Exploring Wearable Technology and Lean Mass Alterations in GLP-1 Agonists, Bariatric Surgery, and Testosterone Replacement Therapy

Commentary

Gabriel J. Sanders[1]

[1]*University of Cincinnati, Cincinnati, OH, USA.*

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Corresponding author: Gabriel J. Sanders, sandergj@ucmail.uc.edu.

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Abstract

The obesity epidemic presents significant health challenges, accompanied by soaring healthcare costs. Interventions such as GLP-1 receptor agonists (GLP-1s), bariatric surgery, and testosterone replacement therapy (TRT) aim to improve body composition, primarily by reducing body fat. While GLP-1s and bariatric surgery effectively promote substantial weight loss, they frequently lead to significant reductions in lean body mass, raising concerns about metabolic health, physical function, and overall physiological well-being. Conversely, TRT demonstrates a unique ability to preserve and increase lean mass while simultaneously reducing fat, highlighting its potential role in body recomposition. However, the broader implications of these therapies remain underexplored due to a lack of real-world data on exercise, physical activity, and their impacts on vascular and cardiac function in human subjects. Wrist-worn wearable technology and noninvasive imaging present transformative opportunities, enabling continuous monitoring of metrics such as heart rate zones, physical activity levels, and cardiovascular imaging to ensure proper function. This commentary advocates for the integration of wearable devices and noninvasive imaging into research and clinical practice to optimize treatment protocols, prioritize muscle preservation, and advance personalized obesity management.

Introduction

The intersection of body composition changes, weight management strategies, and advancements in wearable technology offers fertile ground for innovation in clinical practice. Glucagon-like peptide-1 receptor agonists (GLP-1s), bariatric surgery, and testosterone replacement therapy (TRT) are increasingly employed in treating obesity, yet the differential effects on muscle mass and fat distribution remain underexplored. This commentary argues that integrating wearable technology to monitor exercise, activity, stress, vascular function, and heart rate responses in free-living environments is essential to advancing our understanding of these interventions.

Muscle Mass Preservation Concerns with GLP-1 Agonists and Bariatric Surgery

GLP-1s, such as semaglutide, have demonstrated significant weight loss outcomes, often nearing those achieved through bariatric surgery. However, evidence highlights that a substantial portion of weight loss is attributed to reductions in lean body mass. Studies report that lean mass accounts for 40-60% of total weight lost with GLP-1 therapy, depending on patient characteristics and treatment regimens [1,2]. Similarly, bariatric surgery results in lean mass losses of up to 23.4% of total weight lost within 12 months post-surgery [3]. These findings raise concerns about the long-term implications of diminished muscle mass, including sarcopenia, metabolic health declines, and compromised physical and even cognitive function [3,4].

While some studies suggest improvements in muscle quality, such as reduced intramuscular fat infiltration and enhanced insulin sensitivity, these adaptive changes do not fully mitigate the adverse effects of significant lean mass loss [2,5,6]. Notably, research on GLP-1s indicates a significant reduction in skeletal muscle mass, with lean mass loss observed in both obese and lean models, alongside notable reductions in cardiac mass and cardiomyocyte size [7]. These findings highlight the potential for GLP-1 agonists to induce muscle and cardiac structural changes independent of weight loss, raising concerns about exercise intolerance and long-term cardiac health, particularly in individuals at risk for heart failure. Therefore, addressing muscle preservation remains a critical challenge for both pharmacological and surgical weight-loss interventions, and further long-term investigations are required to assess lean mass and cardiac-related alterations during these interventions

Testosterone Replacement Therapy and Body Composition Enhancements

In contrast, TRT demonstrates a unique dual effect, increasing lean body mass while reducing fat mass[5,6,8,9]. Research indicates that TRT combined with resistance and aerobic exercise achieves a 6-9% increase in lean mass alongside reductions in fat percentage [8]. This anabolic response is dose-dependent, with early TRT phases up to six months showing the most pronounced effects, with a robust exercise regimen [8]. Moreover, TRT appears to enhance exercise performance, as observed in increased time spent in lower heart rate zones during aerobic activities, suggesting cardiovascular efficiency improvements [6]. This contrasts starkly with the muscle atrophy associated with GLP-1s and bariatric surgery, positioning TRT as a potentially promising intervention for body recomposition and sustained weight loss [9,10]. However, long-term adherence, health outcomes, and individualized dosing strategies remain crucial to sustaining these benefits.

Role of Wrist-Worn Wearable Technology and Noninvasive Imaging in Monitoring Interventions

Wrist-worn wearable technology has demonstrated significant potential in optimizing treatment outcomes across various clinical and fitness contexts. For example, numerous types and manufacturers of wearables have been used to track heart rate zones and physical activity levels, enabling personalized exercise regimens allowing patients to objectively track and meet activity goals. In one case, a patient using a wrist-worn wearable to monitor time spent in aerobic and resistance training zones reported improved muscle strength and reduced fat mass, emphasizing the synergy between TRT supplementation and exercise [8]. Similarly, in weight management with GLP-1s, wearables have been instrumental in tracking daily activity levels and energy expenditure to balance energy intake. These examples highlight the actionable insights wearables provide, allowing researchers and healthcare professionals to tailor interventions based on real-time physiological data.

More specifically, wrist-worn wearables offers unparalleled potential to track heart rate zones, physical activity levels, and sleep metrics continuously in free-living environments [8,11]. Modern wrist-worn wearable technology can quantify a wide range of physical activity, exercise intensity and even sleep and recovery behavior. For example, integrating wearable technology into research and real-world settings will facilitate personalized treatment strategies, ensuring optimal outcomes across diverse populations. Patients can use wearables to easily assess and follow exercise, physical activity, and sleep guidelines, leading to better adherence and more effective health management [8,11-13]. Heart rate zones, which represent different levels of exercise intensity based on percentages of maximum heart rate (HR_{max}). Then, this information is used to calculate five heart rate zones ranging from light to maximal effort, with heart rate zone 1 being the least intense (50-60% of HR_{max}) and heart rate zone 5 the most intense (90-100% of HR_{max})[14]. Wearables track the time allocated in each zone during an exercise session, providing insights into exercise behavior and enabling more precise and actionable interventions to optimize outcomes for patients.

In addition to wearable technology, noninvasive imaging techniques such as Doppler ultrasound and cardiac magnetic resonance imaging (MRI) are invaluable for providing detailed insights into vascular blood flow and heart structure[15,16]. These methods are adept at detecting subtle shifts in cardiovascular health, facilitating thorough evaluations of how treatments like GLP-1s, bariatric surgery, and TRT affect cardiac structure and function. By integrating data from wrist-worn wearables with these advanced imaging techniques, researchers can gain a comprehensive understanding of physiological responses, whether favorable or not. This synergy enables the formulation of more precise and tailored treatment plans, or it may indicate the need to discontinue a treatment if adverse effects on cardiovascular health are detected

Conclusion

The differential impacts of GLP-1s, bariatric surgery, and TRT on muscle mass and body composition necessitate a paradigm shift in monitoring and evaluation as a standard of care. Data from wearable technology represents a transformative tool for understanding these interventions in real-world contexts. Future research must prioritize integrating wrist-worn wearable data to optimize therapeutic protocols, focusing on muscle preservation, metabolic health, and overall quality of life. By doing so, research can bridge existing gaps, identify more precise exercise recommendations to optimize health outcomes, and foster a more holistic approach to obesity management.

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