BOTOX’s Mechanism, Diversity Considerations, and Therapeutic Potential in Cosmetic, Medical, and Dental Practice

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Abstract
This review provides a comprehensive overview of the societal pressures of maintaining a youthful appearance and the increasing popularity of BOTOX injections for aesthetic purposes. It discusses the motivation behind BOTOX use for personal psychological gains, partly driven by social media pressure and societal expectations. Ethical considerations and potential psychosocial consequences of cosmetic BOTOX are also addressed. The article delves into the explanation of what BOTOX is and how it works, emphasizing its use for cosmetic and medical purposes, such as treating spasmodic dysphonia and hyperhidrosis. When used appropriately, it highlights the rarity of complications and adverse effects associated with BOTOX. BOTOX’s historical use and development, from its initial medical applications to its widespread adoption in cosmetic procedures, are outlined.
Further explored is the prevalence of BOTOX use among different socioeconomic classes, races/ethnicities, ages, and genders, highlighting disparities and emerging trends. It summarizes the effectiveness and safety of BOTOX injections for facial wrinkles and its non-cosmetic uses (e.g., treating migraines, hyperhidrosis, and pain management). The review describes BOTOX's uses in dentistry, including its therapeutic benefits and safety considerations. It also discusses the possible therapeutic advantages of BOTOX injections in managing psychological conditions, including depression, anxiety, and body dysmorphic disorder (BDD). The diagnostic applications of BOTOX and its mechanism of action are briefly explained. The article concludes with a summary of BOTOX's beneficial and adverse effects and the constraints on access to and use of BOTOX treatments. It acknowledges the limitations of BOTOX research and the need for further investigation to address these limitations.

Abbreviations: BDD: Body Dysmorphic Disorder; FDA: U.S. Food and Drug Administration; QoL: Quality of Life; ROM: Range of Motion; SES: Socioeconomic Status; SNAP-25: Synaptosomal-Associated Protein 25; TMD: Temporomandibular Joint Disorder

Introduction
Societal Pressures and Looking Young
Societal pressure to maintain a youthful appearance has led to an increase in the popularity of BOTOX injections for aesthetic purposes, particularly among women. A study by Singh et al. suggests that women who use BOTOX for aesthetic purposes are motivated by personal psychological gains (intrapersonal attributes) [1]. Social media pressure has been linked to a boom in cosmetic procedures, with younger people using BOTOX and dermal fillers due to societal pressures [2]. Ethical debates surrounding cosmetic BOTOX include patient autonomy and social pressures to conform to beauty standards [3]. Moreover, BOTOX treatment for spasmodic dysphonia has been linked to psychosocial consequences [4].

Medical estheticians recognize ethical and aesthetic considerations in BOTOX and filler injection treatments. Clinical studies have shown the efficacy of BOTOX in reducing pain intensity, muscle tenderness, and psychosocial effects related to pain, as well as improving mandibular range of motion (ROM) [5]. Innumerable individuals use social media to research BOTOX treatments, although the quality of such information about BOTOX may be limited. While some experts suggest that preventative BOTOX can temporarily stop wrinkles from forming, high-quality clinical trials are lacking [1,2,6].

What is BOTOX
BOTOX is a neurotoxin (produced by the Clostridium botulinum bacterium) used for cosmetic and medical purposes. The pharmaceutical agent in BOTOX injections is a purified form of botulinum toxin (a neurotoxic protein) that relaxes muscles by blocking nerve signaling that causes muscle contraction [7]. When used correctly, BOTOX diminishes wrinkles and can treat various medical conditions, such as spasmodic dysphonia (also known as laryngeal dystonia and “Shaky Voice”) and hyperhidrosis (excessive sweating) [7,8].

Complications of BOTOX are rare when appropriately used, and no long-term or life-threatening adverse effects have been reported [8].

Overview of the Historical Use and Development of BOTOX
BOTOX (onabotulinumtoxinA) was first developed in the 1970s by Dr. Alan Scott to treat strabismus, blepharospasm, and hemifacial spasm. Later, it was approved for treating other medical conditions, such as dystonia and spasticity [9]. In the 1980s, ophthalmologist Drs. Jean and Alastair Carruthers noticed the cosmetic benefits of BOTOX for wrinkles and began clinical trials, contributing to its widespread acceptance, usage in cosmetic procedures, and FDA approval in 2002 for aesthetic use [10,11]. Since then, BOTOX has become a household name in cosmetic treatments and has gained popularity for treating medical issues such as migraines and overactive bladder [9,10].

The expanding research into BOTOX’s aesthetic uses led the pharmaceutical company Allergan to study its safety and efficacy for frown lines and gain FDA approval in 2002 [9,12]. The history of botulinum toxin dates back to Emile Pierre-Marie van Ermengem’s discovery and purification of the toxin in 1895 and Edward Schantz and colleagues’ elucidation of its mechanism of action in the 1950s [10,12].

Discussion
Prevalence of BOTOX Use
BOTOX injections have become increasingly popular among people of different socioeconomic classes, ages, and genders for cosmetic and medical purposes. Socioeconomic Class
Socioeconomic status (SES) influences BOTOX utilization primarily due to affordability constraints. Individuals from lower socioeconomic backgrounds
may lack financial resources for BOTOX treatments compared to higher SES counterparts [13].
A study examining voice outcomes in spasmodic dysphonia patients treated with BOTOX revealed that treated individuals were predominantly affluent, Caucasian, well-educated, and English speakers [13].

**Race and Ethnicity**

Limited research has investigated the demographic traits of individuals undergoing BOTOX injections concerning racial and ethnic backgrounds. Clinical trials involving botulinum toxin-A and dermal fillers predominantly feature Caucasian participants, with Hispanic and Black individuals being less represented despite reflecting real-world demographics [14].

Studies on diversity within plastic surgery found that Black women are notably underrepresented in applications to plastic surgery residency programs, suggesting possible racial disparities in access to cosmetic procedures [15,16]. Guidelines have been established to offer guidance on assessing and disclosing age, race, and ethnicity-related data in medical research and clinical guidelines [17].

**Age**

BOTOX injections have been used to reduce wrinkles and address diverse medical conditions across various age demographics. Recent studies indicate a rising interest among younger individuals in leveraging BOTOX for preventive purposes. Clinical trials involving botulinum toxin treatments have included adults aged 18 and older [18,19].

Further research underscores the significance of tailoring botulinum toxin dosages for addressing upper facial concerns, considering patients’ age as a cardinal factor in treatment strategies [18,20]. Evidence-based analyses by Freeman et al. on BOTOX utilization among younger adults highlight an emerging trend of seeking these treatments at earlier stages [19].

Though the risks associated with BOTOX treatments among younger populations remain somewhat ambiguous, randomized clinical trials have encompassed individuals aged 30-70 with moderate to severe forehead wrinkles to evaluate BOTOX’s safety and efficacy [21].

The FDA recommends BOTOX for cosmetic and medical purposes for individuals under 65 [11]. Clinical investigations were conducted across diverse age brackets to evaluate its effectiveness in managing various medical conditions [18].

**Gender**

According to statistics by the American Society of Plastic Surgeons, women are the majority of individuals opting for BOTOX injections. Of the approximately 8.7 million neuromodulator injection procedures completed in 2022, 8.2 million (94%) were performed on women, while 526,062 (6%) were performed on men [22].

Various studies have explored the reasons motivating women to use BOTOX, ranging from economic considerations to perceptions of aging [1]. Additionally, research has investigated BOTOX’s efficacy and safety in treating medical conditions affecting women predominantly, such as interstitial cystitis and overactive bladder [23].

Exploring gender identity reveals potential differences in BOTOX usage among diverse populations, including transgender and non-binary individuals. However, there remains a paucity of research elucidating the frequency and drivers of seeking BOTOX injections within these populations [24].

**Cosmetic Uses of BOTOX; Effectiveness and Safety**

**Most Common Cosmetic Procedures Utilizing BOTOX**

The primary cosmetic applications of BOTOX injections involve addressing facial wrinkles, including crow’s feet, forehead lines, frown lines, and glabellar lines [6]. While hyperhidrosis is commonly considered a medical condition, it can also be recognized as a cosmetic issue because excessive sweating in social settings can lead to anxiety or embarrassment [25].

**Effectiveness and Safety of BOTOX Injections for Facial Wrinkles**

BOTOX injections for facial wrinkles are an effective and safe treatment method in clinical trials. The treatment involves injecting small amounts of botulinum toxin into the muscles, temporarily paralyzing them and preventing the muscles from contracting and causing wrinkles [6,26].

Clinical trials have demonstrated the effectiveness of BOTOX in reducing the appearance of frown lines, crow’s feet, and forehead lines for up to four months. Treatments at regular follow-up intervals are needed to maintain the results [6,26].

The treatment’s effectiveness may vary among patients, depending on factors such as the injection site and extent of muscle hypertonicity [8,27,28]. BOTOX is safe and well-tolerated when administered by proficient clinicians, and adverse effects are typically mild and temporary (e.g., bruising, swelling, pain, redness, and incomplete muscle relaxation) [7].

Patient selection criteria, including medical history, previous adverse reactions to BOTOX, pregnancy, and neuromuscular disorders, should be considered when assessing treatment safety [29,30].

When administered correctly by a certified licensed practitioner, BOTOX injections are safe and effective in smoothing facial wrinkles [6].

**Possible Adverse Effects and Patient Selection Criteria**

Potential adverse effects associated with BOTOX injections range from mild to moderate, including swelling, bruising, pain, or redness at the injection site, and temporary facial weakness or incomplete muscle relaxation [6].
relaxation. In rare instances, more severe reactions (e.g., allergic responses or unintended spread of the toxin to surrounding muscles) may occur [8]. Before BOTOX treatment, patient selection criteria are crucial and typically involve a thorough medical history review to evaluate overall health, past reactions to BOTOX, pregnancy status, and the presence of neuromuscular disorders. Patients must be informed about the procedure’s risks and consent before proceeding [8,31,32]. Individuals with neurological or muscle conditions like myasthenia gravis or Lambert-Eaton syndrome are generally advised against BOTOX treatment due to its mode of action. Furthermore, certain medications, including blood thinners or muscle relaxants, may heighten the risk of bleeding or bruising and are typically avoided before injections [8,33]. When considering BOTOX treatment, consultation with a qualified and licensed medical professional is essential to assess individual risks and ensure proper precautions are taken to minimize adverse effects.

**Onset and Duration of Effects**

The onset and duration of BOTOX effects can be characterized as immediate (short-term) and delayed (long-term) beneficial or adverse effects. The immediate effects of BOTOX injections are the temporary reduction or paralysis of facial muscles, reducing the appearance of wrinkles. Temporary side effects of the treatment may include pain, swelling, and bruising at the injection site, as well as incomplete muscle relaxation [34,35]. Some studies have observed delayed effects of BOTOX treatment, such as prolonged use, possibly leading to changes in skin and muscle health. Long-term safety data for BOTOX indicate toxic effects can appear after uncomplicated administration across various treatment areas over time [34,35]. While BOTOX has some delayed beneficial effects on skin and muscle, there are also concerns about the potential detrimental effects of its long-term use on skin and muscle health [35].

Table 1 summarizes BOTOX cosmetic procedures, their effectiveness, safety considerations, possible adverse effects, and onset and duration of effects.

### Table 1: BOTOX Cosmetic Procedures and Safety Considerations

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Common Procedures</td>
<td>BOTOX injections primarily target facial wrinkles including crow’s feet, forehead lines, frown lines, and glabellar lines. It is also used for hyperhidrosis to address excessive sweating.</td>
</tr>
<tr>
<td>Effectiveness &amp; Safety</td>
<td>BOTOX injections are effective in reducing wrinkles for up to four months, with mild and temporary adverse effects (e.g., bruising and swelling). Safety depends on proper administration and patient selection criteria.</td>
</tr>
<tr>
<td>Adverse Effects &amp; Criteria</td>
<td>Adverse effects range from mild to severe, including swelling and allergic reactions. Patient selection criteria involve medical history review, pregnancy status, and neuromuscular disorders.</td>
</tr>
<tr>
<td>Onset &amp; Duration</td>
<td>Immediate effects include temporary reduction of wrinkles, while delayed effects and long-term use may have both beneficial and detrimental impacts on skin and muscle health.</td>
</tr>
</tbody>
</table>

### Non-Cosmetic Uses of BOTOX

BOTOX has applications for various and diverse non-cosmetic conditions, including migraines, hyperhidrosis, and pain management. BOTOX injections for hyperhidrosis block signals from the nerves to the sweat glands, reducing excessive sweating in treated areas [36]. BOTOX has also been shown to be effective in reducing migraines and chronic headaches in clinical trials, with treatments given regularly to alleviate symptoms [37,38]. Additionally, BOTOX injections have been used for various pain management applications, including reducing muscle pain and spasticity in patients with cerebral palsy or multiple sclerosis [39]. BOTOX injections and patches are sometimes explored as therapeutic approaches for managing pain associated with diabetes mellitus neuropathy.

Studies have shown BOTOX to be effective and safe for migraine and hyperhidrosis treatment when administered correctly by a trained professional [6–8]. In pain management applications, the efficacy of BOTOX may vary depending on the site of injection and the extent of muscle hypertonicity [8,27,28]. Possible adverse effects of BOTOX include mild to moderate side effects such as bruising, swelling, and pain at the injection site. In contrast, rare adverse effects may include allergic reactions or toxin spread [7,8]. Patient selection criteria for these uses are based primarily on medical history, previous adverse reactions to BOTOX, and potential contraindications like pregnancy or neuromuscular disorders [29,30]. When considering BOTOX injections for non-cosmetic uses, it is essential to consult with a qualified medical professional to minimize the risk of adverse effects.
Table 2 provides an overview of certain muscle-related medical conditions treated with BOTOX, including its FDA approval status.

<table>
<thead>
<tr>
<th>Condition</th>
<th>BOTOX FDA Approval</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achalasia</td>
<td></td>
<td>BOTOX injections can be used off-label as a temporary treatment for achalasia by relaxing the lower esophageal sphincter muscles.</td>
</tr>
<tr>
<td>Bell’s Palsy</td>
<td></td>
<td>BOTOX can help manage facial muscle spasms and asymmetry associated with Bell’s palsy by temporarily relaxing affected muscles.</td>
</tr>
<tr>
<td>Blepharospasm</td>
<td>✓</td>
<td>BOTOX is FDA-approved for the treatment of blepharospasm (involuntary blinking or eyelid spasms).</td>
</tr>
<tr>
<td>Bruxism</td>
<td></td>
<td>While not FDA-approved specifically for bruxism, some studies suggest that BOTOX injections into the jaw muscles may help reduce teeth grinding and associated jaw pain.</td>
</tr>
<tr>
<td>Chronic Low Back Pain</td>
<td></td>
<td>While not FDA-approved, some studies suggest that BOTOX injections may provide relief for chronic low back pain.</td>
</tr>
<tr>
<td>Chronic Migraine</td>
<td>✓</td>
<td>BOTOX is FDA-approved for the prevention of chronic migraines in adults.</td>
</tr>
<tr>
<td>Chronic Pelvic Pain</td>
<td></td>
<td>BOTOX injections into the pelvic floor muscles have been used off-label to help alleviate chronic pelvic pain in certain cases.</td>
</tr>
<tr>
<td>Cervical Dystonia</td>
<td>✓</td>
<td>BOTOX is FDA-approved for the treatment of cervical dystonia (spasmodic torticollis).</td>
</tr>
<tr>
<td>Graves’ Disease</td>
<td></td>
<td>BOTOX is not typically used as a treatment for Graves’ disease itself, but it may be used to manage certain symptoms associated with the condition, such as eyelid retraction or hyperfunctional facial muscles.</td>
</tr>
<tr>
<td>Hemifacial Spasm</td>
<td>✓</td>
<td>BOTOX is FDA-approved for the treatment of hemifacial spasm (involuntary muscle contractions on one side of the face).</td>
</tr>
<tr>
<td>Hyperhidrosis</td>
<td>✓</td>
<td>BOTOX is FDA-approved for treating severe primary axillary hyperhidrosis (excessive underarm sweating) when topical treatments are ineffective.</td>
</tr>
<tr>
<td>Muscle Spasticity</td>
<td>✓</td>
<td>BOTOX is FDA-approved for the treatment of muscle spasticity in various conditions, including cerebral palsy and post-stroke spasticity.</td>
</tr>
<tr>
<td>Overactive Bladder</td>
<td>✓</td>
<td>BOTOX is FDA-approved for treating overactive bladder when anticholinergic medications are ineffective.</td>
</tr>
<tr>
<td>Piriformis Syndrome</td>
<td></td>
<td>BOTOX injections into the piriformis muscle can help alleviate pain and muscle tightness associated with piriformis syndrome.</td>
</tr>
<tr>
<td>Plantar Fasciitis</td>
<td></td>
<td>While not FDA-approved, some studies suggest that BOTOX injections may provide relief for plantar fasciitis by relaxing the plantar fascia and reducing inflammation.</td>
</tr>
<tr>
<td>Post-Stoke Spasticity</td>
<td>✓</td>
<td>BOTOX injections can help manage muscle spasticity following a stroke, improving mobility and reducing pain.</td>
</tr>
<tr>
<td>Raynaud’s Disease</td>
<td></td>
<td>BOTOX injections can be used off-label to alleviate symptoms of Raynaud’s disease by blocking the nerves that constrict blood vessels.</td>
</tr>
<tr>
<td>Sialorrhea (Excessive Salivation)</td>
<td></td>
<td>BOTOX injections into the salivary glands can help reduce excessive drooling in conditions like cerebral palsy or Parkinson’s disease.</td>
</tr>
<tr>
<td>Strabismus</td>
<td></td>
<td>BOTOX can be used off-label to treat strabismus (crossed eyes or squint) by weakening specific eye muscles to correct the misalignment.</td>
</tr>
<tr>
<td>Temporomandibular Joint Disorder (TMD)</td>
<td></td>
<td>BOTOX injections into the jaw muscles can help reduce pain and improve jaw function in TMD.</td>
</tr>
<tr>
<td>Trigeminal Neuralgia</td>
<td></td>
<td>BOTOX injections can help alleviate trigeminal neuralgia by targeting and temporarily blocking the transmission of pain signals from the trigeminal nerve, thereby reducing the frequency and severity of painful episodes.</td>
</tr>
<tr>
<td>Spasmodic Dysphonia</td>
<td></td>
<td>BOTOX injections can be used off-label to treat vocal cord dysfunction.</td>
</tr>
</tbody>
</table>
BOTOX Uses in Dentistry

BOTOX has emerged as a promising treatment modality within dentistry, offering solutions for various dental and oral conditions. In dentistry, BOTOX injections mitigate muscle hyperactivity, facilitate pain relief, and yield other therapeutic benefits. Moreover, BOTOX has proven effective in mitigating muscle challenges encountered during intricate dental procedures, enabling effective treatment for patients with disabilities and restricted oral motor functions [40,41]. Clinical investigations have underscored the safety and efficacy of BOTOX injections in dental practice, with reported minimal short-term adverse effects, such as mild pain and swelling [42]. However, comprehensive long-term safety assessments are indicative to ascertain the effectiveness and safety of BOTOX in dental procedures [43].

Dental practitioners can more effectively mitigate adverse effects when integrating BOTOX into dental care protocols by undergoing comprehensive training and obtaining certification for the safe administration of BOTOX injections. Dentists use BOTOX for various therapeutic purposes, including but not limited to [43–45]:

- TMD: BOTOX can alleviate muscle pain and spasms associated with TMD.
- Bruxism: BOTOX injections can help reduce jaw clenching and teeth grinding.
- Oromandibular Dystonia: BOTOX can manage involuntary facial and jaw muscle contractions.
- Sialorrhea: BOTOX injections can reduce saliva production and drooling.
- Trigeminal Neuralgia: BOTOX may relieve facial pain associated with trigeminal neuralgia.
- Chronic Migraines: Some dentists use BOTOX to alleviate migraine headaches.
- Gummy Smile: BOTOX injections can help lower the upper lip to reduce the appearance of a gummy smile.
- Facial Pain: BOTOX may be used to manage facial pain conditions such as myofascial pain syndrome.
- Masseter Hypertrophy: BOTOX injections can reduce the size of enlarged masseter muscles, resulting in a slimmer jawline.
- Tooth Grinding Related to Sleep Apnea: BOTOX may help alleviate tooth grinding associated with sleep-related breathing disorders.

The use of BOTOX for these conditions should be carried out by qualified dental professionals with appropriate training and certification. Additionally, the effectiveness of BOTOX treatment may vary depending on the individual patient and the specific condition being treated [6].

BOTOX Uses for Psychological Conditions

Many studies indicate the therapeutic advantages of BOTOX injections in managing various psychological conditions, including depression, anxiety, and body dysmorphic disorder (BDD) [46]. A study by Magid et al. demonstrated significant mood improvement over the 24 weeks of follow-up post-BOTOX injection in individuals receiving treatment for depression [47]. BOTOX for depression treatment involves injecting the toxin into specific facial muscles associated with emotional expression. The theory behind this approach is that by reducing the ability to make certain facial expressions, the brain receives less feedback related to those expressions, which may help alleviate depressive symptoms. However, it is essential to note that while some studies have shown promising results, further research is needed to fully understand the efficacy and mechanisms of BOTOX in treating depression [46]. Similarly, research has shown a reduction in anxiety symptoms among patients receiving BOTOX injections for cosmetic purposes, accompanied by enhancements in mood and overall quality of life (QoL) [48]. Mafi et al. suggest that BOTOX treatment could enhance body image perception and overall well-being in individuals with BDD [49].

While BOTOX treatment is generally considered safe and well-tolerated for psychiatric conditions, it is crucial to address any underlying mental health issues before administering BOTOX. Referral to mental health specialists may be necessary in some cases [4,50].

BOTOX injections hold promise as a therapeutic option for psychological conditions, albeit requiring careful consideration and medical oversight.

Diagnostic Applications of BOTOX

BOTOX has various diagnostic applications in dentistry and medicine as listed in Table 3.

### Table 3: Diagnostic Applications of BOTOX in Dentistry and Medicine

<table>
<thead>
<tr>
<th>Diagnostic Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessing Muscle Function</td>
<td>Used to evaluate muscle function and identify areas of hyperactivity or dysfunction.</td>
</tr>
<tr>
<td>Differentiating Between Neuromuscular and Structural Issues</td>
<td>Assists in determining whether muscle spasms or tension are contributing to symptoms or if structural issues are present.</td>
</tr>
<tr>
<td>Assessing Nerve Dysfunction</td>
<td>Aids in diagnosing nerve dysfunction by observing changes in muscle activity and responsiveness.</td>
</tr>
</tbody>
</table>
Identifying Trigger Points | Helps pinpoint trigger points in muscles associated with pain or dysfunction.
---|---
Assessing Jaw Movement | Utilized to evaluate jaw movement patterns and identify abnormalities.
Evaluating Salivary Gland Function | Assists in assessing salivary gland function by reducing saliva production temporarily.
Differentiating Between Central and Peripheral Nervous System Disorders | Aids in differentiating between central and peripheral nervous system disorders by observing responses to treatment.
Assessing Orofacial Pain Conditions | Aids in diagnosing orofacial pain conditions by providing temporary relief and observing changes in symptoms.
Monitoring Treatment Responses | Used to monitor responses to treatment over time, helping healthcare providers adjust treatment plans as needed.
Investigating Muscle Spasticity | Assists in investigating muscle spasticity and assessing the effectiveness of interventions in managing spasticity-related symptoms.

**General Overview of the Mechanism of Action of BOTOX**
BOTOX’s mechanism of action involves inhibiting neuronal signaling, which hampers the release of acetylcholine from peripheral nervous system terminals. This inhibition prevents muscle contraction and movement, resulting in temporary muscle paralysis or relaxation [51]. Specifically, botulinum toxin blocks acetylcholine binding to the presynaptic membrane of motor neurons. This obstruction inhibits synaptic vesicle fusion and blocks neurotransmitter release into the synaptic cleft. Consequently, the targeted muscle relaxes, reducing wrinkles, muscle spasms, or other conditions treated with BOTOX [7,51,52].

The duration of action is typically temporary, lasting 3-4 months for most patients due to the regeneration of the neuromuscular junction and the formation of new nerve endings [53]. However, repeated use of BOTOX can lead to long-term effects that persist beyond the drug’s presence in the muscles [54]. Recent studies have uncovered complex molecular and cellular changes in the interstitial organs of the targeted muscles, suggesting that long-term BOTOX use may harm overall muscle health [54].

**Distinct BOTOX Formulations for Cosmetic and Non-Cosmetic (Medical) Purposes**
BOTOX is offered in various formulations, each with distinct properties and intended applications. Among the most commonly available formulations are onabotulinumtoxinA (BOTOX), abobotulinumtoxinA (Dysport), and incobotulinumtoxinA (Xeomin). These formulations derive from different botulinum toxin type A strains, exhibiting unique characteristics regarding potency, diffusion, and duration of effects [55].

While onabotulinumtoxinA and abobotulinumtoxinA primarily target the release of acetylcholine, incobotulinumtoxinA operates by cleaving synaptosomal-associated protein 25 (SNAP-25), crucial for the docking and fusion of synaptic vesicles to the target membrane. These BOTOX formulations differ in their onset and duration of action [55,56]. OnabotulinumtoxinA typically demonstrates a rapid onset, manifesting effects within days to weeks of treatment and lasting up to four months. AbobotulinumtoxinA, although slower to initiate effects, may present a longer action duration than onabotulinumtoxinA. Conversely, incobotulinumtoxinA shows a similar onset to onabotulinumtoxinA but may sustain effects for up to six months or more, contingent upon the treated area and individual patient factors [57].

Considering the target muscle or tissue and desired outcomes, carefully weighing these distinctions when selecting the appropriate therapy for specific applications is fundamental [58]. The varied formulations of BOTOX offer diverse benefits and considerations, necessitating a thorough evaluation of each patient’s unique needs and conditions to determine the most suitable treatment [55].

**Summary of the Beneficial Effects of BOTOX**
BOTOX offers a wide range of benefits encompassing cosmetic enhancements and therapeutic interventions.

In cosmetic contexts, BOTOX effectively diminishes the appearance of facial wrinkles, targeting areas like frown lines, crow’s feet, and forehead creases. Its versatility extends to jawline sculpting and addressing aesthetic concerns such as gummy smiles or bunny lines around the nose [6]. Beyond aesthetics, BOTOX exhibits therapeutic efficacy in alleviating muscle pain and spasticity [58]. It also serves as a treatment for hyperhidrosis and migraines and diminishes drooling in Parkinson’s disease patients [42]. Furthermore, it has proven effective in managing vocal cord dysfunction and curbing excessive sweating [7,8].

BOTOX’s potential therapeutic reach extends to psychiatric conditions, with emerging evidence suggesting its role in mitigating depressive symptoms and exploring additional treatment avenues [33,50].
While BOTOX’s effectiveness varies depending on factors like injection site and individual muscle conditions, extensive clinical trials and research affirm its wide-ranging benefits across cosmetic and medical domains [6–8].

**Summary of the Adverse Effect of BOTOX**

Some patients may experience adverse effects following BOTOX treatment. Typical side effects of BOTOX include local reactions at the injection site (e.g., pain, swelling, redness, and bruising). Other possible side effects may encompass incomplete muscle relaxation, temporary muscle weakness, difficulty swallowing, flu-like symptoms, or headaches [6–8]. Although rare, severe adverse effects might occur, including allergic reactions or unintentional toxins spread to nearby muscles, resulting in symptoms like speech difficulties, drooping eyelids, or double vision [8,34].

Prolonged BOTOX use may have negative implications for muscle and skin health, though further research is warranted to comprehend these effects fully [34,35]. Contraindications to BOTOX encompass a history of toxin allergy, neuromuscular disorders, pregnancy, breastfeeding, clotting disorders, and certain medications [8,29–33]. In select cases, BOTOX therapy might not be advisable or should be approached cautiously under the guidance of qualified medical professionals.

**Constraints Regarding the Access to and Use of BOTOX**

Several factors can hinder patient access to and utilization of BOTOX treatments. One major obstacle is the relatively high cost of BOTOX procedures, which may render it unaffordable for certain individuals. Moreover, some cosmetic procedures may not be covered by insurance, limiting accessibility to BOTOX treatments [13,59]. Needle aversion or fear of injections may discourage some patients from pursuing BOTOX therapy [60]. Psychological, cultural, religious, and social considerations can also influence patients’ decisions regarding BOTOX treatment. For instance, societal stigma surrounding cosmetic procedures or cultural norms opposing artificial interventions may dissuade individuals from seeking BOTOX therapy [61]. Similarly, religious beliefs concerning body alterations or medical interventions may impact patients’ willingness to undergo such treatments [61]. Psychological factors like body image issues, anxiety, or depression can affect patients’ attitudes toward BOTOX procedures [49]. Addressing these barriers may entail enhancing access to cost-effective treatments, providing alternative therapeutic options, and improving patient education about the advantages and disadvantages of BOTOX therapy.

**Limitations of BOTOX Investigation and Research Studies**

Although extensively studied in clinical trials, research on BOTOX faces several limitations. One significant challenge lies in understanding how BOTOX operates. Its impact on the neuromuscular junction and neurotransmitter release complicates predicting its precise effects or optimizing dosage. Also, the duration and variability of its effects among patients and potential long-term repercussions remain inadequately understood [7,62].

Another constraint involves the reliance on surrogate endpoints, like wrinkle severity scales, rather than more meaningful patient outcomes, such as QoL [63]. Most clinical trials focusing on BOTOX’s cosmetic applications have been short-term, lacking long-term assessments of repeated treatments [64].

Another concern is the conflict of interest between clinical investigators and BOTOX’s manufacturer. Such conflicts could introduce study design, publication, and data interpretation biases [65,66].

While BOTOX has demonstrated safety and efficacy in numerous clinical trials, addressing these limitations in endpoints, trial design, and underlying mechanisms of action remains paramount for future research efforts.

**Conclusion**

BOTOX injections have become increasingly popular for both cosmetic and medical purposes. The prevalence of BOTOX use is influenced by socioeconomic class, with lower socioeconomic backgrounds potentially lacking the financial resources for treatment.

Limited research has been conducted on the racial and ethnic backgrounds of individuals receiving BOTOX injections, with studies showing the underrepresentation of Hispanic and Black individuals. Age also plays a role, as younger individuals show rising interest in using BOTOX for preventive purposes. Women are the majority of individuals opting for BOTOX injections, with studies exploring the reasons behind their usage, including economic considerations and perceptions of aging. Research on gender identity and BOTOX usage among transgender and non-binary individuals is limited.

BOTOX has cosmetic and non-cosmetic uses, including treating facial wrinkles, hyperhidrosis, migraines, and various pain conditions. It also has applications in dentistry, with benefits for temporomandibular joint disorders (TMDs), bruxism, and other oral conditions. BOTOX has shown capacity in managing psychological conditions (e.g., depression and anxiety). It has limited applications as a diagnostic tool. BOTOX’s mechanism of action involves blocking neuronal signaling and temporarily paralyzing muscles. It is available in different formulations with unique properties and intended applications.
BOTOX treatment can have both beneficial and adverse effects. Common side effects include pain, swelling, and bruising at the injection site, while severe reactions and toxin spread can occur in rare instances. Long-term use of BOTOX may have implications for muscle and skin health.

Constraints to accessing and utilizing BOTOX treatments include cost, needle aversion, psychological and cultural factors, and religious beliefs. Studies on BOTOX have limitations, including understanding its precise effects and long-term repercussions, reliance on surrogate endpoints, and conflicts of interest. Further research is needed to address these limitations and to provide a comprehensive understanding of BOTOX’s efficacy, safety, and potential applications in various fields of medicine and dentistry.

Conflict of Interest Statement
The authors declare that this paper was written without any commercial or financial relationship that could be construed as a potential conflict of interest.

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