

Hormonal Catalysts in the Addiction Cycle of Muscle Dysmorphia: A Neuroendocrine Perspective

Abstract

Muscle dysmorphia (MD) is a subtype of body dysmorphic disorder characterized by an obsessive belief that one's body is insufficiently muscular. This review provides a comprehensive examination of the addiction cycle in MD, particularly in the context of anabolic steroid and performance-enhancing drug (PED) use. Utilizing a systematic search across databases such as PubMed, PsycINFO, Scopus, and Web of Science, the review draws on peer-reviewed literature published in the past two decades to uncover the roles of hormonal and neural alterations in perpetuating this cycle. Inclusion and exclusion criteria were meticulously applied to ensure a robust analysis of relevant studies. The article details the interaction between exogenous hormonal supplementation from steroids and PEDs and brain receptors, which significantly disrupt neurotransmitter systems and affect mood, cognition, and stress responses. The synthesis of data reveals that hormonal imbalances due to substance abuse lead to profound changes in brain plasticity and function, instigating psychiatric disorders and complicating withdrawal and treatment. Therapeutic strategies are critically assessed, with emphasis on the success of cognitive-behavioral therapy, the role of pharmacological management, and the promise of emerging treatments targeting neuroendocrine disruptions. The review suggests an integrated, holistic treatment model that includes hormonal therapy and neurological considerations, underscoring the importance of personalized and sustained interventions. In conclusion, the intricate cycle of addiction in MD, fueled by the hormonal effects of steroids and PEDs on the brain, calls for an integrated approach to treatment. Future research should focus on the neuroendocrine impact of these substances to refine therapeutic strategies for MD.

Keywords: *Addiction cycle, anabolic steroids, muscle dysmorphia, neuroendocrine effects, performance-enhancing drugs*

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Introduction

Muscle dysmorphia (MD) represents a unique and often misunderstood domain within the spectrum of body dysmorphic disorders.^[1] Characterized by an obsessive preoccupation with not being sufficiently muscular or lean, individuals with MD typically engage in behaviors aimed at increasing muscle mass and reducing body fat. This preoccupation often leads to the use of anabolic steroids and performance-enhancing drugs (PEDs), substances that have become increasingly associated with this condition. The use of these substances in the MD community is not merely a matter of physical enhancement but is intricately tied to psychological factors. The distorted self-perception inherent in MD drives

individuals toward a perpetual cycle of substance use, where steroids and PEDs play a pivotal role. This cycle is not only a psychological phenomenon but also is deeply rooted in the physiological effects; these substances have on the human body, particularly regarding hormonal and neural changes.

Methods

Locating and selecting data

The data for this review were systematically sourced from an array of academic databases, including PubMed, PsycINFO, Scopus, Wiley, Google Scholar, and Web of Science. The search strategy was designed to encompass a comprehensive suite of keywords and MeSH terms relating to muscle dysmorphia, anabolic steroids, performance-enhancing drugs, addiction cycles, and hormonal effects on neuroendocrine function. Boolean

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operators (“AND,” “OR”) were utilized to refine the search and ensure a broad yet relevant collection of literature. Inclusion criteria were established *a priori*: articles must be peer reviewed, published within the past 20 years, and specifically discuss the hormonal and addiction aspects of MD. Exclusion criteria included non-English articles, case studies, and articles not focusing on the neuroendocrine implications of steroid and PED use.

Extracting data

On retrieval of articles, abstracts were screened for relevance, and full texts were obtained for those meeting the inclusion criteria. Data extraction focused on the hormonal mechanisms involved in MD, the neuroendocrine effects of anabolic steroids and PEDs, the psychological and physiological aspects of addiction cycles, and current therapeutic approaches. A standardized form was used to extract relevant data, including study design, sample size, outcomes, and conclusions related to the scope of this review.

Synthesizing data

The extracted data were then synthesized using a narrative approach, allowing for the integration of findings from diverse study designs and methodologies. This approach enabled the articulation of complex interactions between hormonal dysregulation and neurological changes within the context of MD and substance addiction. The synthesis involved a thematic analysis, where patterns and themes were identified and grouped to provide a comprehensive overview of the existing literature. Discrepancies and gaps in the research were also documented, highlighting areas for future investigation.

Ensuring quality and rigor

To ensure the quality and rigor of the review, the PRISMA guidelines were adhered to throughout the process. In addition, a bias assessment was conducted using the Cochrane Collaboration’s tool to identify any potential bias within individual studies.^[2] Articles were also cross-referenced to confirm the accuracy of extracted data and the validity of the authors’ interpretations.

Results

Role of steroids and performance-enhancing drugs in muscle dysmorphia

Anabolic steroids and PEDs are known for their ability to rapidly increase muscle mass and improve athletic performance. However, their use extends beyond the enhancement of physical attributes. In the context of MD, these substances are used as a means to attain an unattainable ideal of physical perfection, often at the expense of mental and physical health.^[3] The relationship between steroid/PED use and MD is complex. On the one hand, these substances provide a temporary solution to the

distress caused by perceived inadequacies in muscularity. On the other hand, they exacerbate the condition by reinforcing the distorted self-image and perpetuating the cycle of abuse. This relationship is further complicated by the hormonal effects of these substances, which have a profound impact on brain function and structure, influencing mood, cognition, and behavior.

Hormonal catalysts in the cycle of addiction

The central focus of this review is to explore the hormonal catalysts that intensify the cycle of addiction in individuals with MD abusing steroids and PEDs. Unlike traditional forms of substance abuse, the addiction cycle in MD is significantly influenced by the direct hormonal effects of these substances.^[4] Steroids and PEDs, through their interaction with specific brain receptors, lead to alterations in neurotransmitter systems, impacting critical brain functions related to mood, cognition, and stress responses.

Hormonal effects and neural mechanisms

Steroids and PEDs can significantly skew the body’s hormonal homeostasis.^[5] The influx of synthetic hormones mimics the effects of testosterone, which not only fuels the increase in muscle mass but also triggers a series of neurochemical events. The activation of androgen receptors in the brain alters the normal functioning of neurotransmitters, such as dopamine and serotonin, which are critical to mood regulation, motivation, and reward. This disruption can lead to mood disorders, aggression, and an altered stress response, all of which are common in individuals with MD. The psychological implications of these hormonal changes are multifaceted. On a behavioral level, the initial euphoria and increased performance can reinforce the continued use of these substances, despite potential adverse effects. However, the altered hormonal milieu also impacts cognition, potentially leading to impaired judgment, decision-making, and heightened risk-taking behaviors. These cognitive effects can perpetuate the cycle of abuse as individuals with MD may be less able to recognize the long-term consequences of their actions or to engage effectively in treatment strategies.

Physiologically, the persistent imbalance in hormone levels due to steroid and PED use can induce changes in brain plasticity. This refers to the brain’s ability to change and adapt as a result of experience. However, in the case of substance abuse, these changes are often maladaptive. For example, chronic steroid use can lead to alterations in brain areas responsible for memory and emotional regulation, such as the hippocampus and amygdala. These changes not only have immediate effects on behavior but may also lay the groundwork for long-term psychiatric vulnerabilities.

Moreover, the endocrine system’s disruption has secondary effects on other physiological systems. For instance, the hypothalamic–pituitary–adrenal axis, which is integral to stress response and is closely linked to the development of

depression and anxiety, can become dysregulated.^[6] This dysregulation can exacerbate the psychological burden experienced by those with MD, potentially leading to a worsening of symptoms and a deepening of the dependency cycle.

The withdrawal from steroids and PEDs introduces a new set of challenges. The body's natural hormone production may be suppressed, leading to a state of hypogonadism, characterized by low or absent levels of testosterone. This hormonal deficit can have dire consequences for mental health, including the emergence of depressive symptoms, anxiety, and irritability. The neurological impact of withdrawal can be profound, with individuals experiencing a stark contrast from the heightened neural activity during substance use to a significant decline when ceasing use.

Hormonal impact on brain function

The hormonal impact on brain function is a complex and nuanced topic, particularly when discussing the effects of steroids and PEDs. These substances significantly alter the endocrine system, which is intricately linked to brain function.^[7] The use of steroids and PEDs introduces exogenous hormones into the body, often in quantities that exceed physiological levels, leading to an imbalance that can profoundly affect mental health.

Endocrine disruption

The endocrine system's disruption through the use of steroids and PEDs has a domino effect on various bodily functions.^[8] Testosterone and its derivatives, when introduced exogenously, can suppress the body's natural hormonal rhythm. This suppression can result in a range of mental health issues, including mood swings, irritability, and even long-term mood disorders. The hormonal imbalance can also lead to behavioral changes; for instance, increased aggression, commonly referred to as "roid rage," has been reported in steroid users. This is likely due to the heightened levels of androgens that affect the limbic system, a brain area crucial for emotion regulation.

Receptor interaction

Steroids and PEDs exert their effects by binding to androgen receptors in the brain, which are not only present in reproductive tissues but also widely distributed in various brain regions, including the hippocampus, amygdala, and prefrontal cortex.^[9] The interaction with these receptors leads to changes in cellular functioning and gene expression, which can influence brain plasticity and long-term brain health.^[10] The activation of androgen receptors modulates the synthesis and release of neurotransmitters and neurotrophic factors, which can affect neuronal growth and survival.

The consequences of these interactions are far-reaching. Neurotransmitters such as serotonin and dopamine, which are critical for mood regulation and the experience of

pleasure, can be dysregulated by the hormonal fluctuations caused by steroids and PEDs. This dysregulation can alter an individual's stress response, potentially leading to heightened anxiety or diminished ability to cope with stress. In addition, cognitive functions such as memory, executive function, and decision-making can be impacted due to the changes in the neural circuits that govern these processes.

Neurotransmitter Alterations and Psychological Dependencies

Impact on neurotransmitter systems

Steroids and PEDs exert a profound influence on the brain's neurotransmitter systems, which play a critical role in regulating mood, behavior, and the reward circuitry.^[11] Neurotransmitters such as dopamine and serotonin are particularly affected by these substances. Dopamine, often referred to as the "feel-good" neurotransmitter, is central to the reward pathway and is associated with feelings of pleasure, motivation, and concentration. The influx of synthetic hormones can cause a surge in dopamine levels, leading to a heightened sense of well-being and euphoria.^[12] This artificially induced state can make the activities associated with steroid and PED use extremely reinforcing, laying the groundwork for psychological dependence. Conversely, serotonin, which is crucial for mood stabilization, impulse control, and overall emotional well-being, can become dysregulated through the use of these drugs. Such dysregulation can manifest as mood swings, depression, or anxiety when the substances are not present, reinforcing use as a form of self-medication. Over time, the individual's brain chemistry adapts to the presence of steroids and PEDs, establishing a new normal where the absence of these substances results in a significant deficit in neurotransmitter activity.^[13] This adaptation can lead to withdrawal symptoms when the individual attempts to discontinue use, which may include depression, irritability, and a general lack of pleasure or motivation. The impact on these neurotransmitter systems extends beyond temporary mood alterations; it can cause long-lasting changes in the brain's neurochemistry and function. Chronic use can alter the sensitivity and density of neurotransmitter receptors, leading to a diminished response to natural rewards and a reduced ability to experience pleasure without the use of steroids or PEDs. This anhedonia-like state can perpetuate the cycle of abuse, as individuals may continue using these substances to chase the diminishing rewards they once provided. The modulation of neurotransmitter systems by steroids and PEDs thus represents a significant factor in the development and maintenance of substance dependence, highlighting the need for targeted interventions that address the neurochemical aspects of recovery.

Cycle of addiction

The cycle of addiction, particularly in the context of steroid and PED use, is intricately tied to the ebb and flow of

neurotransmitter levels within the brain. Steroids and PEDs, by amplifying the release and action of neurotransmitters such as dopamine and serotonin, can create a temporary sense of heightened confidence, well-being, and physical prowess.^[14] This artificially induced state can be intensely rewarding, reinforcing the behavior of substance use and embedding it as a response to both internal and external cues. However, this elevated state is invariably followed by a stark withdrawal phase, characterized by an emotional downturn. Users may experience a marked decrease in mood, increased anxiety, and a pervasive sense of dissatisfaction when not using these substances, which starkly contrasts the earlier feelings of euphoria and invincibility. The adverse emotional states that accompany withdrawal can be distressing, driving individuals to resume substance use to alleviate their discomfort. This self-medication perpetuates the cycle of abuse, as each subsequent use reinforces the neural pathways associated with addiction. The brain's reward system, hijacked by the repeated chemical stimulation, becomes increasingly reliant on the presence of these substances to function optimally. The behavioral patterns become entrenched, and the psychological need for the drug's effects becomes as compelling as physiological dependence. Over time, the cycle of positive reinforcement (use of the drug leading to positive emotions) and negative reinforcement (use of the drug to avoid negative emotions) becomes deeply ingrained.

This cyclic pattern of addiction is further complicated by the potential for tolerance, where the individual requires progressively larger doses of the substance to achieve the same effect, increasing the risk of overdose and severe physiological damage.^[15] The cycle of addiction is thus a complex interplay of enhanced neurotransmitter activity during use and the subsequent psychological and physical withdrawal symptoms. This vicious cycle is challenging to break, as the physical withdrawal symptoms are often accompanied by psychological cravings, leading to a high risk of relapse. Effective treatment must address both the physiological aspects of withdrawal and the psychological drive to use, incorporating strategies such as detoxification, counseling, and support groups to help individuals achieve and maintain sobriety.

Long-term brain changes

The chronic use of steroids and PEDs can lead to significant alterations in the brain's structure and functionality.^[16] These modifications are not only deep seated but also multifaceted, influencing various aspects of neurological health and psychological well-being. Specifically, they may exacerbate the psychological symptoms associated with MD – a disorder characterized by a preoccupation with not being sufficiently muscular or lean. Individuals with MD often engage in compulsive behavior to improve their body images, such as excessive weightlifting and steroid abuse, despite potential negative health consequences.

The brain changes from prolonged PED use can make these psychological symptoms more severe, entrenching the belief that one's body is inadequately muscular. Furthermore, these changes can complicate recovery efforts, making it challenging to reverse the dependency on these substances. Dependence on steroids and PEDs is not solely a matter of willpower; rather, it is entwined with substantial neurological adaptations that may sustain the cycle of abuse and complicate the path to sobriety.^[17] Hence, understanding the neurological impact of these substances is crucial for developing effective treatment strategies for MD and associated substance dependency.

The Addiction Cycle

Physical health risks

The prolonged and unchecked use of steroids and PEDs carries with it a plethora of grave physical health risks, often leading to severe and sometimes irreversible consequences.^[18] The spectrum of potential health issues spans from cardiovascular complications, manifesting as early-onset heart attacks and strokes, to hepatological conditions, such as liver tumors and jaundice. Renal failure is also a significant risk, alongside the potential for other organ damage due to the systemic effects of these substances.^[19] These physical detriments do more than just impact the physiological state of the user; they intricately contribute to the complexity of the addiction cycle. By inducing physical dependence, the substances create a situation where the user's body may require them to avoid withdrawal symptoms, making cessation a challenge. In addition, the physical harm caused by steroids and PEDs can perpetuate psychological dependence, as individuals may continue using to maintain the enhanced physique that these drugs can facilitate, despite the detrimental health effects. The intertwining of physical health risks with psychological dependence creates a formidable barrier to breaking the cycle of addiction, as one must navigate not only the desire for the drug's effects but also the need to mitigate or manage the physical damage incurred. This complex interplay makes addressing steroid and PED addiction a multifaceted challenge requiring a holistic approach to treatment that encompasses both the physical and psychological domains of health.

Psychiatric and cognitive effects

The implications of steroid and PED use extend well beyond the confines of physical health, delving into the realm of psychiatric and cognitive effects. Individuals who engage in chronic use of these substances often find themselves grappling with an array of mental health challenges. These can include psychosis, a state of losing touch with reality, characterized by hallucinations or delusions; depression, marked by persistent sadness and loss of interest; anxiety, involving excessive worry and nervousness; and aggression, which can manifest as irritability and anger.^[20-22] These psychiatric symptoms are not mere by-products of substance

misuse; rather, they actively contribute to the exacerbation of MD, intensifying the disorder's symptoms. MD, a condition characterized by a distorted body image and an obsessive desire to gain muscle mass, can be significantly aggravated by the mental health issues induced by steroids and PEDs. This interaction creates a perilous cycle where psychiatric problems can drive increased substance use as individuals attempt to self-medicate or cope with the stress of their altered mental state. Conversely, the use of steroids and PEDs can worsen psychiatric symptoms, further entrenching the individual in the cycle of addiction and mental health deterioration. The interplay between these factors underscores the need for a comprehensive approach to treatment that addresses both the psychiatric manifestations and the underlying substance use disorder, recognizing the complex bidirectional relationship between mental health and substance abuse in the context of MD.

Challenges in overcoming dependence and withdrawal

The journey to surmount the shackles of dependence on steroids and PEDs is fraught with numerous challenges, both psychological and physiological.^[23] The psychological dependence that ensues from the alteration of neurotransmitter systems and hormonal balances is particularly insidious. It is characterized by a deeply ingrained belief in the necessity of these substances to maintain not only a certain physical appearance but also emotional stability. Individuals trapped in this cycle believe that the use of steroids and PEDs is integral to their self-worth and emotional well-being, making cessation an arduous endeavor. When attempts are made to discontinue the use of these substances, individuals often encounter withdrawal symptoms that can be both physically and psychologically taxing. These symptoms may include profound depression, anxiety, significant loss of muscle mass, and a host of other discomforts that can impinge on everyday functioning. The intensity of these symptoms can be overwhelming, frequently leading to relapse as the immediate cessation of substance use unveils the full brunt of withdrawal effects.^[24] In the quest to mitigate these distressing symptoms, individuals may find themselves reverting to substance use, thus perpetuating the cycle of dependence.

This complex web of psychological dependence, coupled with the daunting withdrawal symptoms, underscores the need for a robust support system and a comprehensive treatment plan. Such a plan must address both the psychological facets of addiction and the physiological aftermath of withdrawal. Effective treatment is multifaceted, often requiring medical intervention, counseling, and long-term support to navigate the precarious path of recovery and to reduce the likelihood of relapse.

The self-perpetuating cycle of addiction

In the context of MD, the addiction cycle fuelled by the use of steroids and PEDs takes on a particularly pernicious

form, largely due to the direct hormonal catalysts these substances provide.^[25] The introduction of synthetic hormones into the body can cause a cascade of effects, altering everything from physical appearance to brain chemistry and emotional states. This hormonal upheaval can amplify the symptoms of MD, as the individual's perception of their body and compulsive behaviors to modify it become intertwined with the drug's effects. Hormonal imbalances induced by steroids and PEDs not only contribute to the maintenance of the addiction cycle but also intensify it. These imbalances can lead to erratic emotional regulation and cognitive function, further entrenching the user in a state of dependence. The challenge in breaking this cycle is multidimensional, requiring a keen understanding of the hormonal underpinnings at play. Effective interventions must be comprehensive, tackling not only the psychological aspects of MD, such as body image distortion and compulsive exercise but also addressing the physiological dependencies that arise from the drug-induced hormonal imbalances.

This necessitates a treatment strategy that is both holistic and nuanced, capable of managing the withdrawal symptoms while also supporting the individual's mental health. Medical treatments may need to be combined with psychotherapy to deal with the psychological reliance on the substances, while strategies to stabilize hormonal levels are also implemented. Understanding the complex interplay between the psychological and physiological elements of this addiction cycle is critical for developing effective treatment plans that can break the relentless grip of dependence.

Clinical Implications and Treatment Strategies

This section focuses on the clinical implications of the addiction cycle in MD, particularly concerning the abuse of steroids and PEDs, and discusses potential treatment strategies that address both the psychological and physiological aspects of this condition.

Current therapeutic approaches for muscle dysmorphia and substance abuse

The treatment of MD and concurrent substance abuse, particularly the abuse of steroids and PEDs, incorporates a multifaceted therapeutic approach to address the complex interplay between psychological issues and physiological dependencies.

Psychological interventions

At the forefront of psychological treatments is cognitive behavioral therapy (CBT), a form of intervention that is particularly effective in tackling the underlying body image issues and the distorted perceptions that characterize MD.^[26] CBT works by helping individuals recognize and challenge their harmful thought patterns and behavior, gradually learning to replace them with healthier ones. This approach

is beneficial in managing the compulsions associated with steroid and PED use, such as the obsessive pursuit of a more muscular physique. Other psychological counseling methods, such as psychoeducation, group therapy, and motivational interviewing, also play a significant role in supporting the individual's journey toward recovery.

Pharmacological treatments

Alongside psychological therapies, pharmacological interventions may be necessary, especially when steroid and PED use has induced significant hormonal imbalances and psychiatric complications. Medications may be prescribed to stabilize mood, manage depression, and alleviate anxiety symptoms that have been exacerbated by substance abuse.^[27] These medications can range from antidepressants to mood stabilizers and antipsychotics, depending on the individual's specific symptoms and needs. The careful management of these medications is crucial, as it is essential to avoid substituting one dependency for another while ensuring that the psychological interventions have the best chance of success.

Overall, the current therapeutic strategies for MD and substance abuse highlight the importance of an integrated treatment plan that considers both the mental health aspects and the physiological effects of steroid and PED abuse. The goal is to provide a comprehensive support system that enables individuals to regain control over their lives, free from the constraints of addiction and the distortions of MD.

Addressing hormonal and neural aspects in treatment

Treatment approaches for steroid and PED abuse, especially when intertwined with MD, must incorporate strategies that directly address the hormonal and neural changes incurred by substance use.

Hormonal therapy

Hormonal imbalances are a central consequence of chronic steroid and PED use, and correcting these imbalances is essential for recovery. Hormonal therapy can be an integral part of treatment, including hormone replacement therapies or other medical interventions to restore the body's natural hormonal balance.^[28] This aspect of treatment is particularly crucial because it targets the physiological dependencies that perpetuate the addiction cycle, helping to reduce cravings and withdrawal symptoms that can trigger relapse.

Neurological considerations

Steroids and PEDs have profound effects on brain function, altering neurotransmitter systems that can lead to changes in mood, behavior, and cognitive processes. Treatment, therefore, may require a focus on neurological health to rebalance neurotransmitter levels and address any long-term cognitive or neurological impairments. This could involve the use of medications that support neurotransmitter function or cognitive rehabilitation techniques that help

individuals recover from any cognitive deficits. Moreover, strategies such as neurofeedback, which can train the brain to function more effectively, or mindfulness-based interventions, which can improve neurological health and emotional regulation, may also be beneficial.

In summary, a comprehensive treatment plan for individuals struggling with steroid and PED addiction and MD should involve both hormonal and neurological interventions. The aim is to provide a holistic approach that addresses the wide-ranging effects of these substances, facilitating a return to both physical and mental health and ultimately breaking the cycle of addiction.

Emerging therapies and holistic approaches

The landscape of treatment for MD and steroid/PED addiction is continually evolving, with emerging therapies reflecting the latest research into the neuroendocrine effects of these substances.

Research-based interventions

As our understanding of the impacts of steroids and PEDs on the brain advances, new treatment modalities are on the horizon. These could encompass cutting-edge pharmacological agents designed to specifically target the neuroendocrine disruptions caused by these substances.^[29] Similarly, therapeutic techniques that emerge from ongoing research might offer tailored approaches to rebalance the hormonal and neural systems affected by MD and substance abuse. Such interventions could range from neuromodulation techniques, which aim to recalibrate brain activity, to new classes of medications that more precisely rectify hormonal imbalances.

Integrative treatment models

Given the complex nature of MD and steroid/PED addiction, a holistic and integrative treatment model is recognized as the most beneficial approach.^[30] This model advocates for the combination of various therapeutic elements: psychological counseling to address mental health components, medical treatment for hormonal and physical issues, nutritional guidance to restore and maintain physical health, and physical rehabilitation to recover from the physiological damages wrought by substance abuse. By encompassing all aspects of health, this integrative model aims to provide comprehensive care that addresses every facet of the individual's well-being. The effectiveness of such a holistic approach lies in its ability to treat the person as a whole, recognizing that the psychological, physical, and hormonal elements are deeply interconnected and must be treated concurrently for the best chance of recovery.

Challenges and considerations in treatment

The management of MD and steroid/PED addiction presents unique challenges and necessitates careful consideration of several critical factors in treatment planning.

Tailoring treatment to individual needs

The personal nature of MD and the varied responses to steroid and PED use demand that treatment plans are highly customized. Individuals come with their own set of experiences, psychological profiles, and physiological responses to substances. A one-size-fits-all approach is not feasible for such complex conditions. Treatment must be adaptive, considering personal history, the severity of the dependency, and the specific psychological and physiological effects experienced by the individual. This personalized approach may involve a combination of different therapeutic interventions, which could range from various forms of counseling and behavioral therapy to specific medical treatments targeting the individual's unique hormonal imbalances.

Long-term management

MD and steroid/PED addiction typically require sustained and often long-term treatment strategies. The chronic nature of these conditions, coupled with the high potential for relapse, underscores the necessity for continuous support and intervention. Long-term management might include ongoing counseling, support groups, and potentially maintenance pharmacotherapy, all aimed at sustaining recovery and preventing relapse. Regular monitoring of psychological and physical health is also crucial to identify and address any signs of relapse early. In addition, since lifestyle factors such as exercise routines, diet, and social influences can significantly impact recovery, these areas should also be included in the long-term management plan. The ultimate goal is to support the individual in maintaining a healthy lifestyle and psychological well-being over time, acknowledging that recovery is a continual process rather than a single event.

Discussion

The interplay between hormonal effects and neurological function in the context of MD and the abuse of steroids and PEDs is a critical nexus for understanding addiction. This complex cycle of addiction, intensified by direct hormonal modulation of brain function, represents a significant departure from classical addiction paradigms, which have traditionally emphasized the psychological and behavioral aspects of substance dependence. Steroids and PEDs, by their pharmacological nature, are designed to enhance physical performance and appearance, primarily through their anabolic effects. However, their impact extends far beyond the musculoskeletal system, reaching into the very fabric of neural function. The acute hormonal shifts induced by these substances lead to marked changes in neurotransmitter systems, particularly those associated with reward and stress, such as the dopaminergic and serotonergic pathways. The resulting neurochemical imbalance manifests as alterations in mood and cognition,

which can range from increased aggression to impaired judgment. The abuse of steroids and PEDs in individuals with MD is often motivated by an intense, pathological drive to achieve and maintain an idealized muscular physique. This drive, while partially rooted in psychological factors such as body image disturbances and perfectionism, is compounded by the reinforcing hormonal effects of the substances themselves. The enhanced dopaminergic activity associated with steroid and PED use may not only create a sense of well-being and heightened energy but can also lead to compulsive drug-seeking behavior, further entrenching the addiction cycle. As these individuals continue to use these substances, their brain chemistry adapts, potentially leading to tolerance and the need for higher doses to achieve the desired effect. Such adaptations can result in a chronic state of neuroendocrine dysregulation, which may be difficult to reverse. Moreover, the alteration in hormonal levels can have deleterious effects on the brain's plasticity, potentially leading to long-term cognitive deficits and increased vulnerability to psychiatric disorders. The withdrawal phase presents its challenges. The cessation of steroid and PED use can precipitate a significant drop in endogenous hormone levels, leading to a state of hypoandrogenism. This hormonal imbalance can have profound neurological implications, including the onset of depressive symptoms, anxiety, and cognitive fog. Such symptoms not only pose a challenge for the individual's mental health but also increase the likelihood of relapse into substance use as a means of alleviating the discomfort associated with withdrawal. The chronic use of steroids and PEDs has been associated with irreversible damage to both the body and the brain. On a structural level, there is evidence to suggest that long-term use can lead to changes in brain morphology, particularly in areas involved in memory, emotion, and executive function. These alterations may contribute to the psychiatric comorbidities often observed in long-term steroid users, such as mood disorders and cognitive impairments. The cycle of addiction in MD is thus a product of an intricate interaction between the endocrine system and neural mechanisms. The hormonal effects on neurotransmission and brain structure create a biological underpinning for the psychological and behavioral manifestations of the disorder. Addressing this cycle requires a nuanced approach that considers both the physical and psychological dimensions of addiction. Therapeutic strategies need to be as multifaceted as the disorder itself, combining pharmacological interventions to restore hormonal and neurochemical balance with psychotherapeutic treatments aimed at addressing the underlying psychological issues. CBT, motivational interviewing, and mindfulness-based interventions can be effective in modifying the cognitive and behavioral patterns associated with MD. Support groups and family therapy may also play a role in providing psychosocial support, challenging societal norms surrounding muscularity, and fostering a more positive body image. In terms of research,

there is a pressing need for comprehensive studies that investigate the long-term neurological and psychiatric outcomes of steroid and PED abuse. Longitudinal research is particularly crucial for understanding the chronic effects of these substances on brain structure and function, which could inform the development of more effective treatment protocols and preventative strategies. Such research should also explore the potential reversibility of the neurological damage associated with steroid and PED use, providing hope for recovery and rehabilitation.

Conclusion

The cycle of addiction in MD reflects a complex interplay between hormonal influences and neurological changes. This cycle is perpetuated by the direct effects of steroids and PEDs on the brain, which complicate the psychological aspects of addiction and pose significant challenges for treatment. An integrated approach, encompassing both medical and psychological interventions, is essential for effectively addressing this unique form of addiction. Future research efforts must aim to unravel the long-term effects of hormonal agents on neurological function, which will be instrumental in advancing our understanding and treatment of MD.

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There is no need for patient informed consent

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References

1. Phillips KA, Wilhelm S, Koran LM, Didie ER, Fallon BA, Feusner J, *et al.* Body dysmorphic disorder: Some key issues for DSM-V. *Depress Anxiety* 2010;27:573-91. [doi: 10.1002/da.20709].
2. Selçuk AA. A guide for systematic reviews: PRISMA. *Türk Arch Otorhinolaryngol* 2019;57:57-8.
3. Skoufa L, Barkoukis V, Lazuras L, Tsozbatzoudis H. Effect of muscle dysmorphia on image-and-performance-enhancement drugs use intentions in a non-clinical sample: The role of social cognition. *Perform Enhanc Health* 2021;9:100204. [doi: 10.1016/j.peh.2021.100204].
4. Hill SA, Waring WS. Pharmacological effects and safety monitoring of anabolic androgenic steroid use: Differing perceptions between users and healthcare professionals. *Ther Adv Drug Saf* 2019;10:2042098619855291. [doi: 10.1177/2042098619855291].
5. Ding JB, Ng MZ, Huang SS, Ding M, Hu K. Anabolic-androgenic steroid misuse: Mechanisms, patterns of misuse, user typology, and adverse effects. *J Sports Med (Hindawi Publ Corp)* 2021;2021:7497346. [doi: 10.1155/2021/7497346].
6. Basu T, Maguire J, Salpekar JA. Hypothalamic-pituitary-adrenal axis targets for the treatment of epilepsy. *Neurosci Lett* 2021;746:135618. [doi: 10.1016/j.neulet.2020.135618].
7. Sessa F, Salerno M, Cipolloni L, Bertozzi G, Messina G, Mizio GD, *et al.* Anabolic-androgenic steroids and brain injury: Mirna evaluation in users compared to cocaine abusers and elderly people. *Aging (Albany NY)* 2020;12:15314-27. [doi: 10.18632/aging.103512].
8. Walker C, Garza S, Papadopoulos V, Culty M. Impact of endocrine-disrupting chemicals on steroidogenesis and consequences on testicular function. *Mol Cell Endocrinol* 2021;527:111215. [doi: 10.1016/j.mce.2021.111215].
9. Frankfurt M, Nassrallah Z, Luine V. Steroid hormone interaction with dendritic spines: Implications for neuropsychiatric disease. *Adv Neurobiol* 2023;34:349-66. [doi: 10.1007/978-3-031-36159-3_8].
10. Moyer AM, Matey ET, Miller VM. Individualized medicine: Sex, hormones, genetics, and adverse drug reactions. *Pharmacol Res Perspect* 2019;7:e00541. [doi: 10.1002/prp2.541].
11. Belchior Santos JP, Lacerda FB, de Oliveira LA, Fialho BB, Assunção IN, Santana MG, *et al.* Neurological consequences of abusive use of anabolic-androgenic steroids. *Braz J Surg Clin Res* 2020;32:52-8.
12. Marwein S, Biswal S, Acharya PC. Hormones and steroids as neurotransmitters. In: *Frontiers in Pharmacology of Neurotransmitters*. Springer Nature; 2020. p. 447-501. [doi: 10.1007/978-981-15-3556-7_14].
13. Lupu VV, Butnariu LI, Fotea S, Morariu ID, Badescu MC, Starcea IM, *et al.* The disease with a thousand faces and the human microbiome-a physiopathogenic intercorrelation in pediatric practice. *Nutrients* 2023;15:3359. [doi: 10.3390/nu15153359].
14. Giorgetti A, Busardò FP, Giorgetti R. Toxicological characterization of GHB as a performance-enhancing drug. *Front Psychiatry* 2022;13:846983. [doi: 10.3389/fpsy.2022.846983].
15. Skauen JE. Lifetime Prevalence, Correlates, and Sequelae of Anabolic-Androgenic Steroid Dependence: A Meta-Analysis, Meta-Regression Analysis, and Meta-Synthesis. Master's Thesis. The University of Bergen; 2023.
16. Kanayama G, Hudson JI, Pope HG Jr. Long-term psychiatric and medical consequences of anabolic-androgenic steroid abuse: A looming public health concern? *Drug Alcohol Depend* 2008;98:1-12. [doi: 10.1016/j.drugalcdep.2008.05.004].
17. Thomas Milhorn H. *Substance use Disorders. A Guide for the Primary Care Provider*. Switzerland: Springer International Publishing AG; 2018.
18. Pope HG Jr., Wood RI, Rogol A, Nyberg F, Bowers L, Bhasin S. Adverse health consequences of performance-enhancing drugs: An endocrine society scientific statement. *Endocr Rev* 2014;35:341-75. [doi: 10.1210/er.2013-1058].
19. Cheema BS. Review article: Tackling the survival issue in end-stage renal disease: Time to get physical on haemodialysis. *Nephrology (Carlton)* 2008;13:560-9. [doi: 10.1111/j.1440-1797.2008.01036.x].
20. Janes M, Kuster S, Goldson TM, Forjuoh SN. Steroid-induced psychosis. *Proc (Bayl Univ Med Cent)* 2019;32:614-5. [doi: 10.1080/08998280.2019.1629223].
21. Pope HG Jr., Katz DL. Psychiatric and medical effects of anabolic-androgenic steroid use. A controlled study of 160 athletes. *Arch Gen Psychiatry* 1994;51:375-82. [doi: 10.1001/

- archpsyc. 1994.03950050035004].
22. Gruber AJ, Pope HG Jr. Psychiatric and medical effects of anabolic-androgenic steroid use in women. *Psychother Psychosom* 2000;69:19-26. [doi: 10.1159/000012362].
23. Hartgens F, Kuipers H. Effects of androgenic-anabolic steroids in athletes. *Sports Med* 2004;34:513-54. [doi: 10.2165/00007256-200434080-00003].
24. Mendizábal S, Zamora I, Berbel O, Sanahuja MJ, Fuentes J, Simon J. Mycophenolate mofetil in steroid/cyclosporine-dependent/resistant nephrotic syndrome. *Pediatr Nephrol* 2005;20:914-9. [doi: 10.1007/s00467-005-1877-x].
25. Cooper JR, Bloom FE, Roth RH. *The Biochemical Basis of Neuropharmacology*. USA: Oxford University Press; 2003.
26. Specter SE, Wiss DA. Muscle dysmorphia: Where body image obsession, compulsive exercise, disordered eating, and substance abuse intersect in susceptible males. In: *Eating Disorders, Addictions and Substance Use Disorders: Research, Clinical and Treatment Perspectives*. Berlin, Heidelberg: Springer; 2014. p. 439-57. [doi: 10.1007/978-3-642-45378-6_20].
27. Pope HG, Kanayama G, Galanter M, Kleber H, Brady K. Treatment of anabolic-androgenic steroid related disorders. In: *The American Psychiatric Press Textbook of Substance Abuse Treatment*. 6th ed. Washington (DC): American Psychiatric Association Publishing; 2008.
28. Cunningham ML, Griffiths S, Mitchison D, Mond JM, Castle D, Murray SB. Muscle dysmorphia: An overview of clinical features and treatment options. *J Cogn Psychother* 2017;31:255-71. [doi: 10.1891/0889-8391.31.4.255].
29. León-Olea M, Martyniuk CJ, Orlando EF, Ottinger MA, Rosenfeld C, Wolstenholme J, *et al.* Current concepts in neuroendocrine disruption. *Gen Comp Endocrinol* 2014;203:158-73. [doi: 10.1016/j.ygcen.2014.02.005].
30. Petróczy A, Aidman E. Psychological drivers in doping: The life-cycle model of performance enhancement. *Subst Abuse Treat Prev Policy* 2008;3:7. [doi: 10.1186/1747-597X-3-7].