

Transforming Obesity Management: Integrating AI-Driven Digital Health and Novel Pharmacotherapy

비만 관리의 혁신: AI 기반 디지털 헬스와 신약 치료의 융합

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Abstract: The global obesity epidemic presents a critical public health and economic challenge, requiring innovative, integrated solutions. (1) Background/Purpose: This study explores advanced strategies for obesity management, focusing on the integration of AI-driven digital health platforms and next-generation pharmacotherapy, using the Technology-Organization-Environment (TOE) framework. Two industry leaders are examined: Noom, known for its AI-powered behavioral coaching platform, and Novo Nordisk, a pioneer in GLP-1 receptor agonist-based pharmacological treatment (Wegovy/semaglutide). (2) Methodology/Approach: A multi-layered qualitative case study methodology was employed, incorporating document analysis of corporate financial reports, investor presentations, and official press releases; a systematic literature review from PubMed, ScienceDirect, and The Lancet; regulatory filings from the FDA, EMA, and WHO; and comparative data extraction. The TOE framework structured analysis across technological, organizational, and environmental dimensions for both companies. (3) Findings: Both companies demonstrate that ecosystem integration—combining digital coaching with pharmacotherapy—substantially enhances obesity management outcomes. Noom achieves 5–7% average body weight reduction through AI-driven behavioral coaching and strategic partnerships, while Wegovy achieves 14.9% average weight reduction over 68 weeks (STEP 1 trial), with additional 20% cardiovascular risk reduction (SELECT trial). The joint integration of behavioral health tools and pharmacotherapy offers a hybrid approach addressing both biological mechanisms and lifestyle-related behaviors. Key challenges include high treatment costs, patient adherence barriers, and complex regulatory frameworks. (4) Originality/Value: This study provides actionable insights into emerging business models and collaborative opportunities that leverage digital innovation and pharmacological advancements, emphasizing the potential for personalized, technology-driven care to transform obesity management. Future research should focus on integrating multi-omics data, advancing precision medicine, and exploring innovative healthcare delivery models.

Keywords: Obesity Management; AI-Driven Digital Health; GLP-1 Receptor Agonists; Pharmacotherapy; TOE Framework; Digital Behavioral Coaching; Semaglutide; Noom; Novo Nordisk; Precision Medicine; Sustainable Healthcare Solutions; Wearable Technology; Supply Chain Management

1. Introduction

Obesity is a condition characterized by excessive body fat that increases the risk of health problems, affecting multiple body systems including metabolic, cardiovascular, and musculoskeletal systems. Metabolic complications include insulin resistance and type 2 diabetes, caused by inflammation linked to excess fat tissue. Cardiovascular issues include high blood pressure, high cholesterol, and atherosclerosis, leading to heart disease, heart failure, and strokes. Obesity also impacts musculoskeletal systems by adding pressure to weight-bearing joints, potentially causing joint damage, cartilage breakdown, and osteoarthritis (Bliddal & Christensen, 2006; Felson et al., 1997; Lavie et al., 2009; Lingvay et al., 2022; Poirier et al., 2006).

Obesity develops along a continuum; even mild overweight can progress to more serious conditions if unmanaged, resulting from a combination of genetic, environmental, and lifestyle factors (Bray et al., 2017; Heymsfield & Wadden,

2017; Kopelman, 2000). Traditional obesity management focuses on lifestyle changes such as diet adjustments, exercise, behavioral therapy, and, in some cases, medications or bariatric surgery. Dietary changes typically reduce calorie intake through balanced, low-calorie, or low-fat diets, including structured plans like the Mediterranean or low-carbohydrate diets, and some patients used meal replacement products (Nordmann et al., 2006). Exercise—walking, jogging, and resistance training—helps burn calories, improve heart health, and support long-term weight maintenance (Jakicic & Otto, 2006).

Global obesity rates are expected to rise dramatically. In 2020, approximately 2.6 billion people worldwide were considered overweight or obese ($\text{BMI} \geq 25 \text{ kg/m}^2$), representing 38% of the world's population. By 2035, this number is projected to exceed 4 billion—more than 50% of the global population (*World Obesity Atlas 2023*, 2023).

Behavioral therapy addresses the psychological and emotional factors behind weight gain. Techniques such as self-monitoring, goal-setting, and cognitive-behavioral therapy (CBT) promote lasting lifestyle changes (Wadden et al., 2004). Several weight-loss medications exist, though effectiveness and safety vary. For severe obesity ($\text{BMI} \geq 40$, or ≥ 35 with health complications), bariatric surgery—gastric bypass, sleeve gastrectomy, and adjustable gastric banding—became a valuable option when other treatments failed (Sjostrom et al., 2007).

Obesity's economic impact extends beyond healthcare costs. The global economic loss from obesity is estimated to reduce GDP by 2.4%, potentially rising to 2.9% by 2035—comparable to the 3% GDP reduction caused by the COVID-19 pandemic in 2020 (*Chapter 1. The economic impacts of the COVID-19 crisis*, 2022; Sjostrom et al., 2007).

This research examines how recent advancements in pharmacotherapy, technology integration, and changing consumer preferences have transformed the obesity care industry. It identifies emerging business opportunities and analyzes how key companies adapt through strategic efforts, partnerships, and technology-driven solutions. By evaluating collaborations between pharmaceutical companies and digital health platforms, the research reveals how integrated, technology-powered approaches are redefining the future of obesity management.

2. Literature Review

2.1 Obesity-Related Management Approaches

Obesity is a serious global health issue affecting millions worldwide and contributing to various comorbidities such as type 2 diabetes, cardiovascular diseases, and sleep disorders. Effective management is crucial to mitigate these health risks (Anderson et al., 2022; Elmaleh-Sachs et al., 2023).

2.1.1 Lifestyle Modifications

Lifestyle interventions form the cornerstone of obesity management, emphasizing sustainable diet, physical activity, and behavior changes.

Dietary modifications are crucial for achieving a calorie deficit. Popular approaches—low-carbohydrate, low-fat, and Mediterranean diets—have proven effective. Research shows low-carbohydrate diets may produce more significant short-term weight loss than low-fat diets, especially during the first six months, though differences even out over time. Long-term success depends on choosing a sustainable eating pattern that fits personal preferences, cultural habits, and lifestyle (Johnston et al., 2014; Nordmann et al., 2006).

Regular physical activity is vital for managing obesity. Aerobic exercises—walking, cycling, or swimming—for at least 150 minutes per week boost weight loss and lower cardiovascular risks. Resistance training helps maintain muscle mass during calorie restriction. Although exercise alone may cause only modest weight loss, it significantly enhances metabolic health and supports long-term weight management (Donnelly et al., 2009; Swift et al., 2014).

Behavioral therapy addresses psychological and emotional factors affecting weight management. Self-monitoring, goal-setting, and problem-solving help individuals adhere to diet and exercise plans. Research shows behavioral interventions help individuals lose 5–10% of initial body weight within six months, improving conditions like type 2 diabetes and hypertension (Wadden et al., 2014).

While lifestyle interventions are essential, they face several challenges limiting long-term effectiveness: difficulties maintaining dietary changes, sustaining physical activity, managing psychological factors, and overcoming accessibility and scalability barriers. Environmental, psychological, and social factors often interfere with prescribed diets. Conditions like depression, anxiety, and stress can trigger emotional eating; counseling services are often unavailable or too expensive; and societal stigma can discourage full participation (Wadden et al., 2014). Despite these challenges, lifestyle interventions remain critical. Addressing barriers requires innovative solutions—personalized programs, technology-driven support, and broader systemic changes (Donnelly et al., 2009).

2.1.2 Pharmacotherapy

Pharmacotherapy has become an essential treatment option for managing obesity, especially for individuals who struggle to lose weight through lifestyle changes alone. Its goals include promoting significant weight loss, managing obesity-

related health conditions, and improving overall quality of life (*Prescription Medications to Treat Overweight & Obesity*). Obesity medications work through different mechanisms: reducing appetite, blocking fat absorption, and increasing energy expenditure. GLP-1 receptor agonists like semaglutide (Wegovy) and liraglutide (Saxenda) mimic natural hormones that control appetite, helping patients lose 10–15% of body weight in clinical trials. Orlistat prevents fat absorption, resulting in moderate weight loss. Combination therapies like phentermine/topiramate (Qsymia) and bupropion/naltrexone (Contrave) use multiple mechanisms to boost results (*FDA Approves New Drug Treatment for Chronic Weight Management*, 2021; Grunvald et al., 2022; Khera et al., 2016).

Common side effects such as stomach issues or increased heart rate can make continued treatment difficult. Pharmacotherapy is typically recommended for individuals with BMI ≥ 30 , or BMI ≥ 27 with related health issues (*Prescription weight-loss drugs*, 2022). Looking ahead, advances include dual-action GLP-1/GIP agonists and triple-action therapies currently under investigation (Grunvald et al., 2022).

2.1.3 Multi-Omics Approach

The multi-omics approach combines genomics, epigenomics, proteomics, metabolomics, and microbiomics to better understand obesity's complex causes, enabling personalized treatments tailored to individual biological profiles (Cifuentes et al., 2021).

Genomic studies identify genetic variations—such as SNPs in the FTO gene—that increase obesity risk. Epigenomics examines how lifestyle factors like diet and exercise influence gene activity through reversible changes such as DNA methylation (Ling & Ronn, 2019; Locke et al., 2015). Proteomics identifies specific proteins linked to inflammation and energy metabolism. Metabolomics tracks metabolic markers like elevated branched-chain amino acids (BCAAs) related to insulin resistance. Microbiomics studies gut bacteria that regulate energy balance, fat storage, and inflammation, offering another pathway for personalized therapies (Turnbaugh et al., 2006).

By grouping individuals into biological subtypes, the multi-omics approach allows tailored management. However, widespread adoption faces challenges including high implementation costs, difficulties integrating large datasets, and limited public understanding (Cifuentes et al., 2021).

2.1.4 Surgical Interventions

Bariatric surgery is highly effective for severe obesity, especially when lifestyle changes or medications have not produced sufficient weight loss. It reduces stomach size and alters digestion, leading to significant and lasting weight loss while improving type 2 diabetes, high blood pressure, and sleep apnea (Arterburn et al., 2020; De Luca et al., 2024).

Restrictive procedures include sleeve gastrectomy—removing a large part of the stomach, reducing hunger hormones, and leading to 50–60% excess weight loss within 12–18 months—and adjustable gastric banding, which has become less popular due to lower long-term success (De Luca et al., 2024; Tresca, 2024). Malabsorptive procedures include Roux-en-Y gastric bypass, supporting 60–80% excess weight loss, and biliopancreatic diversion with duodenal switch, achieving 70–90% excess weight loss but requiring lifelong nutrient supplements (De Luca et al., 2024; Rubino et al., 2016).

Newer techniques include single-anastomosis duodenal-ileal bypass with sleeve gastrectomy, endoscopic sleeve gastroplasty (minimally invasive, incision-free), and intragastric balloons (temporary, non-surgical). These advancements offer personalized weight management solutions tailored to individual health needs (Adams et al., 2007; Arterburn et al., 2020; De Luca et al., 2024; Mingrone et al., 2021; Rubino et al., 2016; Tresca, 2024).

2.2 Obesity-Related Business

The global increase in obesity has fueled rapid growth of obesity-related businesses across pharmaceuticals, digital health, and wellness. The recognition of obesity as a chronic health problem requiring long-term management has expanded business opportunities. Obesity-related illnesses contribute billions in annual healthcare costs, placing significant economic burden on healthcare systems worldwide.

In 2019, the global economic impact of obesity was estimated at 0.8–2.4% of GDP across various countries. Without action, these costs could increase to 2.4–4.9% of GDP by 2060. The World Obesity Federation predicts annual economic impact of obesity will exceed \$2 trillion globally by 2030 (*Economic impacts of overweight and obesity*, 2021; *Global Obesity Report 2022*, 2022). OECD member countries allocate approximately 8.4% of healthcare expenditures to treating obesity-related conditions (*The Heavy Burden of Obesity*, 2019). In the United Kingdom, obesity-related work absences cost approximately £8.9 billion annually (*Timid approach to weight-loss drug*, 2023). Combined global costs of overweight and obesity are projected to exceed \$4.32 trillion per year by 2035—nearly 3% of global GDP (*Economic impact of overweight and obesity to surpass \$4 trillion by 2035*, 2023).

Obesity-related businesses can be grouped into four major sectors:

Pharmaceuticals and medical devices: Anti-obesity medications such as GLP-1 receptor agonists (e.g., semaglutide) have transformed weight management. Companies like Novo Nordisk and Eli Lilly are leaders in this field (Rubino et al., 2016).

Digital health platforms: Apps like Noom combine behavioral science and AI to create tailored programs, integrating

data from wearable devices and glucose monitors (Kozak et al., 2017).

Wellness and lifestyle solutions: Fitness programs, meal replacement products, and wearable devices like Fitbit and Apple Watch encourage physical activity and healthier eating (Tresca, 2024).

Precision medicine: Multi-omics approaches—including genomics, metabolomics, and microbiomics—enable customized treatment plans. Companies like Phenomix Sciences classify patients into specific obesity subtypes (Hasin et al., 2017).

Bariatric surgery has advanced with robotic-assisted and minimally invasive techniques. Metabolic surgery is also recognized for treating type 2 diabetes, even without significant weight loss, broadening its therapeutic potential (De Luca et al., 2024; Rubino et al., 2016; Tresca, 2024).

3. Methods

3.1 Case Selection

Managing obesity requires a multi-dimensional approach that includes behavioral changes, medication, and personalized treatments supported by advanced technology. This study focuses on two leading companies: Noom, which specializes in lifestyle modification, and Novo Nordisk, known for its obesity medication Wegovy. These companies were selected for their groundbreaking innovations, scientific contributions, and significant impact on the obesity care industry. Bariatric surgery and the multi-omics approach were excluded from detailed analysis due to their specific eligibility requirements and limited scalability.

3.1.1 Lifestyle Modification: Noom

Noom, founded in 2008 and based in New York City, is a digital health company specializing in behavior-based weight management through its mobile platform. The company uses a psychology-driven approach powered by AI and human coaching to help users make lasting lifestyle changes by integrating CBT, personalized plans, and habit-tracking tools.

Noom's evidence-based and scalable model emphasizes psychological coaching and habit-forming strategies. Clinical studies show Noom users achieve an average weight loss of 5–7% of body weight within 12 months, supported by personalized coaching and AI-powered recommendations (Kim et al., 2022; Mitchell et al., 2023).

3.1.2 Pharmacotherapy: Novo Nordisk (Wegovy)

Novo Nordisk, founded in 1923 and headquartered in Denmark, is a global healthcare leader specializing in diabetes, obesity, and hormone replacement therapies. One of its most notable achievements is Wegovy (semaglutide), a breakthrough medication for long-term obesity management that activates GLP-1 receptors, helping regulate appetite and control blood sugar.

The STEP 1 study demonstrated that patients treated with Wegovy experienced an average weight loss of approximately 14.9% over 68 weeks—far exceeding results from earlier obesity medications. Its proven safety and effectiveness have earned its inclusion in international obesity treatment guidelines (Phillips & Clements, 2022; Singh et al., 2022).

3.2 Research Framework

This study uses the Technology-Organization-Environment (TOE) framework, a well-known model for analyzing factors influencing organizations' adoption of new technologies, consisting of three key dimensions (Tornatzky et al., 1990):

Technological dimension: evaluates technological capabilities including infrastructure, innovation potential, and system integration efforts, highlighting how technology improves efficiency and achieves strategic goals.

Organizational dimension: focuses on internal structures such as leadership, resource management, and a culture of innovation, determining readiness to adopt and implement new technologies.

Environmental dimension: considers external influences like market dynamics, government regulations, and social trends, which can either drive or restrict an organization's technological progress.

3.3 Data Collection and Analysis

The data collection process gathered detailed insights into the business models, technological innovations, and market environments of Noom and Novo Nordisk. Key sources included:

Primary sources: Corporate financial reports and investor presentations; clinical trial results (STEP and SELECT trials); official press releases tracking strategic partnerships, product launches, and new business initiatives; and regulatory filings and approvals from the FDA, EMA, and WHO.

Secondary sources: Peer-reviewed academic journals from PubMed, ScienceDirect, and The Lancet; media articles from respected health-tech platforms.

Three key research methods were employed: (1) **Document analysis** reviewing corporate financial records, clinical trial results, organizational structures, and partnership announcements; (2) **Literature review** examining academic journals, regulatory filings, and industry white papers; and (3) **Comparative data extraction** gathering quantitative metrics such as clinical trial results, market share, and revenue growth, alongside qualitative data including business strategies and leadership changes.

The research methodology employed a multi-layered analytical approach:

Descriptive analysis summarized technological and business strategies, highlighting core innovations and market expansion efforts.

Comparative analysis created a comparison table based on the TOE Framework, showing similarities and differences in technological integration, organizational structures, and market-driven strategies.

Content analysis examined leadership strategies, marketing campaigns, and patient engagement efforts.

Quantitative analysis evaluated financial growth, clinical trial results, and product market performance.

4. Results

4.1 Noom

Noom's platform uses AI and machine learning (ML) to deliver personalized health recommendations, collecting data from users' dietary logs, physical activity levels, and psychological assessments to create tailored plans that encourage positive behavior changes (Kim et al., 2022).

4.1.1 Technology

(1) Data-Driven AI Integration in Behavioral Coaching

Initially, Noom's coaching model relied heavily on human-led support from certified health coaches providing one-on-one guidance using CBT principles—helping users set health goals, track progress, and stay motivated. However, managing a large team of human coaches proved costly over time (Biggs, 2021; Thau, 2021).

To address this, Noom introduced AI-powered features including advanced food logging and 'Welli,' an AI chatbot, in June 2024. These tools enhance scalability and reduce operational costs by complementing human coaching with instant, personalized assistance and improving user engagement while keeping costs manageable (*Noom Introduces AI-Enabled Products to Enhance On-Demand Health Care and Interactive Coaching*, 2024).

Noom's AI and ML technologies continuously analyze user-generated data to provide real-time, personalized coaching tips. The system monitors user progress, detects potential setbacks, and sends customized recommendations. For example, if a user logs irregular physical activity or unhealthy eating habits, the AI system adjusts the intervention plan, offering motivational reminders and tailored suggestions. This has helped Noom maintain high user engagement and deliver long-term weight management results (May et al., 2023; *Weight-loss platform Noom bulks up on \$540 million*, 2021).

(2) Localized and Gamified App Development

Noom has localized its app to meet cultural, dietary, and language preferences of users in different regions. In Europe—especially Germany and the UK—Noom tailored offerings by including regional dietary recommendations and wellness preferences. In South Korea, Noom integrated local food databases and culturally relevant coaching content, appealing to the country's tech-savvy and health-conscious population. The app has been translated into multiple languages including German, Korean, Spanish, and French (Comstock, 2012; *Noom grows revenue by 80% through localization on Google Play!*).

In 2024, Noom launched 'Noom Vibe,' a gamified app where users earn 'Vibes' points for completing healthy tasks—logging meals, reaching daily step goals, and participating in wellness activities. These points unlock badges and personalized motivational messages. This gamification feature is based on behavioral economics and motivational psychology, encouraging long-term user engagement and adherence (*Meet four women using apps and games to drive culture and create change*, 2023).

(3) Strategic Partnerships

Noom's strategic partnerships have strengthened its platform by integrating healthcare and wearable technologies. Users can sync data from wearable devices like Fitbit directly into Noom's platform, allowing automatic tracking of activity metrics (*Noom + Fitbit: How to Sync Them Together*, 2022).

In 2019, Noom partnered with Novo Nordisk to provide digital coaching support for patients using Saxenda, a GLP-1 receptor agonist, demonstrating how digital health coaching could complement traditional medical treatments (Rubino et al., 2016). In October 2024, Noom expanded capabilities by partnering with Prism Labs to integrate Body Scan Technology into its platform, targeting users of GLP-1 medications such as Wegovy. Using smartphone-based body scans,

the technology allows users to monitor body composition metrics—muscle mass and body fat percentage—addressing muscle mass retention during weight loss treatments. This AI-powered tool analyzes body composition metrics including body fat percentage, muscle mass, and visceral fat levels through image recognition, helping healthcare providers adjust treatment plans more effectively (*Noom Introduces Innovative In-App Body Scan Technology*, 2024).

4.1.2 Organization

(1) Founding and Leadership

Noom was founded in 2008 by Saeju Jeong and Artem Petakov to transform healthcare from a reactive 'sick care' model to a preventive, behavior-driven approach. Jeong's background in healthcare innovation and Petakov's expertise in data-driven product design at Google helped create a technology-powered platform combining psychology with real-time data analytics (*Noom*, 2024).

During the COVID-19 pandemic, Noom's leadership quickly adapted by expanding the platform beyond weight management to include mental health support, stress management, and general wellness tools. Revenue surged from \$237 million in 2019 to \$400 million in 2020, attracting a \$540 million Series F funding round in 2021 and boosting valuation to approximately \$4 billion (*Weight-loss platform Noom bulks up on \$540 million*, 2021).

Capital raised allowed Noom to scale operations, invest in advanced research, and enhance technological infrastructure. Key investments included improving AI-powered coaching algorithms, launching Noom Mood for mental health support, and introducing Noom Vibe, a gamified wellness app launched in 2024.

(2) Organizational Structure

Noom operates under a hybrid organizational structure combining centralized leadership with decentralized teams focused on product development, customer service, and health coaching. Co-founders Saeju Jeong (former CEO) and Artem Petakov (President and CTO) oversee long-term vision, financial strategy, and technological development.

With over 3,000 employees, including 2,700 behavior-change coaches, Noom balances human support with tech-driven health services. Teams are organized into four key divisions: (1) **Product Development**—UX/UI designers, software engineers, and product managers following an agile development process; (2) **Data Science**—machine learning engineers and data analysts building AI algorithms for personalized user experiences; (3) **Behavioral Coaching**—over 2,700 certified health coaches trained in CBT and motivational interviewing; and (4) **Marketing**—driving user acquisition and brand growth through digital advertising (*Noom Introduces AI-Enabled Products*, 2024).

Noom has implemented comprehensive training programs. Health coaches undergo more than 75 hours of specialized training through 'Noomiversity' and can pursue National Board Certification as Health and Wellness Coaches (*The Art of Invisible Learning; What Is the Noom Diet?*, 2022).

(3) Organizational Restructuring

Noom faced significant organizational changes driven by shifting market conditions. Mike Noonan, who played a key role in securing the \$540 million Series F funding, left the company to join TripAdvisor. In response to financial challenges, Noom reduced its workforce by 10% and laid off more than half its health coaches (*The startups we back grow fast*, 2024).

Saeju Jeong stepped down as CEO and now serves as Executive Chairman of the Board. Geoff Cook was appointed as new CEO, while Artem Petakov continues as President leading product development and technological innovation (*Geoff Cook Joins Noom as Chief Executive Officer*, 2023). Under this leadership, Noom shifted focus toward a more comprehensive platform addressing mental and physical health, reflecting growing consumer demand for integrated health solutions (*Growth Strategy and Future Prospects of Noom*, 2024).

4.1.3 Environment

(1) Competitive Market Landscape

In 2017, the CDC recognized Noom as the first mobile diabetes prevention program (Caffrey, 2017). Concerns about data privacy emerged in 2021, prompting Noom to strengthen data security measures and align with GDPR and HIPAA regulations (Biggs, 2021; *Covered Entities vs Non-Covered Entities under HIPAA*, 2024).

The COVID-19 pandemic accelerated adoption of digital health solutions, contributing to revenue growth from \$237 million in 2019 to \$400 million in 2020 (*Noom Revenue and Usage Statistics*, 2023). Noom competes with WeightWatchers, MyFitnessPal, Livongo, and Samsung Health. As of 2021, Noom's app had been downloaded over 45 million times globally (*Growth Strategy and Future Prospects of Noom*, 2024).

(2) Marketing and Brand Strategy

Noom's marketing relies heavily on partnerships with influencers, health professionals, and celebrities who share success stories on social media. In 2022, Noom partnered with over 150 influencers on Instagram and YouTube, generating around 200 million impressions. Several celebrities have shared positive experiences with Noom, enhancing platform credibility and broader audience appeal (*Noom marketing mix; Noom Weight Loss Success*). User-generated content (UGC) from

Noom's community provides relatable, real-life success stories that resonate with potential users, expanding reach and strengthening brand presence (Sevan, 2024). In 2021, Noom reportedly spent \$250 million on marketing campaigns (*Weight-loss platform Noom bulks up on \$540 million*, 2021).

(3) Global Penetration

As of May 2021, Noom's app had been downloaded over 45 million times across 100 countries. Noom announced plans to expand its AI-powered health coaching platform to more than 100 countries by 2023 (*Noom Revenue and Usage Statistics*, 2023). Strategic local partnerships have played a crucial role—for example, Noom partnered with Allianz in Germany to provide health coaching services through the 'AllRight Coach' app (Jae-won, 2015). Despite global success, Noom must comply with data protection laws such as GDPR and HIPAA, with non-compliance risking severe fines and legal penalties (*Noom PESTEL Analysis*).

4.2 Novo Nordisk (Wegovy)

Pharmacological treatments have become essential for managing obesity-related conditions such as type 2 diabetes, high blood pressure, and heart disease. Novo Nordisk's Wegovy has emerged as a groundbreaking treatment due to its proven ability to promote weight loss and suppress appetite through GLP-1 receptor activation.

4.2.1 Technology

(1) Innovative Product Development

Wegovy, a GLP-1 receptor agonist initially developed for managing type 2 diabetes, became a groundbreaking treatment for obesity through drug repurposing research. Novo Nordisk discovered that semaglutide, the active ingredient in Wegovy, promotes weight loss by targeting the brain's hypothalamic appetite-regulation system. It mimics the natural GLP-1 hormone, stimulating signals that reduce appetite, increase feelings of fullness, and delay stomach emptying. This leads to fewer food cravings, lower calorie intake, and long-term weight loss. Additionally, Wegovy enhances insulin sensitivity, helping prevent fat buildup and support overall metabolic health (Mahapatra et al., 2022; Roomy et al., 2024; Singh et al., 2022).

Novo Nordisk invests approximately 15% of its annual revenue—about \$3.2 billion in 2023—into clinical research, including developing obesity treatments (Nordisk, 2023). Following Wegovy's success, Novo Nordisk developed CagriSema, a combination of semaglutide and cagrilintide (an amylin analog), showing 25% average weight reduction in Phase 3 clinical trials while improving blood sugar control. The company also explores triple-action therapies targeting GLP-1, GIP, and amylin receptors, enhancing appetite suppression, delaying stomach emptying, boosting insulin production, and reducing fat storage (Nordisk, 2023).

(2) Clinical Validations

Semaglutide's effectiveness and safety were evaluated through comprehensive STEP and SELECT clinical trial programs:

STEP 1 Trial (2021): 1,961 adults with obesity ($\text{BMI} \geq 30$) or overweight ($\text{BMI} \geq 27$) with at least one weight-related health condition experienced an average weight reduction of approximately 14.9% after 68 weeks, with 30% achieving $\geq 20\%$ reduction (Amaro et al., 2022; Bergmann et al., 2023; Wilding et al., 2021).

STEP 2 Trial (2022): Adults with type 2 diabetes and obesity achieved an average weight loss of approximately 9.6%, highlighting semaglutide's dual benefits in controlling blood sugar and reducing weight (Amaro et al., 2022; Bergmann et al., 2023; Ghusn et al., 2022).

STEP 3 Trial (2021): Evaluated semaglutide 2.4 mg or placebo over 68 weeks combined with intensive behavioral therapy and low-calorie diet. Combining semaglutide with lifestyle interventions significantly enhanced weight loss (Amaro et al., 2022; Bergmann et al., 2023; Wadden et al., 2021).

STEP 4 Trial (2021): Withdrawal trial assessing impact of continuing versus stopping semaglutide after initial 20-week treatment. Continuing medication resulted in sustained weight loss, underscoring the importance of long-term use (Amaro et al., 2022; Bergmann et al., 2023).

STEP 5 Trial (2023): Examined semaglutide's long-term effectiveness over 104 weeks, with participants achieving up to 18% reduction in body weight (Amaro et al., 2022; Bergmann et al., 2023; Garvey et al., 2022).

SELECT Trial (2024): Investigated cardiovascular outcomes in people with obesity but no diabetes. Semaglutide reduced the risk of major adverse cardiovascular events (MACE) by 20%, confirming long-term health benefits beyond weight loss (Bergmann et al., 2023; Deanfield et al., 2024).

(3) Digital Health Integration

Novo Nordisk has embraced digital health trends by integrating behavioral coaching platforms, real-world evidence (RWE) systems, and remote patient monitoring technologies to provide personalized care, track patient outcomes, and improve product effectiveness.

The most notable initiative is the 2019 partnership with Noom. Patients using Wegovy for weight management receive personalized coaching sessions, meal tracking, and CBT-based support. Noom's platform uses AI and machine learning to tailor real-time coaching recommendations based on users' behaviors (*Novo Nordisk and Noom to partner around digital health solutions*, 2019).

Novo Nordisk has also invested significantly in RWE platforms that collect and analyze data from real-world patients. Using advanced analytics—including natural language processing (NLP), predictive modeling, and AI-driven insights—the company monitors treatment effectiveness, identifies safety concerns, and refines product development. This supports regulatory compliance, product updates, and personalized dosing recommendations while ensuring early detection of potential side effects (*Digital partnerships & solutions*).

4.2.2 Organization

(1) Leadership and Corporate Structure

CEO Lars Fruergaard Jørgensen has played a key role in expanding the company's focus beyond diabetes to lead the global obesity market. His strategic vision led to Wegovy's development and launch, redefining pharmacological obesity treatment worldwide. A significant development is the specialized Obesity Business Unit, focusing entirely on obesity-related research, clinical trials, product development, and global marketing.

With global headquarters in Bagsværd, Denmark, and regional subsidiaries in over 80 countries, Novo Nordisk combines centralized strategic leadership with decentralized operational management, allowing quick adaptation to local market conditions (*Annual Report 2023*).

(2) Financial Performance

Novo Nordisk reported \$25.4 billion in annual revenue in 2022, with \$2 billion directly from obesity treatments including Wegovy. Between 2021 and 2023, Wegovy sales surged 300%, fueled by expansion into new international markets and growing patient demand. Key factors include increased product availability, expanded production capacity, and stronger reimbursement agreements in the United States, Europe, and Asia-Pacific (*Annual Report 2023*). The company allocates \$3.2 billion annually to R&D, supporting clinical trials, next-generation drug development, and regulatory compliance (Nordisk, 2023).

(3) Strategic Partnerships

The 2019 Noom partnership combined AI-powered coaching with Novo Nordisk's medical expertise, offering personalized coaching programs, dietary tracking, and psychological support. This improved patient engagement and increased treatment adherence, reducing risk of weight regain (*Novo Nordisk and Noom to partner around digital health solutions*, 2019).

Novo Nordisk has also secured agreements with major healthcare providers, insurance companies, and government healthcare programs such as UnitedHealthcare, Medicare, and private insurers across Europe and Asia-Pacific. These partnerships have led to favorable reimbursement policies, making Wegovy more accessible through prescription drug coverage programs (Ahmed Aboulenein, 2024; *Digital partnerships & solutions*; Willson, 2024).

4.2.3 Environment

(1) Societal and Market Trends

The global obesity drug market has grown rapidly due to rising prevalence, increased public awareness, and expanding healthcare reimbursement. According to WHO, approximately 1 in 6 adults worldwide is classified as clinically obese (*Obesity and overweight*, 2024). To address these needs, Novo Nordisk launched the global awareness campaign 'Changing Obesity,' aimed at reducing obesity stigma and promoting recognition of obesity as a chronic medical condition (*Annual Report 2023*). Healthcare systems in the U.S., Canada, Europe, and Australia have expanded insurance coverage for weight-loss medications like Wegovy.

(2) Regulatory Compliance

Novo Nordisk secured FDA approval for Wegovy in 2021 and EMA approval in 2022 as a first-line chronic weight management therapy, supported by evidence from the STEP trial program (*FDA Approves First Treatment to Reduce Risk of Serious Heart Problems*, 2024; *Wegovy semaglutide*). Following these approvals, Novo Nordisk expanded Wegovy's availability to key markets including Europe, North America, Japan, and Australia (*Annual Report 2023*).

(3) Competitive Landscape

The obesity drug market has become increasingly competitive. Eli Lilly developed Tirzepatide (Mounjaro), a dual GLP-1/GIP receptor agonist with superior weight-loss effectiveness in Phase 3 clinical trials—with plans for global market launch in 2024 (Fernando, 2024; Gardner, 2024). Recent studies indicate Eli Lilly's Zepbound demonstrated superior outcomes, with users achieving 20.2% weight reduction compared to Wegovy's 13.7% (*Lilly's Zepbound® superior to Wegovy®*, 2024). Pfizer and Amgen have also invested in early-stage trials for next-generation obesity drugs targeting GLP-1, GIP, MC4R, and amylin receptors (Gardner, 2024). Biotech startups like Phenomix Sciences and Altimmune are

advancing precision-medicine solutions focused on obesity genetics and personalized treatments (*Altimune Presents Data from Phase 2 MOMENTUM Trial*, 2024; Ghusn et al., 2022).

4.3 Comparative Analysis Results

The obesity management industry is evolving rapidly, driven by innovative business models combining technology, science, and strategic partnerships. Noom uses AI and digital coaching to provide scalable and personalized health programs, focusing on behavior change and long-term health improvement. In contrast, Novo Nordisk specializes in advanced pharmaceutical research and develops cutting-edge obesity treatments through rigorous clinical trials and regulatory approvals.

Despite different strategies, both companies demonstrate how ecosystem integration enhances market reach. By collaborating with healthcare providers, insurers, and tech platforms, they have expanded access to obesity management solutions worldwide. In the U.S., some state health plans require patients to complete a digital lifestyle management program like Noom before receiving coverage for costly anti-obesity drugs. The U.K.'s NICE-endorsed programs, including Gro Health W8Buddy, Oviva, Roczen, and Second Nature, highlight how digital-first approaches are essential to weight management insurance coverage (*Digital Health Trends 2024*, 2024).

Table 1. TOE Framework Comparison between Noom and Novo Nordisk

Dimension	Aspect	Noom	Novo Nordisk
Technology	Core Technology	AI-driven behavioral coaching and ML algorithms	GLP-1 receptor agonist-based pharmacological innovation
	Innovation Focus	AI-powered health coaching, gamified features (Noom Vibe)	Next-gen therapies like CagriSema and triple-receptor agonists
	Digital Integration	Integrates with wearables, offers real-time coaching and data insights	Partnerships with Noom and adoption of digital monitoring tools
Organization	Leadership Structure	Decentralized with tech-enabled leadership	Centralized with global subsidiaries and specialized Obesity Business Unit
	Business Model	Subscription-based digital health platform	Pharmaceutical development driven by R&D and clinical trials
	Workforce Development	Comprehensive training for health coaches and data scientists	Invests \$3.2B annually in R&D; specialized obesity-focused teams
Environment	Market Landscape	Highly competitive digital health sector with direct-to-consumer strategy	Pharmaceutical sector with growing global obesity drug market
	Regulatory Compliance	Adheres to GDPR and HIPAA regulations	FDA, EMA approvals, and compliance with global health policies
	Competitive Position	Competes with WeightWatchers, MyFitnessPal, and Livongo	Competes with Eli Lilly, Pfizer, Amgen, and biotech startups

4.3.1 Technology Dimension Insights

Noom: Uses AI-driven personalized health coaching by combining behavioral science with machine learning-based recommendations. Its platform continuously analyzes user data to provide customized health guidance. 'Noom Vibe' gamifies the health journey, rewarding users with points and interactive challenges. Advanced digital health infrastructure supports global expansion while minimizing dependence on human coaches, enabling scalable, personalized health support with high operational efficiency.

Novo Nordisk: Focuses on advanced pharmaceutical research specializing in GLP-1-based therapies like Wegovy. The company uses AI-powered clinical trial management and RWE platforms to enhance drug development and track treatment outcomes. Integration of cutting-edge technologies, such as Body Scan Technology for biometric tracking, highlights a tech-forward approach to healthcare innovation.

4.3.2 Organization Dimension Insights

Noom: Shifted from a decentralized structure reliant on human coaches to a more tech-driven model. The company streamlined operations following workforce reductions by integrating AI-powered coaching tools like 'Welli' and

advanced behavioral algorithms, reducing reliance on human coaches and enabling more efficient service delivery, increased scalability, and smoother global expansion.

Novo Nordisk: Operates through centralized headquarters supported by more than 80 regional subsidiaries ensuring localized regulatory compliance and smooth product distribution. Its specialized Obesity Business Unit drives research, clinical trials, and global marketing strategies, balancing centralized scientific leadership with regional adaptability.

4.3.3 Environmental Dimension Insights

Noom: Competes in the fast-changing digital health sector, facing competition from established brands like WW and MyFitnessPal. Influencer partnerships and direct-to-consumer marketing campaigns fuel global presence, strengthening brand visibility and retaining customers through personalized engagement.

Novo Nordisk: Operates within the highly regulated pharmaceutical industry, adhering to strict global healthcare standards set by agencies like the FDA and EMA. Strong partnerships with major insurers and healthcare providers—including UnitedHealthcare and Medicare—enhance market access while maintaining competitive advantage in the global obesity treatment market.

5. Discussion and Conclusions

The analysis of Noom and Novo Nordisk using the TOE Framework revealed key strategic strengths and market drivers for both companies. Technologically, Noom excels in AI-driven behavioral coaching while Novo Nordisk leads in research-based pharmaceutical innovation. Organizationally, Noom's tech-enabled, decentralized structure contrasts with Novo Nordisk's centralized, research-focused model. Environmentally, Noom thrives through influencer-driven marketing while Novo Nordisk dominates through clinical trial excellence and healthcare partnerships.

5.1 Technological Transformations in Obesity Management

AI and ML have become essential tools in obesity management, particularly in processing multi-omics data. AI facilitates predictive modeling by analyzing complex genomics, metabolomics, and microbiomics datasets, enabling personalized interventions based on individual biological profiles. This data-driven approach advances precision medicine, optimizing patient outcomes (Woldemariam et al., 2023).

Digital health platforms with wearable devices—smartwatches and continuous glucose monitors (CGMs)—continuously track key metabolic indicators. Platforms integrating CGMs, mobile apps, and virtual coaching provide comprehensive weight management solutions that monitor physiological responses and deliver real-time behavioral guidance, improving adherence and supporting long-term health outcomes (Villar, 2024). Data collected from devices is transmitted to mobile applications, allowing healthcare providers to track patient progress. Additionally, cloud-based health records enable seamless data sharing, fostering coordinated care (*Wearable Tech in Healthcare*, 2024).

AI-powered virtual coaching has proven highly effective in delivering behavioral interventions. These coaching systems use real-time data from wearable devices to provide customized diet, exercise, and sleep recommendations. Research shows AI-driven coaching improves patient adherence, enhancing weight loss and metabolic outcomes. AI algorithms can predict behavior patterns, offering proactive guidance to prevent lapses (*Noom Introduces AI-Enabled Products*, 2024; Thau, 2021).

Engaging patients through user-friendly digital platforms promotes long-term treatment adherence. Features like progress tracking, reward systems, and social support networks motivate users to reach weight management goals. Research shows interactive platforms help patients achieve better engagement and sustained weight loss compared to traditional care alone. Digital telemedicine platforms provide continuous support through remote consultations (May et al., 2023; Milne-Ives et al., 2024).

The pharmaceutical industry's growing investment in obesity research reflects commitment to developing next-generation therapies. Major companies including Novo Nordisk, Eli Lilly, and Amgen are advancing drug development using multi-receptor agonists and AI-powered clinical trials. RWE platforms enhance trial precision and speed development of personalized treatments. Future research could explore integrating multi-omics data with advanced analytics to redefine obesity pharmacotherapy (Brandfon et al., 2023; Fountzilas et al., 2022).

5.2 Strategic Benefits of the Noom–Novo Nordisk Collaboration

The collaboration between Noom and Novo Nordisk offers mutual strategic benefits by blending digital behavioral coaching with advanced pharmaceutical therapies.

For Noom: The partnership expands market reach by allowing access to medically supervised patients using Wegovy. Working with Novo Nordisk strengthens Noom's credibility as a clinically recognized digital health platform. Real-world data from clinical trial participants allows Noom to improve its AI-driven algorithms, offering more precise and personalized coaching. The collaboration also opens potential reimbursement opportunities through healthcare provider

partnerships.

For Novo Nordisk: Noom's AI-powered platform complements Novo Nordisk's pharmaceutical offerings by addressing the behavioral aspects of obesity management, leading to better long-term treatment outcomes. The partnership generates valuable RWE by collecting anonymized patient data, enabling Novo Nordisk to track treatment effectiveness and refine clinical protocols. By integrating a digital platform, Novo Nordisk differentiates itself from competitors by extending value beyond medications, offering a comprehensive, patient-centered care model.

5.3 Emerging Business Models

Precision medicine partnerships: Pharmaceutical-digital partnerships increasingly adopt precision medicine approaches using genetic and metabolic data to customize obesity treatments. Novo Nordisk incorporates precision medicine into its R&D pipeline by analyzing genetic and multi-omics data to optimize treatment plans (Nordisk, 2023). Studies published in *Nature Medicine* highlight how multi-omics technologies can revolutionize obesity care by enabling treatments tailored to individual biological profiles (Watanabe et al., 2023).

Corporate wellness programs: Employee wellness programs now include obesity-focused initiatives helping employers manage obesity-related healthcare costs. Companies like IBM have integrated weight management services into corporate wellness programs, improving employee health and reducing absenteeism (Esch, 2023). Obesity-specific digital EAPs reduce employees' BMI by an average of 3% within six months through personalized coaching and real-time monitoring (Lee et al., 2022).

Value-based care contracts: Pharmaceutical companies and digital health providers are entering value-based contracts where payments are tied to specific health outcomes like sustained weight loss or improved metabolic markers. Wegovy's insurance coverage currently targets patients with cardiovascular disease or diabetes who are overweight or obese. Digital platforms that enhance weight loss through structured lifestyle change programs could drive broader insurance coverage (*A New Use for Wegovy Opens the Door to Medicare Coverage*, 2024; Thorgeirsson et al., 2022).

5.4 Challenges and Limitations

Despite significant advancements, the obesity management industry faces critical limitations hindering its ability to effectively address the growing global epidemic:

Cost barriers: Therapies like GLP-1 receptor agonists and bariatric procedures are often expensive, limiting access particularly in low- and middle-income countries where obesity rates are rapidly increasing (*Global Obesity Report 2022*, 2022; *The Heavy Burden of Obesity*, 2019).

Behavioral adherence: Long-term weight management is complex due to emotional eating, stress-related behaviors, and loss of motivation. Personalized digital health coaching can address these issues by offering tailored support and real-time feedback (Biggs, 2021; *Digital Health Trends 2024*, 2024; Kozak et al., 2017; Villar, 2024).

Regulatory hurdles: Lengthy approval processes for medications and medical devices delay market entry and increase development costs. Streamlining regulatory procedures while ensuring safety and effectiveness is essential to encouraging innovation and making treatments more widely available (*Covered Entities vs Non-Covered Entities under HIPAA*, 2024; *FDA Approves First Treatment to Reduce Risk of Serious Heart Problems*, 2024).

These challenges require collaboration among healthcare providers, policymakers, and industry leaders. By developing cost-effective therapies, enhancing patient engagement with digital health tools, and simplifying regulatory pathways, the obesity management industry can better address growing global demand.

5.5 Future Directions

The obesity-related business landscape is evolving rapidly due to technological advancements, precision medicine, and behavioral science. Looking ahead, the obesity management industry must continue to innovate by integrating cutting-edge technologies, evidence-based pharmacological treatments, and personalized digital health solutions. Expanding accessibility through affordable therapies, scalable digital platforms, and streamlined regulatory processes will be essential to addressing rising global obesity rates.

Collaborative efforts between digital health providers, pharmaceutical companies, and policymakers can drive development of holistic care models combining lifestyle interventions with advanced medical solutions. Future research should focus on:

- Integrating multi-omics data and AI-driven tools to enhance precision medicine
- Exploring innovative business models that promote long-term patient engagement and improved health outcomes on a global scale
- Investigating how hybrid obesity management models—combining clinical pharmacology with behavioral health interventions—could be adapted to manage other chronic diseases
- Developing more accessible, scalable, and sustainable solutions to reduce global health disparities

- Advancing next-generation therapies including dual-action GLP-1/GIP agonists and triple-action receptor therapies

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