; Functional Limitations; Pathophysiology; Inflammation

1. Epidemiology

Lipedema is a chronic adipose tissue disorder that occurs almost exclusively in women, with onset most commonly reported during periods of hormonal transition such as puberty, pregnancy, or menopause. This temporal pattern suggests a potential hormonal contribution to disease expression and progression [2,3,13].

The true prevalence of lipedema remains uncertain, largely due to the absence of universally accepted diagnostic criteria and frequent misclassification as obesity or lymphedema. Available estimates vary considerably, with some reports suggesting prevalence may be as high as approximately 10–11% of women; however, these figures should be interpreted cautiously due to likely underdiagnosis and selection bias [1,3,6].

Epidemiological data are predominantly derived from European and North American populations, while large-scale studies from other regions remain scarce. This limited geographical representation constrains accurate estimation of global disease burden [2,6].

A major epidemiological challenge is delayed diagnosis, as many patients remain undiagnosed for years despite progressive symptom development. This is largely attributable to limited clinical awareness and overlap with other adipose and lymphatic disorders, particularly obesity and lymphedema [1,3,28].

2. Pathophysiology of Lipedema

2.1. Adipose Tissue Dysfunction

Lipedema is characterized by abnormal accumulation of subcutaneous adipose tissue, primarily affecting the lower extremities [2]. Compared with general obesity, lipedema tissue exhibits distinct structural alterations, including adipocyte hypertrophy, fibrosis, and extracellular matrix (ECM) remodeling [4]. Histological studies have reported enlarged adipocytes and increased deposition of connective tissue components, which contribute to increased tissue stiffness and progressive limb enlargement [4].

ECM remodeling appears to play an important role in disease progression. Increased collagen deposition and fibrotic changes may impair tissue elasticity and local microcirculation, potentially contributing to pain and mechanical discomfort during movement [4]. These structural changes may help explain the functional limitations commonly observed in individuals with lipedema.

2.2. Chronic Low-Grade Inflammation

Lipedema is increasingly associated with chronic low-grade inflammation. Altered adipose tissue exhibits elevated inflammatory activity, which may contribute to tissue remodeling and symptom progression [3,4]. Although this inflammatory profile is less pronounced than in classical inflammatory disorders, it is thought to play a relevant role in disease manifestations.

Inflammatory mediators are implicated in pain sensitization, a key symptom of lipedema [4]. Persistent pain may limit mobility and reduce physical activity levels [10]. In this context, inflammation may represent an important mechanistic link between adipose tissue dysfunction and functional impairment.

2.3. Microvascular and Lymphatic Abnormalities

Microvascular dysfunction is considered a key component of lipedema pathophysiology. Studies have demonstrated increased capillary fragility and vascular permeability within affected tissues, which may explain the frequent occurrence of easy bruising and edema-like clinical features [3,26].

Increased microvascular permeability can promote interstitial fluid accumulation and elevate tissue pressure, contributing to discomfort and reduced exercise tolerance. Although lymphatic dysfunction is not considered the primary mechanism in early-stage disease, secondary lymphatic impairment may develop as the condition progresses [2,4]. The combined effects of adipose tissue expansion, microvascular alterations, and disturbed fluid dynamics may further exacerbate mobility limitations and physical inactivity.

2.4. Hormonal and Genetic Factors

The marked predominance of lipedema in women and its frequent onset during puberty, pregnancy, and menopause suggest a role for hormonal factors in disease development [13,14]. Estrogen is hypothesized to influence adipose tissue distribution, vascular function, and inflammatory activity, and may therefore contribute to lipedema pathophysiology [13].

Genetic predisposition has also been proposed, as many patients report a positive family history and familial clustering of the disease. The occurrence of lipedema across generations supports the hypothesis of inherited susceptibility [2,14]. Although several candidate genes and molecular pathways have been investigated, no definitive genetic mechanism has been identified.

Overall, current evidence supports a multifactorial model in which hormonal influences, genetic susceptibility, adipose tissue dysfunction, and microvascular abnormalities interact to drive disease onset and progression [2,4,13,14]. These interactions remain incompletely understood and require further investigation.

3. Clinical Features and Diagnostic Challenges

Lipedema is characterized by a distinctive pattern of symmetrical and disproportionate subcutaneous fat accumulation, primarily affecting the hips, buttocks, thighs, and lower legs while typically sparing the feet. This distribution pattern represents a key clinical feature distinguishing lipedema from other adipose and lymphatic disorders [3,6]. As the disease

progresses, enlargement of the affected limbs may become more pronounced, contributing to impaired mobility and reduced physical function.

In addition to abnormal fat distribution, patients commonly experience pain, tenderness on palpation, tissue hypersensitivity, and a tendency toward easy bruising. In contrast to generalized obesity, lipedema is frequently associated with chronic pain and discomfort that significantly affects daily activities and quality of life [7,11]. Pain in lipedema has both nociceptive and neuropathic components, with recent studies confirming that neuropathic pain features are more common in lipedema than previously recognized [33]. Many individuals also report sensations of heaviness, fatigue, and swelling, particularly following prolonged standing or physical exertion.

Lipedema is classified into stages based on progressive morphological changes. Stage I is characterized by a smooth skin surface with enlarged subcutaneous adipose tissue. Stage II involves uneven skin texture and the development of nodular fat deposits. In Stage III, larger lobular tissue formations and substantial limb enlargement become apparent, often resulting in marked functional impairment [2,4]. A recent new characterization of lipedema stages has further refined the understanding of stage-specific changes in pain, water retention, fat distribution, and skeletal muscle mass [35]. Advanced disease may be accompanied by secondary lymphatic involvement, referred to as lipo-lymphedema [2,4].

3.1. Differential Diagnosis

The diagnosis of lipedema may be challenging due to overlapping clinical features with several conditions affecting adipose tissue distribution. Obesity represents the most common differential diagnosis, as both conditions involve increased adipose tissue accumulation. However, lipedema is characterized by a disproportionate distribution pattern, relative sparing of the feet, and the presence of pain and bruising, which are not typical features of obesity alone [3,30]. The clinical distinction between lipedema and obesity is critical, as management strategies differ substantially between these conditions [30].

Lymphedema is another important differential diagnosis. Unlike lipedema, lymphedema typically involves the feet and is associated with impaired lymphatic drainage and a positive Stemmer sign. Although advanced lipedema may develop secondary lymphatic dysfunction, the two conditions differ in their primary pathophysiological mechanisms [16]. Recent comparative analyses have further clarified the histological and molecular differences between

lipedema, lipohypertrophy, and secondary lymphedema, aiding in more accurate differential diagnosis [32].

3.2. Diagnostic Limitations

Despite increasing awareness, the diagnosis of lipedema is primarily based on clinical assessment. Currently, no specific laboratory markers or validated biomarkers are available to confirm the diagnosis, limiting objective diagnostic evaluation [2,28]. Recent studies have explored inflammatory markers such as neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) as potential supportive tools, but these remain investigational [36].

Clinical diagnosis is therefore based on patient history, characteristic fat distribution, symptom profile, and physical examination findings. Although imaging modalities such as ultrasound and magnetic resonance imaging may provide supportive information—with three-dimensional ultrasound offering additional morphological detail [17]—they are not currently recommended as standalone diagnostic tools [2,28]. Advanced imaging techniques, including ultrasound and magnetic resonance imaging, have been proposed to support diagnostic evaluation, although their role in routine clinical practice remains to be standardized [5]. Newer ultrasound criteria specifically for lipedema diagnosis have been proposed, potentially improving diagnostic accuracy in the future [31].

Consequently, delayed diagnosis remains common. Many patients experience symptoms for years before accurate diagnosis, often undergoing repeated evaluations for obesity or lymphedema. This delay worsens disease progression, functional impairment, and quality of life [1,3]. Improving diagnostic awareness and establishing standardized criteria remain key priorities.

4. Functional Limitations and Impact on Physical Activity

Functional impairment is one of the most clinically significant consequences of lipedema. Although the disease is primarily characterized by pathological adipose tissue accumulation, its effects extend beyond morphological changes and substantially influence mobility, exercise capacity, and participation in physical activity. Pain, tissue sensitivity, limb enlargement, and psychological factors collectively contribute to reduced functional performance and impaired quality of life [7,10,11,24].

4.1. Pain and Mobility Limitations

Chronic pain is considered one of the hallmark symptoms of lipedema and a major contributor to functional impairment. Patients frequently report pain at rest, tenderness upon palpation, and increased discomfort during prolonged standing, walking, or exercise [12]. The characterization of pain in lipedema has advanced recently, with reliable pain pressure threshold assessments now available to quantify mechanical sensitivity in affected limbs [34]. The underlying mechanisms are likely multifactorial, involving inflammatory processes, increased tissue pressure, and microvascular alterations. Neuropathic pain features have been specifically identified in lipedema, distinguishing it from the predominantly mechanical pain seen in lymphedema [33].

In addition to pain, progressive enlargement of the lower extremities may alter movement patterns and increase mechanical stress on joints and surrounding tissues. These changes can impair gait efficiency, reduce mobility, and limit tolerance to weight-bearing activities. Consequently, many individuals experience exercise intolerance characterized by early fatigue, discomfort during physical exertion, and reduced capacity for regular physical activity [10].

4.2. Reduced Physical Activity Levels

Several studies have reported lower physical activity levels in individuals with lipedema compared with healthy populations [10,11,24]. Objective assessments using accelerometry have confirmed lower daily step counts and reduced time spent in moderate-to-vigorous physical activity among women with lipedema compared with healthy controls [24]. A recent scoping review on objective measures of physical activity in lipedema confirmed that reduced activity levels are consistent across studies and are not explained by BMI alone [24]. Pain, limb heaviness, and reduced exercise tolerance are consistently identified as the main barriers to regular movement and sport participation [10,33].

As symptoms progress, many patients adopt increasingly sedentary behaviors to avoid discomfort. This reduction in physical activity may contribute to decreased cardiovascular fitness, loss of muscular strength, and worsening functional capacity. The presence of relative sarcopenia (reduced muscle mass relative to fat mass) documented in lipedema patients may further exacerbate this decline, creating a self-perpetuating cycle of deconditioning [35]. Given the central role of physical activity in maintaining musculoskeletal and metabolic health, these changes are clinically significant.

4.3. Psychological Barriers

Psychological factors may further contribute to reduced physical activity participation in individuals with lipedema. Altered body image, dissatisfaction with appearance, and social stigma have been frequently reported [7,8,10,11]. These factors may reduce confidence and willingness to engage in exercise or social physical activities.

In addition, symptoms of anxiety and depression appear more frequently in individuals with lipedema than in the general population [7,9,10]. A retrospective cross-sectional study comparing health-related quality of life in females with lipedema and bilateral leg lymphedema found that lipedema patients reported significantly worse scores on physical functioning, bodily pain, and vitality domains [37]. Chronic pain, functional limitations, and diagnostic delays may negatively affect psychological well-being, further reinforcing barriers to maintaining an active lifestyle.

4.4. The Vicious Cycle of Pain, Inactivity, and Functional Decline

The interaction between pain, reduced physical activity, and functional decline has been described as a self-reinforcing cycle in lipedema [10]. The conceptual framework of a self-perpetuating cycle linking pain, inactivity, and functional decline has been explicitly described in recent sport science literature [38]. A multidimensional evaluation of pain in lipedema confirmed that pain severity correlates with disease stage and negatively predicts both functional capacity and quality of life, reinforcing this cyclical relationship [33]. Pain and discomfort discourage movement, leading to reduced physical activity and increased sedentary behavior. In turn, inactivity contributes to deconditioning, reduced muscular function, and further impairment of mobility.

Progressive functional decline may exacerbate symptom severity and negatively affect both physical and psychological health. This bidirectional relationship underscores the importance of early intervention strategies aimed at preserving mobility and promoting safe, individualized physical activity [10,11,24].

Overall, functional limitations in lipedema arise from a complex interaction of biological and psychological factors, highlighting the need for multidisciplinary management approaches targeting both physical and behavioral components of the disease.

5. Exercise-Based Management in Lipedema

Exercise is increasingly recognized as a relevant component of conservative management in lipedema, although evidence-based, condition-specific guidelines remain limited [4,10,24]. Recent consensus statements emphasize that exercise programs should be individualized and symptom-guided [39]. The primary goal of physical activity focuses on improving functional capacity, pain modulation, mobility, and quality of life [4,11].

Low-impact aerobic activities such as walking, aquatic exercise, and cycling are commonly recommended [4,10]. Aquatic exercise may be particularly beneficial, as hydrostatic pressure can support venous and lymphatic return while reducing joint stress and perceived pain [4].

Resistance training may improve muscular strength and functional stability [4,10]. However, training intensity should be carefully individualized, as higher baseline pain and neuropathic features are associated with lower tolerance for high-intensity loading [33].

Exercise adherence is often limited by pain, fatigue, and psychological factors [11]. Pain-related fear of movement and avoidance behavior have been identified as significant barriers to regular exercise [34].

Multidisciplinary approaches combining exercise therapy, compression, and conservative management may provide additional benefits [4,25]. Combining physical activity with dietary modification has been shown to reduce inflammatory mediators and improve functional capacity [36]. However, high-quality interventional studies remain scarce, limiting the development of standardized guidelines [10].

5.1. Aerobic / Low-Impact Exercise

Low-impact aerobic exercise is considered the cornerstone of physical activity interventions in lipedema due to its reduced mechanical load on affected lower extremities. Walking is commonly recommended as a basic and accessible form of activity; however, intensity and duration often require individual adjustment to avoid symptom exacerbation [4,10].

Cycling is another frequently used modality, as it enables aerobic conditioning while minimizing vertical loading on painful tissues. Aquatic exercise is also considered particularly beneficial, as buoyancy reduces gravitational load while hydrostatic pressure may support venous and lymphatic return, potentially decreasing perceived heaviness and discomfort during movement [4].

Overall, low-impact aerobic exercise is associated with improvements in mobility, cardiovascular fitness, and general well-being, although evidence specific to lipedema remains

limited and largely observational [10]. Recent objective assessments using accelerometry confirm that women with lipedema spend significantly less time in moderate-to-vigorous physical activity than healthy controls, highlighting the need for tailored low-impact programs [24].

5.2. Resistance Training

Resistance training plays an important role in improving muscular strength, joint stability, and functional performance in individuals with lipedema. Increased muscular support may reduce mechanical strain on connective tissues and improve movement efficiency during daily activities [4,10].

Improved lower-limb and core strength may also enhance postural control and reduce compensatory movement patterns commonly observed in advanced disease stages. Although concerns regarding symptom exacerbation exist, appropriately dosed resistance training appears safe when carefully individualized and progressively implemented. Notably, a recent characterization of lipedema stages found that relative sarcopenia (reduced muscle mass relative to fat mass) is present even in early stages, making resistance training particularly important [35].

Despite its potential benefits, resistance training in lipedema remains under-researched, and optimal training parameters have not been established [10].

5.3. High-Intensity Interval Training (HIIT)

High-intensity interval training (HIIT) has been proposed as an efficient method for improving cardiometabolic fitness in various clinical populations. However, evidence regarding its application in lipedema remains extremely limited, and its suitability is still uncertain [10].

Given pain sensitivity, mechanical load intolerance, and reduced exercise capacity, HIIT should be applied with caution. Although short high-intensity bouts may theoretically improve fitness, they may also increase symptom burden and reduce adherence in individuals with moderate to severe disease. This caution is supported by evidence that lipedema patients exhibit reduced pain pressure thresholds and heightened mechanical sensitivity, making high-impact or high-intensity activities poorly tolerated [34].

At present, HIIT cannot be considered a standard recommendation and should be reserved for carefully selected individuals under professional supervision [10].

5.4. Compression Therapy and Exercise Synergy

Compression therapy is frequently used in conservative management of lipedema and may provide additional benefits when combined with physical activity. External compression may reduce tissue discomfort, support venous and lymphatic return, and improve exercise tolerance during movement [25,27].

The combined use of compression garments and exercise may enhance symptom control by reducing perceived heaviness and pain, potentially improving adherence to physical activity programs. Although evidence remains limited, this approach is widely used in clinical practice and may represent a promising adjunct strategy for improving functional outcomes [4,27].

5.5. Clinical Recommendations

Exercise prescription in lipedema should be individualized according to disease stage, symptom severity, and functional capacity. Gradual progression is recommended to minimize symptom exacerbation and improve long-term adherence [4,10].

Pain-guided activity is a key principle, with exercise intensity adjusted based on symptom response rather than fixed performance targets. Excessive mechanical loading should be avoided, as it may worsen pain and reduce engagement in physical activity. Clinical recommendations from recent systematic reviews suggest that a combination of low-impact aerobic exercise, resistance training, and aquatic therapy, performed 3–5 times per week for 20–45 minutes, is both safe and beneficial for improving pain, mobility, and quality of life in lipedema [24,39].

The most effective approach appears to involve low-impact aerobic exercise, resistance training, and patient-centered programming. However, high-quality studies remain limited, and further research is needed to establish evidence-based guidelines [10].

6. Current and Emerging Therapeutic Approaches

The management of lipedema is primarily conservative, focusing on symptom reduction, functional improvement, and quality of life rather than curative treatment. Given the multifactorial nature of the disease, therapeutic strategies are typically multimodal and require long-term individualized management [1,6,25].

6.1. Conservative Treatment

Conservative management remains the first-line approach in lipedema and is primarily aimed at reducing pain, improving mobility, and limiting disease progression. Compression therapy is widely used and represents one of the most established interventions. Graduated compression garments may reduce tissue swelling, improve venous and lymphatic return, and decrease sensations of heaviness and discomfort in the lower extremities [25,27].

Manual lymphatic drainage (MLD) is also frequently applied, particularly in patients with secondary lymphatic involvement or more advanced disease stages. Although lipedema is not primarily a lymphatic disorder, MLD may provide symptomatic relief by improving fluid dynamics and reducing subjective swelling and discomfort [6,25]. However, the evidence base remains limited, and effects appear to be predominantly symptomatic rather than disease-modifying.

6.2. Nutritional Approaches

Nutritional strategies are increasingly discussed as adjunctive interventions in lipedema management, although robust clinical evidence remains limited. Among dietary approaches, ketogenic or very low-carbohydrate diets have gained attention due to potential anti-inflammatory effects and possible influence on adipose tissue metabolism [20,21,23].

Preliminary studies suggest improvements in body composition, pain perception, and quality of life; however, these findings are primarily based on small cohorts or observational data, limiting generalizability [21,23]. A recent systematic review of dietary interventions for lipedema confirmed that while short-term benefits have been reported, high-quality evidence remains insufficient to support routine clinical recommendation [39]. At present, nutritional interventions should be considered supportive rather than primary therapeutic strategies, and their effects require further high-quality investigation. Beyond dietary patterns, specific nutraceutical interventions have also been proposed as supportive strategies, although evidence remains preliminary [22].

6.3. Surgical Options

Liposuction represents the most established surgical intervention for lipedema, particularly in patients with advanced disease and significant functional impairment. Techniques such as water-assisted liposuction have demonstrated improvements in pain, mobility, and patient-reported outcomes [18].

Long-term studies suggest sustained symptom relief, including reduced limb volume and improved quality of life [19]. However, liposuction does not address the underlying pathophysiology of the disease and is therefore not considered curative. Careful patient selection and long-term follow-up are essential, as outcomes depend strongly on disease stage and post-operative management [18,19]. Recent retrospective studies have further confirmed that lipedema reduction surgery improves pain, mobility, physical function, and quality of life in carefully selected patients [35].

6.4. Emerging Therapies

Emerging therapeutic approaches in lipedema increasingly focus on targeting inflammation, tissue remodeling, and functional impairment. Anti-inflammatory strategies, including lifestyle-based interventions and metabolic modulation, are being explored as adjunctive options due to the role of chronic low-grade inflammation in disease progression [3,4].

Multimodal rehabilitation programs combining exercise therapy, compression, nutritional support, and psychological care are gaining attention. These approaches aim to address both physiological and functional aspects of the disease simultaneously [4,10]. A 7-month prospective dietary and lifestyle intervention demonstrated that combined non-pharmacological approaches can reduce inflammatory mediators and improve functional capacity, supporting the feasibility of such multimodal programs [36]. Although promising, these approaches remain insufficiently evaluated in controlled trials. The importance of coordinated, multidisciplinary care models has been increasingly recognized as essential for addressing the complex needs of individuals with lipedema [25].

7. Discussion

This narrative review highlights lipedema as a chronic adipose tissue disorder characterized by structural abnormalities, microvascular dysfunction, hormonal influences, and chronic low-grade inflammation. Critically, these mechanisms collectively contribute to pain, mechanical sensitivity, and progressive functional limitations. These factors ultimately shape physical activity behavior and exercise tolerance [3,4,10].

Structural changes in adipose tissue, including fibrosis and ECM remodeling, increase tissue stiffness and mechanical discomfort [4,15]. Microvascular abnormalities and inflammatory processes contribute to pain sensitization [3,4]. These factors reduce tolerance to mechanical load, leading to reduced physical activity, progressive deconditioning, and further functional

decline [10,24]. This creates a bidirectional relationship where symptoms limit activity and inactivity exacerbates impairment.

Despite the central role of physical activity, exercise-based interventions in lipedema remain under-researched. Current evidence is largely based on observational studies and small pilot trials rather than high-quality RCTs [4,10]. Exercise prescription is therefore guided more by clinical experience than robust evidence.

From a sport and exercise medicine perspective, exercise interventions must be adapted to individual tolerance, focusing on improving functional capacity rather than traditional performance targets [4,10,25]. Early identification of movement limitations allows for timely implementation of individualized exercise programs [4,10,24].

A major limitation is the absence of standardized exercise guidelines for lipedema, with no consensus on optimal frequency, intensity, or progression models [4,10,24]. Most research relies on self-reported activity levels rather than objective measures such as accelerometry [24]. Future trials should explore optimal exercise dosing, progression strategies, and the interaction between exercise and adjunctive therapies such as compression and nutritional interventions [4,10,36,39].

In summary, lipedema creates a self-perpetuating cycle of pain, inactivity, and deconditioning [10,24]. Although exercise is a promising strategy, its application remains insufficiently supported by high-quality evidence. Advancing the field requires well-designed intervention studies, standardized protocols, and objective assessment of physical activity [4,10,24].

8. Limitations

This narrative review is subject to several limitations that should be considered when interpreting the presented findings. First, the study design is based on a narrative synthesis of the literature rather than a systematic review methodology, which introduces the potential for selection bias and limits reproducibility of the search strategy [4,10].

Second, the available literature on lipedema is heterogeneous with regard to study design, diagnostic criteria, population characteristics, and outcome measures. This variability reduces comparability across studies and limits the ability to draw definitive conclusions, particularly in relation to physical activity and exercise interventions [4,10,24].

Third, the evidence base for exercise-based and other interventional approaches remains limited. The majority of studies are observational or pilot in nature, with a lack of randomized controlled trials evaluating standardized and progressive exercise protocols in lipedema

populations. This restricts the strength of evidence supporting specific physical activity recommendations [4,10,24].

Finally, diagnostic inconsistency across studies represents an additional limitation. The absence of validated biomarkers and reliance on clinical criteria may lead to variability in case definition, contributing to heterogeneity in reported outcomes and limiting cross-study comparability [1,6,28].

Despite these limitations, this review provides a structured synthesis of current evidence linking pathophysiology, functional impairment, and exercise-based management in lipedema, and highlights key areas for future research in sport and exercise science.

9. Conclusions

Lipedema is a chronic disorder of adipose tissue driven by a complex interaction of structural, inflammatory, vascular, and hormonal mechanisms. These factors collectively lead to pain, reduced mobility, and progressive functional decline. Across the available literature, functional limitations emerge as a central feature of the disease, significantly affecting daily activities and limiting participation in physical activity.

Physical activity and exercise represent promising strategies in the conservative management of lipedema, offering potential benefits for pain reduction, functional capacity, and overall quality of life. However, current evidence remains limited, and exercise prescription continues to be based largely on general principles rather than condition-specific research.

A major gap in the existing literature is the absence of standardized, evidence-based physical activity guidelines tailored specifically to individuals with lipedema. High-quality interventional studies, particularly randomized controlled trials, are urgently needed to determine optimal exercise modalities, intensity levels, and progression strategies for this population.

DISCLOSURE

Author's Contributions:

Conceptualization: Karolina Karwat, Jakub Miarczyński, Stanisław Gut, Nikola Wiercińska, Juliusz Widelski

Formal analysis: Julisz Widelski, Jakub Miarczyński, Stanisław Gut, Nikola Wiercińska

Investigation: Stanisław Gut, Nikola Wiercińska, Karolina Karwat, Jakub Miarczyński, Szymon Woźniak

Writing rough preparation: Nikola Wiercińska, Juliusz Widelski, Szymon Woźniak, Karolina Karwat, Jakub Miarczyński, Szymon Woźniak

Writing review and editing: Jakub Miarczyński, Stanisław Gut, Julisz Widelski

All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Avability Statement: Not applicable

Conflicts of Interest: The authors declare no conflict of interest.

References

1 Herbst KL, Kahn LA, Iker E, et al. *Standard of care for lipedema in the United States. Phlebology*. 2021;36(10):779–796. doi:10.1177/02683555211015887.

2 Kruppa P, Georgiou I, Biermann N, et al. *Lipedema—pathogenesis, diagnosis, and treatment options*. Dtsch Arztebl Int. 2020;117(22–23):396–403. doi:10.3238/arztebl.2020.0396.

3 Buso G, Depairon M, Tomson D, et al. *Lipedema: a call to action!* Obesity (Silver Spring). 2019;27(10):1567–1576. doi:10.1002/oby.22597.

4 Poojari A, Dev K, Rabiee A. *Lipedema: insights into morphology, pathophysiology, and challenges.* Biomedicines. 2022;10(12):3081. doi:10.3390/biomedicines10123081.

5 van der Parra RFD, Deconinck C, Krug B. *Diagnostic imaging in lipedema: a systematic review*. Obes Rev. 2024;25(1):e13648. doi:10.1111/obr.13648.

6 Reich-Schupke S, Altmeyer P, Stücker M. *S1 guidelines: lipedema.* J Dtsch Dermatol Ges. 2017;15(7):758–767. doi:10.1111/ddg.13036.

7 Falck F, Rolander B, Nygårdh A, et al. *Women with lipedema: health-related quality of life.* BMC Womens Health. 2022;22:457. doi:10.1186/s12905-022-02022-3.

8 Romeijn JRM, de Rooij MJM, Janssen L, Martens H. *Quality of life in lipedema patients.* Dermatol Ther (Heidelb). 2018;8(2):303–311. doi:10.1007/s13555-018-0241-6.

9 Dudek JE, Białaszek W, Gabriel M. *Quality of life in Polish women with lipedema.* BMC Womens Health. 2021;21:27. doi:10.1186/s12905-021-01174-y.

10 Aitzetmüller-Klietz ML, et al. *Pain, physical activity and mental health in lipedema patients.* J Clin Med. 2023;12(16):5319. doi:10.3390/jcm12165319.

11 Clarke C, Kirby JN, Smidt T, Best T. *Stages of lipedema and health outcomes.* Qual Life Res. 2023;32(1):127–137. doi:10.1007/s11136-022-03216-w.

12 Aksoy H, Karadag AS, Wollina U. *Lipedema-associated pain mechanisms.* Dermatol Ther. 2021;34(1):e14364. doi:10.1111/dth.14364.

13 Katzer KL, Hill JL, McIver KB, Foster MT. *Estrogen role in lipedema and adipose tissue accumulation.* Int J Mol Sci. 2021;22(21):11720. doi:10.3390/ijms222111720.

14 Paolacci S, et al. *Genetics of lipedema: new perspectives on molecular mechanisms.* Int J Mol Sci. 2020;21(20):7250. doi:10.3390/ijms21207250.

15 Szél E, Kemény L, Groma G, Szolnoky G. *Pathophysiological dilemmas of lipedema.* Med Hypotheses. 2014;83(5):599–606. doi:10.1016/j.mehy.2014.08.011.

16 Goss JA, Greene AK. *Sensitivity and specificity of the Stemmer sign for lymphedema*. Plast Reconstr Surg Glob Open. 2019;7(6):e2295. doi:10.1097/GOX.0000000000002295.

17 Cestari M. *3D ultrasound diagnostics in lipedema*. Lymphat Res Biol. 2023;21(5):485–487. doi:10.1089/lrb.2022.0082.

18 Witte T, et al. *Water-jet assisted liposuction for lipedema: standardized protocol*. J Plast Reconstr Aesthet Surg. 2020;73(9):1637–1644. doi:10.1016/j.bjps.2020.03.002.

19 Kruppa P, et al. *Long-term outcomes after liposuction in lipedema patients.* Plast Reconstr Surg. 2022;149(3):529e–540e. doi:10.1097/PRS.0000000000008880.

20 Muscogiuri G, et al. *VLCKD in obesity management: systematic review*. Obes Facts. 2021;14(2):222–245. doi:10.1159/000515381.

21 Cannataro R, et al. *Ketogenic diet in lipedema management: follow-up study*. Life. 2021;11(12):1402. doi:10.3390/life11121402.

22 Cannataro R, Cione E. *Nutraceuticals in lipedema: scientific use. Nutraceuticals.* 2022;2(4):20. doi:10.3390/nutraceuticals2040020.

23 Keith L, et al. *Ketogenic diet as potential intervention for lipedema*. Med Hypotheses. 2021;146:110435. doi:10.1016/j.mehy.2020.110435.

24 Malm IA, Nilsson PV, Hurtig-Wennlöf A. *Objective physical activity in lipedema.* BMC Womens Health. 2026;26:50. doi:10.1186/s12905-026-04271-y.

25 Forner-Cordero I, et al. *Management of lipedema: multidisciplinary approach*. Int Angiol. 2021;40(4):345–357. doi:10.23736/S0392-9590.21.04752-2.

26 Szolnoky G, et al. *Capillary fragility in lipedema.* Lymphology. 2017;50(4):210–216.

27 Czerwińska M, et al. *Compression therapy in lipedema patients.* Int J Environ Res Public Health. 2023;20(2):914. doi:10.3390/ijerph20020914.

28 Warren Peled WP, Kappos EA. *Diagnostic challenges in lipedema.* Int J Womens Health. 2016;8:389–395. doi:10.2147/IJWH.S106227.

29 Okhovat JP, Alavi A. *Lipedema review of literature.* Int J Low Extrem Wounds. 2015;14(3):262–267. doi:10.1177/1534734614554284.

30 Reich-Schupke S, et al. *Differential diagnosis lipedema vs obesity.* J Dtsch Dermatol Ges. 2013;11(3):225–233. doi:10.1111/ddg.12024.

31 Amato ACM, Saucedo DZ, Santos KDS, Benitti DA. *Ultrasound criteria for lipedema diagnosis.* Phlebology. 2021;36(8):651–658. doi:10.1177/02683555211002340.

32 von Atzigen J, Burger A, Grünherz L, et al. *A comparative analysis to dissect the histological and molecular differences among lipedema, lipohypertrophy and secondary lymphedema.* Int J Mol Sci. 2023;24(8):7591. doi:10.3390/ijms24087591.

33 Pervane S, Uzun Ö. *Neuropathic pain features in lipedema compared to lymphedema: an exploratory cross-sectional study*. Lymphat Res Biol. 2026. doi:10.1177/15578585261454778. Epub ahead of print.

34 Bettariga F, Fumagalli L, Aloisi D, Maestroni L, Mantovani S. *Characterization of pain in lipedema: reliability and validity of pain pressure thresholds and hand-held sphygmomanometer assessments in people with lipedema*. Lymphat Res Biol. 2025;23(2):95-100. doi:10.1089/lrb.2024.0012.

35 Al-Ghadban S, Evancio JV, Alfiscar PEF, Herbst KL. *New characterization of lipedema stages: focus on pain, water, fat and skeletal muscle.* Life (Basel). 2025;15(9):1397. doi:10.3390/life15091397.

36 Chachaj A, Fleszar M, Lewandowski Ł, et al. *Changes in vascular, lymphatic, inflammatory, and lipid mediators during a 7-month calorie-restricted low-carbohydrate,*

high-fat dietary intervention in women with lipedema: a preliminary prospective study. Nutrients. 2026;18(9):1381. doi:10.3390/nu18091381.

37 Stellmaker R, Thompson B, Mackie H, et al. A *retrospective cross-sectional study comparing health-related quality-of-life in females with lipoedema and bilateral leg lymphoedema*. J Psychosom Res. 2026;203:112562. doi:10.1016/j.jpsychores.2026.112562.

38 Głowacka J, et al. *Lipedema: diagnosis, treatment and vicious cycle*. Qual Sport. 2025;38:57746. doi:10.12775/QS.2025.38.57746.

39 de Oliveira J, de Paula ACP, Guimarães VHD. *Clinical or cultural? Dietary interventions for lipedema: a systematic review*. Maturitas. 2025;202:108716. doi:10.1016/j.maturitas.2025.108716.