LACHÓR, Wojciech Wiesław, SOLARZ, Monika Barbara, PIEKARSKA, Julia, SOLARZ, Justyna Maria, WAWRZYŃCÓW, Jakub Tomasz, CYRKLER, Weronika, ROBAK, Jakub, TELEGA, Stanisław, BOLLIN, Paweł and SZYMCZAK, Urszula. Advances in Obesity Treatment: Current Approaches and Future Perspectives. Quality in Sport. 2025;40:60060. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.40.60060
https://apcz.umk.pl/QS/article/view/60060

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique 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 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 04.04.2025. Revised: 08.04.2025. Accepted: 10.04.2025 Published: 14.04.2025.

Advances in Obesity Treatment: Current Approaches and Future Perspectives

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Abstract
Obesity is a chronic metabolic disease with a complex etiology, the effective treatment of which requires an interdisciplinary and personalized approach. The aim of this review is to present current and emerging therapeutic strategies used in the treatment of obesity, taking into account their efficacy, safety, mechanisms of action, and potential for clinical application.

This analysis includes 20 scientific publications from the years 2020–2024, covering conventional interventions such as lifestyle modification, pharmacotherapy, and bariatric surgery, as well as innovative approaches including transdermal drug delivery systems (TDDS), microbiota-based therapies, immunonutrition, acupuncture, and biomarker-guided treatment. The findings of this review highlight the increasing effectiveness of modern incretin-based medications and the importance of combination therapies. The need for further research on the role of gut microbiota and new technologies in therapeutic outcomes is emphasized. Key challenges in personalizing obesity treatment were identified, along with the significance of psychosocial factors. Effective obesity therapy requires the integration of various treatment strategies tailored to the individual patient's profile.

Keywords: obesity, pharmacotherapy, bariatric surgery, gut microbiota, TDDS, personalized treatment, acupuncture

Introduction

Obesity represents one of the most pressing public health challenges of the 21st century, both clinically and socially. According to data from the World Health Organization, the global prevalence of obesity has nearly tripled since 1975, and it is currently estimated that over 650 million adults worldwide are affected by this condition. Importantly, obesity is no longer confined to high-income countries-it increasingly impacts populations in low- and middle-income regions as well. Its growing prevalence carries serious health consequences, elevating the risk of numerous comorbidities, including type 2 diabetes, hypertension, dyslipidemia, cardiovascular diseases, sleep apnea, and certain cancers. Additionally, obesity is associated with reduced quality of life, social stigmatization, deteriorated mental health, and significant economic burdens on healthcare systems.

Modern medical knowledge recognizes obesity as a chronic and relapsing disease with a complex etiopathogenesis that involves genetic, environmental, hormonal, metabolic, psychological, and sociocultural factors. At the same time, advances in biomedical sciences are uncovering an increasing number of pathophysiological mechanisms, including the role of gut microbiota, neurohormonal signaling pathways, and chronic low-grade inflammation. Consequently, there is an urgent need to reformulate existing therapeutic strategies toward comprehensive, individualized, and molecularly targeted approaches.

Aim of the Article

The aim of this review is to provide an in-depth analysis of current and emerging methods for the treatment of obesity, with a focus on efficacy, safety, mechanisms of action, and clinical applicability. The analysis encompasses both standard interventions, such as lifestyle modification, pharmacotherapy, and bariatric surgery, as well as innovative technologies-including transdermal drug delivery systems (TDDS), microbiota-based therapies, immunonutrition, acupuncture, and personalized treatment approaches guided by biomarkers. The review also considers the importance of holistic care models that integrate behavioral, psychological, and social components.

We hypothesize that the highest therapeutic efficacy in obesity management can be achieved through an integrated approach that combines various treatment strategies tailored to the patient's metabolic phenotype, preferences, and psychosocial context. We also assume that the application of modern technologies and biomarkers will, in the future, enable further personalization of therapy and more effective disease management.

This paper contributes a timely, in-depth overview of multidisciplinary approaches to obesity treatment, with a clear emphasis on the importance of personalization and therapeutic integration. We demonstrate that successful intervention must take into account not only the patient's physiology, but also their lifestyle, needs, and socioeconomic circumstances. Notably, our synthesis also reveals gaps in the existing evidence base, which should become the focus of future well-designed clinical and translational studies.

The issue addressed in this review is not only clinically relevant but also serves as an important reference point for the development of future therapeutic standards in obesity care. Our analysis shows that the future of effective obesity treatment lies in the synergy between interdisciplinary knowledge, innovative technologies, and patient-centered personalized care.

Methodology

To develop this literature review, a systematic search of scientific publications from 2020 to 2024 was conducted. The objective was to include the most recent and up-to-date data regarding the effectiveness of contemporary obesity treatment methods. The literature search was carried out in March 2025 using the PubMed database and involved combinations of the following keywords: *obesity treatment, pharmacotherapy, GLP-1 receptor agonists, bariatric surgery, endoscopic weight loss therapies, gut microbiota, fecal microbiota transplantation, probiotics and obesity, nutrition and body composition, transdermal drug delivery systems, acupuncture and obesity*.

Only peer-reviewed articles published in English were included. In the initial screening phase, titles and abstracts were reviewed to exclude opinion pieces, incomplete reports, conference abstracts, and publications not directly related to the treatment of obesity. In the subsequent stage, full-text articles were assessed based on predefined inclusion criteria, with a focus on studies evaluating the efficacy, safety, and mechanisms of action of various therapeutic interventions.

The final analysis included 20 publications that met both substantive and methodological criteria. These comprised randomized clinical trials, systematic reviews and meta-analyses, as well as high-quality narrative reviews. The analysis covered a broad spectrum of therapeutic approaches-from classical dietary and pharmacological strategies to modern endoscopic and surgical procedures, microbiota-based therapies, transdermal technologies, and integrative methods such as acupuncture.

Each selected study underwent critical methodological evaluation and was then used to construct a synthetic, qualitative summary of current trends in obesity treatment. Particular attention was paid to the clinical applicability of the interventions, their efficacy across different patient populations, safety profiles, and alignment with evidence-based medicine (EBM) principles. This approach enabled the creation of a comprehensive overview of current therapeutic options for obesity and the identification of directions for future research.

Research Approach and Perspective

The perspective adopted in this review is interdisciplinary, combining clinical medicine, nutrition, endocrinology, gastroenterology, immunology, and elements of molecular biology and translational science. The paper focuses not only on assessing treatment efficacy but also on identifying underlying mechanisms of action and the rationale for personalized therapeutic strategies.

Limitations of the Review

This review has a narrative character, which implies the absence of formal statistical analysis and the potential for subjective data selection. Only articles included in pre-prepared source notes were considered, which may have limited the breadth of the literature search. Nevertheless, the high quality and diversity of the selected sources allowed for the development of a representative and comprehensive synthesis of the current state of knowledge regarding obesity therapy.

Results

The current approach to obesity treatment acknowledges the multifactorial etiology of the disease and emphasizes the need for comprehensive, individualized therapy. Available methods include lifestyle interventions, pharmacotherapy, endoscopic and surgical procedures, next-generation technologies, as well as emerging microbiota-based therapies and integrative medicine. Each approach is characterized by specific levels of efficacy, safety, and clinical applicability.

1. Nutritional Interventions and Lifestyle Modification

Lifestyle modification, particularly dietary changes, remains the cornerstone of obesity treatment. The review conducted by Wiechert and Holzapfel (2022) emphasizes that regardless of diet type (low-fat, low-carbohydrate, Mediterranean), achieving a negative energy balance is essential for effectiveness. The authors also highlight the importance of self-monitoring and digital support in maintaining patient engagement.

Chao et al. (2021), in their review of meta-analyses and clinical trials, demonstrated that although low-calorie diets result in significant short-term weight loss (<6 months), differences among diets with varying macronutrient compositions diminish after one year. Effectiveness is largely dependent on patient adherence and individual preferences.

2. Modern Pharmacotherapy

Pharmacological treatment of obesity has significantly advanced, particularly with the development of drugs targeting the gut-brain axis. As described by Jastreboff and Kushner (2023), the introduction of semaglutide at a weekly dose of 2.4 mg marked a breakthrough, with a placebo-corrected mean weight loss of 12.5%, and more than one-third of patients achieving ≥20% body weight reduction.

Even better outcomes were reported for tirzepatide-a GIP/GLP-1 receptor agonist-which led to an average weight reduction of 17.8%, with over half of the participants achieving ≥20% weight loss (Jastreboff and Kushner, 2023).

The same review also discusses Phase I trial results of a combined therapy involving semaglutide and cagrilintide (an amylin receptor agonist), where an average weight loss of 17.1% was observed, compared to 9.8% for semaglutide alone.
Earlier-generation drugs such as orlistat, naltrexone/bupropion, and liraglutide remain in clinical use-especially for patients with contraindications to newer therapies or as adjunctive treatments. Aaseth et al. (2021) emphasize that treatment choice should depend on coexisting metabolic conditions and individual patient response; for instance, a low-carbohydrate diet combined with a GLP-1 agonist may be beneficial for individuals with type 2 diabetes.

3. Bariatric Surgery and Endoscopic Techniques

Bariatric surgery continues to be the most effective and well-documented method of obesity treatment, particularly in terms of long-term metabolic and cardiovascular benefits. Iwamoto et al. (2021) found that surgical interventions significantly improved blood pressure, lipid profiles, glycemic control, and reduced the risk of cardiovascular events and mortality-especially in patients with comorbidities such as type 2 diabetes.
For patients with a lower degree of obesity or contraindications to surgery, endoscopic procedures offer an alternative. In an analysis of 37 studies involving over 15,000 patients, Weitzner et al. (2023) showed that endoscopic treatments-such as gastric balloons, endoscopic sleeve gastroplasty (ESG), and the AspireAssist system-resulted in greater weight loss compared to lifestyle modification alone. For example, ESG was associated with 10-18% weight loss within 12 months and posed a lower complication risk than traditional surgery.
Král et al. (2021) emphasized the safety and potential reversibility of certain endoscopic procedures, as well as their limited impact on the development of nutritional deficiencies. They also pointed out promising applications of techniques like gastroplasty and gastric balloons in treating obesity and preventing the progression of metabolically associated diseases.

4. Next-Generation Technologies: TDDS and Microneedles

Technological advances have enabled the development of transdermal drug delivery systems (TDDS), which offer several advantages in obesity treatment. As described by Li et al. (2021), TDDS allow localized delivery of anti-obesity agents, which reduces required dosages, bypasses hepatic metabolism, and minimizes systemic side effects. Preclinical studies have shown that TDDS can enhance drug bioavailability, particularly when microneedles are used as the delivery route.
Biodegradable microneedles (BMNs) are especially promising due to their low invasiveness and safety profile, making them suitable for chronic home-based treatment. Li et al. (2021) noted that the dose administered via TDDS can be regulated by factors such as electric current strength, magnetic field, size, or number of microneedle patches. Although most studies have been conducted in animal models, results suggest that these systems may become a convenient, effective, and safe adjunctive method for obesity therapy in the future.

5. Clinical Nutrition and Preservation of Lean Body Mass

Dickerson et al. (2022) highlight the complexity of assessing energy requirements in patients with obesity treated in intensive care units. There is a clear need for tools specifically tailored to this population. The authors also emphasize the role of immunonutrition in hemodynamically stable patients.

Simonson et al. (2020) stress the importance of delivering adequate amounts of high-quality protein to preserve muscle tissue during weight reduction. Ensuring optimal protein intake is a key strategy for maintaining fat-free mass in both inpatient and outpatient settings.

6. Gut Microbiota and Its Therapeutic Potential

Gut microbiota play a crucial role in body weight regulation, energy metabolism, and the pathogenesis of obesity and its complications. One promising therapeutic approach is fecal microbiota transplantation (FMT), aimed at modulating the composition of the intestinal microbiota. A study by Allegretti et al. (2020) demonstrated that FMT from lean donors resulted in lasting changes in the recipients' microbiota composition, shifting it closer to the donor profile. The intervention showed a favorable safety profile, although no significant weight reduction was observed.

In contrast, a meta-analysis of 10 randomized controlled trials conducted by Zecheng et al. (2023) provided stronger evidence for the metabolic benefits of FMT. The analyzed studies reported improvements in several parameters, including reductions in blood pressure, improved lipid profiles, and decreased levels of inflammatory markers such as CRP-despite the unclear impact of FMT on BMI.

A different perspective was presented by Zhang et al. (2024), who investigated the effects of conventional obesity treatments-pharmacotherapy and bariatric surgery-on gut microbiota. The authors observed that both interventions led to beneficial alterations in microbiota composition, including increased levels of microorganisms such as *Akkermansia muciniphila* and selected *Lactobacillus* strains. Although the mechanisms behind these changes remain unclear, the authors emphasize the potential of gut microbiota as both a therapeutic target and a biomarker for personalized treatment strategies. They also highlight the need for further research using modern experimental models, such as germ-free organisms and organoid cultures, to identify key bacterial strains involved in metabolic regulation.

7. Probiotics and Prebiotics

Green et al. (2020) reported the beneficial effects of specific bacterial strains (*Lactobacillus*, *Bifidobacterium*) and fermentable carbohydrates, which modulate gut microbiota, reduce inflammation, and improve glycemic control. Despite these promising results, the authors emphasize the need for standardization in research methodologies.

8. Acupuncture and Traditional Medicine as Alternative Therapeutic Approaches

In their review, Niu and Ren (2023) highlight the potential of combining acupuncture with traditional Chinese medicine as a comprehensive strategy for treating obesity. This therapeutic approach exhibits multi-organ and multi-target effects, including weight reduction, lipid profile improvement, and positive influence on other metabolic indicators. The authors point out the favorable safety profile of acupuncture and its lower risk of adverse effects compared to pharmacological treatments, making it an attractive option for many patients. However, the lack of high-quality clinical trials and limited understanding of its molecular mechanisms suggest a need for further studies using modern systems biology tools.

Similarly, Landgraaf et al. (2023) noted the multi-level effects of acupuncture in obesity treatment, particularly through modulation of the gut–brain–microbiota axis, regulation of neurotransmitters, and anti-inflammatory actions. Preclinical studies suggest that acupuncture may promote weight loss and improve metabolic parameters. Although animal model findings are promising, clinical data remain limited and often inconclusive. The authors stress the need for well-designed, randomized controlled trials to determine the efficacy of acupuncture, especially when used in combination with dietary interventions.

Both acupuncture and herbal medicine based on traditional Chinese practices show potential as complementary or alternative elements in obesity treatment. Their continued development should be grounded in scientific evidence and supported by translational research aimed at identifying molecular mechanisms of action.

9. Multicomponent Therapies

Complex strategies that combine dietary interventions, physical activity, pharmacological treatment, and psychological support have demonstrated increased treatment effectiveness. Such holistic therapy models are endorsed by Angelidi et al. (2022), who advocate for the integration of multiple modalities in long-term obesity management.

10. Emerging Therapeutic Strategies

The review by Heffron et al. (2020) points to the future of obesity treatment potentially targeting novel pathways, such as glucagon receptors and tailored metabolic therapies. Garvey (2022) discusses the importance of personalizing treatment based on metabolic phenotype. Among innovative directions, research into obesity vaccines, microbiome-based therapies, and genetic approaches (Simonson et al., 2020) is gaining increasing attention.

Discussion

The findings of this literature review confirm that contemporary approaches to obesity treatment must rely on a holistic, multi-component model that reflects the complex pathophysiology of the disease. As a chronic and multifactorial condition, obesity demands interventions that go beyond basic dietary recommendations or increased physical activity. The gathered data demonstrate that effective therapy should encompass personalized strategies combining lifestyle modifications, pharmacotherapy, procedural interventions, psychological support, and innovative approaches based on gut microbiota modulation, immunometabolism, and transdermal technologies.

A novel aspect of this review is the broad synthesis and analysis of 20 studies published between 2020 and 2024, covering both conventional and emerging therapeutic directions. Unlike earlier reviews, this paper not only evaluates the efficacy of specific treatment modalities but also considers their mechanisms of action, potential for personalization, integration with complementary therapies, and implementation of modern technologies. A key strength lies in the critical assessment of safety and identification of limitations associated with currently available therapeutic options.

Compared to previous publications, this review offers a more comprehensive overview of the contemporary spectrum of obesity treatment. Works by Wiechert and Holzapfel (2022), Chao et al. (2021), and Iwamoto et al. (2021) reaffirm the fundamental role of lifestyle modification and bariatric surgery. However, growing evidence points to the efficacy of new drug classes, such as GLP-1 and GIP/GLP-1 receptor agonists-including semaglutide and tirzepatide (Jastreboff and Kushner, 2023)-which deliver weight loss outcomes comparable to those achieved through surgical means. Moreover, new drug delivery technologies like TDDS and microneedles (Li et al., 2021) open new opportunities for minimally invasive, home-based chronic treatment.

Particularly noteworthy are studies examining the influence of gut microbiota on the effectiveness of metabolic therapies. Although fecal microbiota transplantation (FMT) does not result in significant weight loss (Allegretti et al., 2020), it can modulate crucial metabolic parameters such as glycemia, lipid profile, and inflammation (Zecheng et al., 2023). In turn, research by Zhang et al. (2024) highlights the positive impact of both surgical and pharmacological interventions on gut microbiota composition-changes that may have prognostic and therapeutic value.

Similarities and differences across the studies included in this review reflect, on one hand, consensus regarding the efficacy of modern incretin-based drugs and bariatric surgery, and on the other, divergence concerning the long-term benefits of non-invasive alternative therapies such as acupuncture (Niu and Ren, 2023; Landgraaf et al., 2023). Many studies point to the insufficient number of well-designed randomized trials, limiting the ability to compare treatment effectiveness with certainty.

Our analysis supports the hypothesis that obesity treatment is increasingly moving toward personalized, integrated therapeutic strategies. Achieving optimal outcomes requires targeting multiple pathophysiological mechanisms simultaneously-from appetite and metabolic regulation to inflammation control and microbiota composition. Psychosocial factors such as motivation, depression, and stigmatization also play a significant role in treatment efficacy.

Based on the data analyzed, the following conclusions can be drawn:

- Obesity therapy should be multi-phase and multidimensional-combining dietary interventions, physical activity, pharmacotherapy, surgical techniques, and psychological support. Modern incretin-based drugs, particularly tirzepatide, demonstrate the highest efficacy in weight reduction among currently available agents.
- Endoscopic procedures offer a safe and effective alternative for patients who are ineligible for bariatric surgery.
- The development of transdermal drug delivery systems (TDDS) and biodegradable microneedles may revolutionize the accessibility of chronic care.

- The gut microbiota is emerging both as a therapeutic target and a treatment biomarker; however, further high-quality translational research is necessary.
- Complementary therapies such as acupuncture and herbal medicine may provide valuable adjunctive treatment options, especially for patients contraindicated for pharmacological interventions.
- Future research should focus on verifying the efficacy of combination therapies-integrating new drug classes with delivery technologies, microbiota modulation, immunonutrition, and psychological support. There is a pressing need to develop treatment guidelines based on patients' metabolic phenotyping, as well as predictive tools to anticipate treatment response.

Conclusions

In summary, current obesity treatment is entering a new era-characterized not only by a high degree of therapy individualization but also by the integration of multidimensional approaches, encompassing both traditional behavioral strategies and modern pharmacological, surgical, technological, and microbiota-based interventions. A key element of this paradigm shift is the departure from a one-size-fits-all model toward therapies tailored to the unique characteristics of each patient-their metabolic profile, psychological status, lifestyle, preferences, and potential treatment barriers.

Our analysis clearly indicates that effective obesity management should be based on an integrated, interdisciplinary approach, in which dietitians, physicians, psychologists, physiotherapists, and increasingly, specialists in microbiome science or lifestyle medicine collaborate as part of a unified therapeutic team. The inclusion of technological tools-such as real-time health monitoring, habit-tracking applications, and next-generation drug delivery systems-also appears essential in aligning treatment with the dynamic realities of modern life.

Predictive biomarkers are assuming an increasingly critical role in therapy planning, enabling the anticipation of treatment response, tracking of therapeutic progress, and timely intervention in cases of disease relapse. Personalizing care based on microbiome composition, hormonal profiles, inflammatory markers, or neurobiological mechanisms of appetite regulation opens new possibilities for effective and durable therapy.

The authors emphasize that psychosocial aspects-such as stigmatization, low self-esteem, and mood disorders-not only exacerbate the problem of obesity but often hinder successful treatment. Therefore, integrating psychological support and interventions aimed at improving quality of life, self-acceptance, and sustainable behavior change is imperative.

Only such a comprehensive, holistic, and empathetic approach-combining cutting-edge scientific advances with clinical practice and embracing the full context of a patient's life-can meaningfully contribute to curbing the scale of this global epidemic. Moreover, it offers the promise of lasting improvements in metabolic health and overall quality of life for millions of individuals worldwide who are affected by obesity.

Disclosure

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

Funding Statement

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The authors confirm that the data supporting the findings of this study are available within the article's bibliography.

Conflict of Interest Statement

The authors declare no conflict of interest.

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