Obsessive-Compulsive Disorder: Effective Mainstream Treatments and the Need for Alternatives

Channing Ly

Abstract

Obsessive-compulsive disorder (OCD) is a neuropsychiatric disorder that affects 1-3% of the population. The main symptoms are obsessions (intrusive thoughts) and compulsions (repetitive behavior). This paper explores the subtypes (contamination, harmful thoughts, symmetry, and hoarding) and symptoms of OCD. The environmental (e.g., stress, autoimmune responses) and genetic (e.g., SLC1A1) contributors of OCD are also detailed. Results from studies and tests of both behavioral and pharmacological treatments are evaluated, with exposure and response prevention (ERP) therapy and selective serotonin reuptake inhibitors (SSRIs) established as gold-standard treatment options. Because of the poor safety profile of clomipramine, its effectiveness and application are limited, so it is identified as an alternative to SSRIs. Combination therapy of ERP and SSRIs is concluded to be highly effective, despite study results that may not support this conclusion. Limited evidence on alternative treatments, especially medical cannabis, warrants further research. Overall, this paper emphasizes the importance of personalized treatment plans and identifies knowledge gaps that should be addressed with further research to improve the lives of individuals with OCD.

Introduction

Obsessive-compulsive disorder (OCD) is a common neuropsychiatric disorder, affecting 1-3% of the population, that causes obsessions and compulsions that can interfere with daily life. Although OCD causes distress and is time-consuming, it can be treated both behaviorally and pharmacologically (Brock, 2024). The complexity of OCD is important to understand when considering what treatment option is most effective, as it may vary from person to person because of factors like comorbid conditions, side effects, and responses to different drugs and dosages. The aim of this review is to develop a clear understanding of the most effective OCD treatments. Through a thorough investigation of OCD, evidence will be collected to answer the question: What is OCD, and what are the most effective treatments for it? The specific aims of the research are to (a) describe the symptoms and general subtypes of OCD, (b) investigate how environmental triggers can lead to the development of OCD, and how genetic contributions may be associated with a higher risk, (c) describe the effects of behavioral therapy on OCD, (d) describe the effects of prescribed medications, including less orthodox treatments (e.g., medical cannabis), on OCD, and (e) create a graphic that details and summarizes the effectiveness and limitations of OCD treatments as a clear guide for people looking to treat their OCD, and also to educate people on OCD and its treatment. By answering the research question and fulfilling the aims, healthcare providers can better select more effective treatments for individuals with OCD based on their specific conditions and responses to treatments, allowing for greater and facilitated symptom reduction in these individuals.

OCD Subtypes and Symptoms

OCD is a psychiatric disorder that affects 1-3% of people (Brock, 2024). It can be categorized into contamination, harmful thoughts, symmetry, and hoarding (Jalal et al., 2023). The main symptoms are obsessions (intrusive thoughts) and compulsions (repetitive actions). These cause distress and impairment, and are also significantly time-consuming. First, the obsessions lack purpose, are hard to control, and bring distress. As a result, OCD individuals will often perform compulsions, a maladaptive method to mitigate the distress and bring relief (Brock, 2024). OCD individuals also frequently avoid triggers of their obsessions to avoid performing time-consuming compulsions. As mentioned earlier, OCD can be categorized into four general subtypes: contamination (contamination obsessions and compulsive cleaning), harmful thoughts (obsessions around causing harm paired with compulsive checking), symmetry (symmetry obsessions and compulsive ordering), and hoarding (obsessions with object collecting paired with compulsive hoarding) (Jalal et al., 2023). There may be a subtype that only involves obsessions (intrusive thoughts surrounding blasphemy, sex, and violence), but empirical support is mixed (Jalal et al., 2023). Additionally, although hoarding compulsions affect around 30% of OCD individuals, hoarding in itself may have a different cause, so hoarding disorder is therefore listed as a distinct condition that is separate from OCD, but still related. However, in children and adolescents, hoarding is not distinct from other OCD symptoms, so it may only become so in adulthood (Jalal et al., 2023). While OCD symptoms develop through various subtypes, it is important to understand the causes for symptom development. The next section will focus on the environmental and genetic etiology of OCD.

Environmental and Genetic Contributions

One key factor of OCD is its etiology, which is responsible for the symptoms and various subtypes previously mentioned, and involves several elements. Based on twin studies, the heritability quotient of OCD is 48%, but when considering the role maternal effects play in this statistic, it drops to 35%. Despite this, there is still limited knowledge of genetic contributions to OCD, and little is known about potential genetic markers. The SLC1A1 gene is a possible candidate (Brock, 2024). This is because there may be a link between OCD and the chromosome region 9p24, which contains the SLC1A1 gene and other genes. There is also a significant link between OCD and the 3’ region of SLC1A1, with the association being stronger in males. Therefore, OCD may be triggered by higher SLC1A1 expression (Zike et al., 2017).

Similar to genetic contributions of OCD, there is currently limited knowledge of environmental triggers of OCD, such as childhood trauma, parenting style, stress, or social environment. However, there is some existing information about environmental triggers, not necessarily encompassing the ones mentioned above. As mentioned earlier, there are environmental triggers of OCD during pregnancy, and these may include prenatal exposure to stress or infection (Brock, 2024). These factors play a role in twin studies of OCD. There may also be an autoimmune etiology for OCD, particularly when it comes to children. With Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections (PANDAS)

and Pediatric Acute-onset Neuropsychiatric Syndrome (PANS), autoimmune responses to infections, inflammatory reactions, or toxins can result in the sudden and severe onset of OCD symptoms. These symptoms are often combined alongside other nonrelated symptoms, such as worsened handwriting, mood swings, and intermittent disease episodes (Brock, 2024). A specific pathogen, group A streptococcal infection, is responsible for PANDAS, while for PANS, it may be triggered by different microbes, such as Lyme disease and Epstein-Barr virus (Cocuzza et al., 2022). Additionally, cognitive impairments, like heightened responsibility, thought overemphasis, controlling thoughts, overestimation of threats, perfectionism, and intolerance of uncertainty, feed into the OCD cycle. These impairments cause obsessions, therefore promoting compulsions as a means of reducing the anxiety and distress brought about by the obsessions (Brock, 2024). Environmental influences, like trauma and stress, may be a cause of these maladaptive beliefs, which can, in turn, develop and worsen OCD.

Behavioral Therapy Effectiveness

Because the symptoms, subtypes, and etiology of OCD are complex and diverse, treatment methods must be able to address all of these factors. One effective way to counteract OCD symptoms, as developed by genetic or environmental influences, is through behavioral therapy, specifically, exposure and response/ritual prevention (ERP) therapy. ERP is a highly effective behavioral treatment for OCD. Considered a gold-standard treatment, it is the active ingredient of cognitive-behavioral therapy (CBT), involving exposure to obsession-triggering content without performing anxiety-relieving compulsions. With this, ERP allows for the undoing of the conditioned relationship between obsession triggers and the compulsive response and new learning where OCD beliefs are rejected (Spencer et al., 2023). In other words, it eliminates rituals and avoidance to encourage tolerance for distress without counterproductively engaging in compulsions (Hezel & Simpson, 2019).

Although ERP is undoubtedly effective, it has some limitations and challenges. First, some therapists may hesitate to deliver ERP, as they may have doubts about its safety or their patients' ability to tolerate the exposures, or they may perceive that ERP is not essential for treating OCD. However, ERP rarely has serious consequences, and these doubts from therapists are often unfounded (Spencer et al., 2023). Next, when it comes to delivering ERP, some therapists make certain mistakes that can reduce its effectiveness. These mistakes include only having patients engage in lower-difficulty exposures, unintentionally providing reassurance or not noticing patients providing reassurance for themselves, failing to create exposures relevant to patients' lives or failing to help patients apply what they learn to real-life scenarios, and focusing on using logic to disprove obsessions (Spencer et al., 2023). One mistake patients may make with ERP is low adherence to treatment; symptoms are likely to worsen without full commitment to exposures assigned as homework (Hezel & Simpson, 2019).

Furthermore, comorbid psychiatric conditions, including anxiety, depression, and ADD, often create more challenges and complexities for ERP to work effectively. There are several considerations for properly and effectively utilizing ERP to treat OCD with comorbid conditions.

One such consideration is whether comorbid conditions should be simultaneously treated with OCD or sequentially treated, as well as how much the comorbid conditions affect the ERP treatment process. If a comorbid condition is highly interfering with ERP, it may be better to address it beforehand. However, ERP is tailorable to address the condition without interfering with the treatment process, and some comorbid conditions may even improve with successful ERP (Spencer et al., 2023). Additional complicating factors that may limit the effectiveness of ERP include low insight, comorbid conditions of disorganized or tangential thinking, substance abuse, and higher levels of disability from the OCD. When considering these factors, higher levels of care may be more effective as a treatment method (Spencer et al., 2023).

Pharmacotherapy and Alternative Treatments

In addition to behavioral therapy, pharmacotherapy is another viable treatment option for OCD. In the same manner as ERP, selective serotonin reuptake inhibitors (SSRIs), the top option for pharmacotherapy, can properly and effectively address the various factors that may make OCD unique from case to case. At the presynaptic axon terminal of the brain, SSRIs inhibit the serotonin transporter (SERT), leaving more serotonin in the synaptic cleft to stimulate post-synaptic receptors for longer periods (Chu, 2023). Among the different SSRIs, fluvoxamine is widely considered the most effective. However, there is no differential advantage for any SSRI, and the best option depends on each patient's reaction and preference (Pittenger & Bloch, 2014). With SSRIs, the higher the dose, the more effective the treatment, as multiple studies prove. Even so, this idea may not apply to all patients. Although raising the dosage is beneficial, there is only a small chance that doing so will make a non-responding patient a responding one (Pittenger & Bloch, 2014). Still, when increasing dosage, even if patients do not have a full response according to how it is strictly defined in studies, they may experience small but meaningful improvements, not categorized as a full response (Pittenger & Bloch, 2014). Although it has been clinically established that SSRIs take 8-12 weeks to take effect, improvement may begin quicker; patients may experience subjective improvement within the first few weeks of treatment, but this improvement is only clinically significant weeks later (Pittenger & Bloch, 2014). Furthermore, some factors may limit the effectiveness of SSRIs, including hoarding, low insight, a severe concurrent episode of depression, and higher levels of disability from the OCD (Del Casale et al., 2019). Some side effects from all SSRIs include somnolence, sexual dysfunction, hyponatremia, initial weight loss, and suicidal behavior. These side effects can be easily managed by adjusting the dosage, switching the time of day when the SSRI is taken, or switching to another SSRI (Janardhan Reddy et al., 2017).

Although SSRIs are an effective treatment method, they may be incompatible with some patients. In these cases, the tricyclic antidepressant clomipramine, another option for pharmacotherapy, should be considered. Clomipramine is a potent serotonin reuptake inhibitor with a strong affinity for SERT, and its administration results in the increased number and transmission of serotonergic and noradrenergic neurotransmitters (Wilson, 2024). Its strong inhibition of serotonin reuptake makes it uniquely useful against obsessions (Del Casale et al.,

2019). Though meta-analysis suggests that clomipramine may be more effective than SSRIs, technical issues complicate this picture; head-to-head trials have also not shown clomipramine to be superior (Pittenger & Bloch, 2014). SSRIs are more effective at higher doses, as patients who take higher doses may experience small, meaningful improvements. However, clomipramine poses dangers at higher doses, so when it is tested against SSRIs, both drugs are tested at lower, standard doses. At this level, clomipramine maintains its normal effectiveness, while SSRIs may have lower effectiveness compared to when administered at higher doses. Therefore, in these tests, there may be a bias favoring clomipramine. Nevertheless, clomipramine may still yield better results even when tested against SSRIs at higher doses, so it may be slightly advantageous for some (Pittenger & Bloch, 2014). Despite this, clomipramine has a problematic safety profile, making it an alternative to SSRIs rather than a first choice. Clomipramine has anticholinergic, anti-histaminergic, and alpha-adrenergic blocking side effects, which can result in dry mouth and constipation, weight gain and drowsiness, and low blood pressure, respectively. There is also risk for arrhythmia: doses at 250 mg may require an ECG, and cardiotoxicity may occur with overdose. Aminotransferase enzyme levels may be increased in the blood (Del Casale et al., 2019), and seizures may even occur at doses higher than 250 mg (Pittenger & Bloch, 2014).

For those with more severe OCD, it is intuitive that these individuals would benefit from SSRI pharmacotherapy and CBT in conjunction. However, studies suggest that this may not be a more effective treatment method (Pittenger & Bloch, 2014). For children with OCD, studies indicate that the combination of SSRI pharmacotherapy and CBT is more effective than just one of those treatments (Pittenger & Bloch, 2014). However, in adults, this combination treatment may not be beneficial; a study has shown that CBT is more effective than both SSRI pharmacotherapy and the combination treatment (Pittenger & Bloch, 2014). One consideration for these studies is that the CBT was highly effective, as it was administered intensively by experts at academic centers, while the medication may not have been as effective, as it was administered inflexibly and according to strict protocol. Most clinical experts still recommend combination treatment as a better option than either SSRI pharmacotherapy or ERP alone (Pittenger & Bloch, 2014).

In cases where SSRIs are incompatible with patients, and clomipramine is either also incompatible or avoided because of its safety profile, patients, understandably, may consider looking into alternative drug treatments. Among treatment-resistant individuals, alternative drug treatments are necessary and crucial, although there is little well-established information about them (Khan et al., 2023). One such treatment is medical cannabis. In a study of 726 participants, 541 (74.5%) participants had symptom improvements after cannabis intake, and 185 (25.5%) participants had worsened symptoms. Of the 185 participants, 101 (13.9%) had worsened obsessions only, 81 (11.2%) had worsened compulsions only, and 3 (0.4%) had worsened obsessions and compulsions (Khan et al., 2023). However, the study had limitations. The small sample size did not apply to a broad population, and there was also low-quality evidence, with most of it being observational (Khan et al., 2023). The study on medical cannabis

as an alternative treatment for OCD laid some groundwork for future studies; much more research is necessary to establish the effectiveness of medical cannabis, as there is currently too little known about it to definitively determine its effects on OCD.

Methods

This paper used the PubMed database to gather free texts on OCD topics. The texts were gathered through manual searching on the database and Google, as well as searching through ChatGPT. Specific keywords included “OCD environmental factors,” “OCD genetic markers”, “OCD pharmacotherapy”, and “OCD behavioral therapy”. The articles were selected based on whether or not the information provided was relevant to the research question and aims. Specific information from the articles was also selected and utilized based on its relevance to the research question and aims.

Results

Aim 1 (OCD Subtypes and Symptoms): *Describe the symptoms and general subtypes of OCD.*

OCD affects 1-3% of the population and presents with both obsessions (anxiety-inducing intrusive thoughts) and compulsions (anxiety-relieving repetitive actions) (Brock, 2024). The main subtypes are contamination, harmful thoughts, symmetry, and hoarding, with hoarding sometimes being considered a separate diagnosis in adults. There may be a subtype involving only obsessions (e.g., religious or violent thoughts), but research is mixed on whether this is a distinct category (Jalal et al., 2023).

Aim 2 (Environmental and Genetic Contributions): *Investigate how environmental triggers can lead to the development of OCD, and how genetic contributions may be associated with a higher risk.*

The environmental and genetic etiologies of OCD are not well understood. The SLC1A1 gene may serve as a genetic marker (Brock, 2024), as there are links between OCD and 9p24 (the chromosome region containing SLC1A1), as well as links between OCD and the 3’ region of SLC1A1 (Zike et al., 2017). In rare pediatric cases, OCD symptoms may be triggered by autoimmune responses to infections, inflammatory reactions, or toxins, with PANDAS and PANS (Brock, 2024). Other environmental triggers, such as trauma and stress, may cause maladaptive beliefs that fuel OCD.

Aim 3 (Behavioral Therapy Effectiveness): *Describe the effects of behavioral therapy on OCD.*

ERP is a highly effective behavioral treatment for OCD. Through direct exposure to triggering content, ERP breaks the OCD cycle and encourages tolerance (Hezel & Simpson, 2019). Therapist mistakes (e.g., unintentionally providing reassurance and failing to create

exposures relevant to patients' lives) and patient mistakes (low adherence) can hinder the treatment process (Hezel & Simpson, 2019; Spencer et al., 2023). An important consideration with ERP is the presence of comorbid conditions. This may serve as a limitation, but it can be easily resolved with a personalized ERP treatment plan that can address comorbid conditions and OCD simultaneously. However, ERP may not be as effective in the presence of other complicating factors, like substance abuse and comorbid conditions of disorganized or tangential thinking, that may warrant higher levels of care (Spencer et al., 2023).

Aim 4 (Pharmacotherapy and Alternative Treatments): *Describe the effects of prescribed medications, including less orthodox treatments (e.g., medical cannabis), on OCD.*

SSRIs are an effective pharmacological treatment option, and this effectiveness increases with a higher dosage. SSRIs take effect within 8-12 weeks, but sometimes quicker, providing small, meaningful improvements (Pittenger & Bloch, 2014). Clomipramine is potent and effective, but its problematic safety profile and dangerous side effects (e.g., anticholinergic side effects, arrhythmia, and seizures) make SSRIs the preferred treatment option (Pittenger & Bloch, 2014). The combination treatment of SSRI pharmacotherapy with CBT, shown in studies to be less effective than either treatment alone, is still likely to be more effective; in these studies, the CBT had a higher level of potency, while the inflexible administration of SSRIs reduced their potency (Pittenger & Bloch, 2014). One particular study on the effectiveness of medical cannabis in treating OCD was poor because of a small sample size and low-quality evidence (Khan et al., 2023). Therefore, future research is needed to demonstrate the effectiveness and limitations of medical cannabis.

Aim 5 (Treatment Comparison Summary Graphic): *Create a graphic that details and summarizes the effectiveness and limitations of OCD treatments as a clear guide for people looking to treat their OCD, and also to educate people on OCD and its treatment.*

Treatment	Effectiveness	Side Effects	Best Used For	Limitations
ERP	High	• Initial increased anxiety	• General OCD	• Improper delivery from the therapist • Low adherence from the patient • Comorbid

				conditions • Low insight • Substance abuse • Very high severity
SSRIs	High	• Somnolence • Sexual dysfunction • Hyponatremia • Initial weight loss • Suicidal behavior	• General OCD	• Hoarding • Low insight • Severe depression • Very high severity • Side effects
Clomipramine	High	• Anticholinergic side effects (e.g., dry mouth and constipation) • Anti-histaminergic side effects (e.g., weight gain and drowsiness) • Alpha-adrenergic blocking side effects (e.g., low	• OCD that is not treatable by SSRIs	• Poor safety profile as a result of side effects that are more common and dangerous

		blood pressure) ● Cardiotoxicity ● Increased aminotransferase enzyme levels in the blood ● Seizures		
ERP* + *SSRIs* *(Combo)	High	● A combination of side effects from ERP and SSRIs	● General OCD ● OCD of higher severity	● A combination of limitations of ERP and SSRIs
Medical Cannabis	Limited information	● Limited information	● Treatment-resistant individuals (limited information)	● Possible worsened symptoms (limited information)

Discussion

Current research on the etiology of OCD highlights both genetic and environmental influences, but the mechanisms behind these contributions remain poorly understood. Studies suggest that increased expression of the SLC1A1 gene may partially account for OCD's 48% heritability in twin studies. Environmental stress and maladaptive beliefs may interact to increase the risk of OCD. In contrast, autoimmune triggers like PANDAS or PANS are rare and often present with broader neurological symptoms beyond OCD. Improving understanding of the mechanisms behind the various genetic and environmental influences is crucial to furthering the understanding of OCD as a disease and its treatments.

Among the main treatment options, ERP, SSRIs, clomipramine, and combination treatments, ERP and SSRIs consistently emerge as the most effective first-line interventions. Clomipramine, with its side effects, cardiovascular risks, and other dangers, poses a high risk

and is therefore generally considered a second-line treatment. On the other hand, SSRIs are safer, even at higher doses, where their effectiveness even increases, and the different SSRIs are equally effective. SSRIs are therefore the gold standard for pharmacotherapy. ERP, if administered and practiced properly, is also a gold standard treatment; it is the most direct way to rewire and retrain the OCD brain, and can even treat OCD and comorbid conditions simultaneously. The best way to enhance ERP when treating OCD of higher severities is through SSRI combination treatment. Although studies have shown that ERP alone is more effective than combination treatment, the ERP in these studies was highly potent, more so than the SSRIs in the way they were administered. Intuitively, SSRI pharmacotherapy in conjunction with ERP is more effective. With this knowledge, healthcare providers can better understand how to personalize treatment and maximize symptom reduction. However, there are still gaps, specifically in the understanding of alternative treatments. Although the current mainstream treatments are effective options, the number of safe and effective treatments, especially pharmacotherapies, remains limited. For example, medical cannabis cannot be used as a treatment by healthcare providers because few studies demonstrate its effectiveness, and these studies use weak evidence. Because of the limited amount of safe and effective treatments for OCD, further research on alternative treatments is necessary. This way, alternative treatments can be incorporated into mainstream medical practice, providing patients with more options for treatment plans that work most effectively for themselves, thus improving quality of life.

Conclusion

The research indicates the high degree of effectiveness of SSRIs, ERP, and combination treatment in treating OCD. This is significant for healthcare providers and those suffering from OCD, as understanding the mechanisms behind the safest and most effective treatments is key to effective symptom reduction. The research also indicates the lack of information on the development of OCD. Specifically, more studies are needed on the role of genetic and environmental influences in OCD development. Knowledge gaps in alternative treatments must also be addressed with further research. In doing so, patients will eventually have more options for more personalized and effective treatment plans. Overall, future research should place a stronger emphasis on the etiology of and alternative treatments for OCD. This will result in the improvement of existing treatment plans and the development of new treatments.

References

Brock, H. (2024, February 24). Obsessive-compulsive disorder. StatPearls [Internet]. https://www.ncbi.nlm.nih.gov/books/NBK553162/

Chu, A. (2023, May 1). Selective serotonin reuptake inhibitors. StatPearls [Internet]. https://www.ncbi.nlm.nih.gov/books/NBK554406/

Cocuzza, S., Maniaci, A., La Mantia, I., Nocera, F., Caruso, D., Caruso, S., Iannella, G., Vicini, C., Privitera, E., Lechien, J. R., & Pavone, P. (2022, January 26). Obsessive-compulsive disorder in pans/pandas in children: In search of a qualified treatment-A systematic review and metanalysis. Children (Basel, Switzerland). https://pmc.ncbi.nlm.nih.gov/articles/PMC8869780/

Del Casale, A., Sorice, S., Padovano, A., Simmaco, M., Ferracuti, S., Lamis, D. A., Rapinesi, C., Sani, G., Girardi, P., Kotzalidis, G. D., & Pompili, M. (2019). Psychopharmacological treatment of obsessive-compulsive disorder (OCD). Current neuropharmacology. https://pmc.ncbi.nlm.nih.gov/articles/PMC7059159/

Hezel, D. M., & Simpson, H. B. (2019, January). Exposure and response prevention for obsessive-compulsive disorder: A review and New Directions. Indian journal of psychiatry. https://pmc.ncbi.nlm.nih.gov/articles/PMC6343408/

Jalal, B., Chamberlain, S. R., & Sahakian, B. J. (2023, June). Obsessive-compulsive disorder: Etiology, neuropathology, and cognitive dysfunction. Brain and behavior. https://pmc.ncbi.nlm.nih.gov/articles/PMC10275553/

Janardhan Reddy, Y. C., Sundar, A. S., Narayanaswamy, J. C., & Math, S. B. (2017, January). Clinical practice guidelines for obsessive-compulsive disorder. Indian journal of psychiatry. https://pmc.ncbi.nlm.nih.gov/articles/PMC5310107/

Khan, I., Jaura, T. A., Tukruna, A., Arif, A., Tebha, S. S., Nasir, S., Mukherjee, D., Masroor, N., & Yosufi, A. (2023, April 5). Management of obsessive-compulsive disorder: NDT. Neuropsychiatric Disease and Treatment. https://www.dovepress.com/use-of-selective-alternative-therapies-for-treatment-of-ocd-peer-reviewed-fulltext-article-NDT

Pittenger, C., & Bloch, M. H. (2014, September). Pharmacological treatment of obsessive-compulsive disorder. The Psychiatric clinics of North America. https://pmc.ncbi.nlm.nih.gov/articles/PMC4143776/

Spencer, S. D., Stiede, J. T., Wiese, A. D., Goodman, W. K., Guzick, A. G., & Storch, E. A. (2023, March). Cognitive-behavioral therapy for obsessive-compulsive disorder. The Psychiatric clinics of North America. https://pmc.ncbi.nlm.nih.gov/articles/PMC11170287/

Wilson, M. (2024, August 16). Clomipramine. StatPearls [Internet]. https://www.ncbi.nlm.nih.gov/books/NBK541006/

Zike, I. D., Chohan, M. O., Kopelman, J. M., Krasnow, E. N., Flicker, D., Nautiyal, K. M., Bubser, M., Kellendonk, C., Jones, C. K., Stanwood, G., Tanaka, K. F., Moore, H., Ahmari, S. E., & Veenstra-VanderWeele, J. (2017, May 30). OCD candidate gene slc1a1/eaat3 impacts basal ganglia-mediated activity and stereotypic behavior. Proceedings of the National Academy of Sciences of the United States of America. https://pmc.ncbi.nlm.nih.gov/articles/PMC5465902/