Genetic Counseling: Changing the Landscape of Mental Illness

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Abstract

When most people think of genes and the way DNA impacts their bodies, they think of physical characteristics such as appearance, body type, diseases and overall physical health. Individuals usually put the mind, what is thought to be a more metaphysical aspect of our beings, in a different category. This distinction has kept mental health and psychological treatment in a separate category from health and the hard sciences. However, in the last century, breakthrough discoveries have proved the link between the mind and biology to be stronger than had been anticipated. The biological underpinnings of many mental illnesses have directed scientists towards research that strengthens the ever-growing correlation between genes and mental health. Based on biological differences between individuals with mental illness and those without, scientists have been able to identify candidate genes linked to these illnesses and use twin and adoptee studies to distinguish between genetic and environmental factors. Mental illnesses with strong correlations to genes include obsessive compulsive disorder (OCD), schizophrenia, attention deficit hyperactivity disorder (ADHD), bipolar disorder, alcohol use disorder and eating disorders. While the field of genetic counseling has traditionally been used to identify, educate, and manage individuals at increased risk or affected with certain physical diseases, as science progresses, genetic counseling can play a key role in treating and preventing mental illness as well. Genetic counselors can use family history, send for genetic tests that determine susceptibility to mental illness and work with patients and their families on ways to prevent onset of disease or mitigate symptoms. Ultimately, this can change the lives of so many who suffer with mental illness in their families as well.

Mental health describes the mind's condition in terms of psychological and emotional well-being, and serves as a huge contributing factor to the way a person sees, understands and interacts with the world. When most people think of genes and the way DNA impacts our bodies, they think of physical characteristics such as appearance, body type, hereditary diseases and overall physical health. Individuals usually put the mind, what is thought to be more of a metaphysical aspect of our beings, in a different category. In fact, psychology is often referred to as a 'soft science' because of its abstract, less concrete nature in comparison to hard sciences such as chemistry and physics (Howard, 1993).

Mental illness occurs when there is a change in a person's thinking and behavior that impacts their ability to function properly on a daily basis (Sandhya, 2019). Approximately fifty percent of people are affected by mental illness in some capacity throughout their lifetimes, and one in five Americans experience mental illness annually (Kessler, 2007). Mental illness can impact a person at any age and stage of life with approximately twelve million children under 18 suffering from mental illness. Warning signs of mental illness include personality changes, extreme mood swings, excessive anger, hostility and the inability to function in daily life and activities (National Institute of Health, 2007). Throughout history, when people have exhibited these types of behaviors, theories were developed in order for society to make sense of what they were witnessing. Mental health as a whole has therefore transitioned in the way that it has been perceived, and any behavior that was deemed abnormal in the broader context of societal norms was labeled with some sort of explanation that was relevant at the time.

Some of the earliest theories of mental health were attributed to supernatural causes. Before the mind was scientifically studied, and the fields of psychology and neuropsychology became a respected and reliable explanation for mental illness, society would turn towards

supernatural forces when they experienced something that was considered out of the norm. This is exemplified on a physical level during the Middle Ages when the black plague wiped out fifty five million people across Europe. At the time, people blamed the disease on demons and supernatural forces punishing humanity for their sins (Getz, 1991). Later, microbes were discovered and bacterial infection was identified as the cause of the illness. Similarly, whenever a person exhibited abnormal behaviors, society claimed the person was possessed by, "evil or demonic spirits, displeasure of gods, eclipses, planetary gravitation, curses, and sin" (Restak, 2000). This explanation dates as early as 6500 BCE. Supporting evidence of this theory includes signs of trephination, which is the drilling of holes in skulls in order to treat mental health conditions and release the demons from possessing the mind, as found in ancient cave paintings (Restak, 2000). The supernatural explanation for mental health was widespread regardless of society and culture. Early Egyptian, Hebrew and Greek writing attributes madness to possession by demons or gods. Furthermore, for centuries, the Chinese believed poor mental health was the result of an imbalance between yin and yang, positive and negative bodily forces (Kchessler, 2000).

This supernatural explanation for poor mental health continued throughout antiquity all the way through the Middle Ages. During the Middle Ages, women in Europe and the Americas who exhibited abnormal behavior were accused of being witches; hysteria was confused for sorcery, and abnormal noises and behaviors deemed to be possession by demons. Until the 1700s, thousands of innocent women were locked up and put to death based on fake evidence and false confessions by people claiming they were guilty of working with Satan (Tasca, 2012).

Despite these long lasting beliefs, at around 400 BCE, the Greek physician Hippocrates was the first person to suggest a linkage between mental health and biology. He studied physical

symptoms of the body such as excess phlegm or bile that accompanied some mental disorders (Kchessler, 2000). Though his theories were largely rejected at the time, some later Greek physicians such as Galen took a scientific approach to mental health as well. Though these scientific theories were ignored for centuries, they did set the stage when the resurgence of scientific questioning and humanism in Europe took place in the 1500s and brought these long buried theories to the forefront. Slowly, over the course of the century, the understanding of the cause of mental health shifted from a supernatural approach to more scientific reasoning. Psychological asylums were created in order to medically treat those that were mentally ill. Though these institutions were known to be brutal and inhumane, over time changes were made to have more humane conditions (Farreras, 2022).

The scientific approach to mental health has deepened and expanded as humanity's understanding of biology has continued to progress. While the mind itself is an abstract concept, more and more research points to changes in brain structures and processes that accompany mental illness. Mental health disorders such as schizophrenia, OCD and bipolar disorder are associated specifically with imbalances in brain chemistry and abnormal brain structures (National Institute of Health, 2007). Dr. Richard McNally, a physician and hematology specialist in Kingston, NY, said that mental disorders such as these fit a biological model just as physical diseases do due to their biological underpinnings (Weir, 2012). It is therefore no wonder that the field of psychiatry has been so successful in treating mental illness with medications that alter the brain chemistry of affected individuals, and have been proven to successfully improve mental symptoms. In some cases, surgery on certain brain structures can help relieve mental illness as well (De Jesus, 2022). Dr. Thomas R. Insel, the director of the National Institute of Mental Health, goes as far as to say that while medicine once thought otherwise, the biological

discoveries of mental health make it strikingly similar to physical diseases such as heart disease. He claims, "The only difference here is that the organ of interest is the brain instead of the heart or pancreas. But the same basic principles apply" (Weir, 2012). Furthermore, he feels that just as a century ago knowledge about the cause of heart disease was still developing, and today science knows so much more about heart disease on a physical level, so too, with enough continued research on the connection between mental health and biology, significant progress can be made with treating mental health disorders on the biological level (Weir, 2012).

From a physical, biological standpoint, genes are the foundation that determine everything from skin color, height, development of disease and so forth. While some genes are expressed regardless of environmental factors, epigenetics explains why some genes are impacted in how or if they are expressed based on behavioral and environmental influences. Diseases such as cancer, diabetes, heart disease and cholesterol have strong hereditary links but are considered multifactorial, and therefore their expression is influenced by a person's genetic makeup along with many other influences in their environment. The genetic susceptibility of the individual reflects the likelihood of that person to develop a particular disease, and how that person lives their life and interacts with their environment can help determine whether they develop that disease or not. Therefore, if a particular physical ailment runs in the genes of a family, that person may have genetic variations that increase their likelihood to develop that disease. Examples of these diseases include breast and ovarian cancer, which can be caused by mutations in the BRCA1 and BRCA2 genes. Mutations within these genes can increase a person's susceptibility to develop breast cancer and ovarian cancer, however epigenetics may play a role in determining who develops cancer, and what type of cancer they develop (Blazer &

Hernandez, 2006). Proper knowledge on how to care for themselves and their environment can dramatically affect people who have genetic susceptibility for these diseases for the better.

Armed with this knowledge of the interplay between genes and the environment, genetic counseling has come to the forefront in terms of ensuring that people lead healthy lives in relation to what their genes and family history dictate for them. Genetic counseling is defined by the National Society of Genetic Counselors as, “the process of helping people understand and adapt to the medical, psychological and familial contributions to disease” (Macleod, 2019). A genetic counselor is the person who meets with patients and educates them on their particular situation, stays attune to psychological needs and wellbeing of the patients and their families, while working with the patient to create a care plan moving forward. In order to do this, a genetic counselor usually reviews a patient's family history for features suggestive of a hereditary cause for a particular medical condition, and then sends for genetic testing to help inform a person’s level of risk for that disease. Based on this information, genetic counselors and other medical professionals can provide recommendations for the patient so that they can minimize their risk of disease, or mitigate symptoms of a disease that is already expressed. Genetic counseling is also used for reproductive purposes, such as carrier screening and screening for aneuploidy, and also to help manage the health of patients affected with genetic conditions. As a result, particular behavior changes may be made and encouraged, such as engaging in more exercise, implementing diet changes and engaging in particular therapies (Biesecker, 2001). In this way, genetic counseling combines a person’s predisposition and susceptibility to disease, and combines it with the opportunity to use this information proactively for screening and early detection, or prevention. Ultimately this knowledge can protect a person from harm to the extent that it is in their control.

If this model has proven so successful for dealing with physical diseases, then as our understanding of genes and its connection to mental health grows, this model can be used to help people with mental illnesses as well in order to best serve themselves and their families by lowering risks and taking control over their circumstances. Genetic counseling on a physical level has led to, "increased knowledge, perceived personal control, positive health behaviors, and improved risk perception accuracy as well as decreases in anxiety, cancer-related worry, and decisional conflict" (Madlensky et al., 2017). These results are helping society in such a groundbreaking way, so as the ever growing connection between mental health and genes unfolds, this form of counseling can be applied to mental disorders as well. It can help to put preventative measures in place, raise awareness and help guide people to be more in control of their genetic ties with mental illness. As research continues to grow and progress, this genetic counseling model can be applied to the mind that has for so long been thought of to be in a different category, and therefore less treatable. Humans can bring a concept, which for so long was thought to be an abstract, esoteric, possessed by demons, out of human understanding and control to a place where people are empowered to make changes so that they can control their mind instead of allowing their mind to control them. It will no longer be on the shoulders of psychologists and psychiatrists alone to care for patients with mental illness's well being by providing numerous therapies and prescribing medicines for people who are already suffering. Instead, knowledge about genes can enable genetic counselors to work with susceptible individuals in order to face issues head on prior and help people prior to reaching that breaking point.

It's important, therefore, to explore the basis of this ever growing mental health and biology theory, and what research has been done thus far to prove the link between genes and

mental health. A deeper understanding of this can help set the stage for future research, ultimately paving the path for a way to utilize genetic counseling in the favor of those whose genes serve as risk factors with mental health. Many mental illnesses such as OCD, schizophrenia, ADHD, eating disorders, bipolar disorder and alcohol use disorder have strong genetic ties. This paper reviews the prevalence, heritability, and biological underpinnings of some of these psychiatric conditions, and discusses breakthroughs in genetic link analysis as well as studies on how the environment can affect disease development in susceptible individuals. With these newer explanations and understandings of how mental illnesses develop, genetic counseling can be used to improve the mental health of patients and their families.

Obsessive compulsive disorder (OCD) is a mental illness that is characterized by intrusive, unwanted thoughts, images and urges that cause immense anxiety and distress. In order to mitigate those feelings, people will usually engage in actions to try and decrease the anxiety they experience, however, the relief they experience is usually fleeting and reinforces this cycle of obsessions and compulsions that ultimately increase its severity. There are many subgroups of this disorder. For some individuals, OCD expresses itself around fears of contamination, and for others it drives them to harm to one's self or others. OCD can also be observed with regards to religious and sexual practices and the need for precision and symmetry (Stein, 2002). This debilitating mental disorder is the fourth most prevalent mental illness and studies show that 2-3% of the population experience this mental illness during their lifetime (Gava et al., 2007).

This disease of the mind has been brought to a physical realm with its strong ties to biological deficiencies. The biological factors that correlate with OCD include lower levels of serotonin, defects in serotonin reuptake inhibitors, and brain scans show increased activity in certain levels of the brain when an individual engages in obsessive compulsive behavior.

(Nestadt et al., 2010). Brain structures in the brain of patients with OCD differ from those of individuals without OCD in that the brain has reduced brain matter volume in the medial frontal gyrus, the medial orbitofrontal cortex, and the left insulo-opercular region, as well as reduced amygdala volume in the right hemisphere (Pujol et al., 2004). A lot of these brain structures that display abnormalities are associated with symptoms of OCD. For example, the orbitofrontal cortex is a region in the frontal lobe that is associated with the cognitive process of decision making. People who suffer from OCD usually experience difficulties in decision making, stemming from obsessing over outcomes, seeking reassurance and fearing uncertainty (Nielen et al., 2002). It is these biological underpinnings of OCD that point scientists to look at the genes that code for proteins that impact these neural processes and structural brain differences in order to see how these gene alterations correlate with OCD patients.

One of the earliest studies that showed a strong link between heredity and OCD was in 1936 when fifty patients were admitted to a hospital with obsessions. Later on, 37% percent of these patients' parents and 21% of their siblings were diagnosed with the same disorder (Lewis, 1936). Since then, the interest in studying the genetic basis of OCD has skyrocketed and research has evolved, now typically done using family studies and monozygotic twins. One of these studies showed that identical twins have a concordance rate of developing OCD of 80%, whereas dizygotic twins have 50% concordance (Hudziak et al., 2004). These percentages show a high rate of heritability, however, since the concordance rates are not 100% for monozygotic twins, there must be other factors, such as exposures and environment, that can determine how those genes are expressed. Based on the strong evidence for underlying hereditary risks, in addition to the known biological underpinnings of the disease, several candidate genes for OCD risk have been identified.

Genome-wide association studies through 2010 have identified more than eighty genes related to OCD (Pauls, 2022). Most genes that have been linked to OCD include genes related to serotonin, neurotransmission, the glutamatergic system, and the dopaminergic system (Purty et al., 2019). The gene that has been focused on the most is the SLC6A4 gene that codes for the serotonin transporter protein. In people with OCD, there is a variation in the promoter region of the gene that is known as 5-HTTLPR. When the region exists as the L_A allele, the long allele of the serotonin transporter gene, most people exhibit OCD. (Walitza, 2014). Further studies also looked at particular chromosomal regions that generally contain mutations for this disorder. For example, many studies have identified a linkage peak in the 9p24 region of chromosome 9, a region which holds genes involved with neurotransmision (Hanna et al., 2002). This is one of many mental illnesses where studies on heritability have shown strong genetic connection, and serves as a foundation for future research to strengthen and further define those ties. Environmental conditions that influence the expression of OCD genes in high risk individuals include particularly high emotional expression in parental figures as well as family engagement in ritualistic behaviors (Bressi & Guggeri, 1996). These environmental factors are noteworthy for genetic counselors who work with patients who show susceptibility to obsessive compulsive disorder. Perhaps changes can be made in rituals that families engage in, including the religious realm.

Another mental illness with similar promising research in the realm of genetics is schizophrenia. Schizophrenia is a mental disorder in which an individual loses touch with reality in a way that affects how he or she thinks, feels and behaves. Symptoms can range from difficulty showing emotions and trouble concentrating on and processing information all the way to psychotic episodes including hallucinations, delusions, mood changes and movement

abnormalities (McGrath et al., 2008). Schizophrenia has a prevalence of 1% in the population (Saha et al., 2005).

On a biological level, schizophrenia has been found to be connected to disturbances in the prefrontal cortex and the mesocortical dopamine system (Cohen & Servan-Schreiber, 1992). Similar to OCD, the abnormalities in these brain structures relate to symptoms that people with schizophrenia experience. For example, the mesocortical dopamine system is one of the four major dopamine pathways in the brain that connects the ventral tegmentum to the prefrontal cortex, and excess dopamine is what is associated with delusions and hallucinations. Twin studies show that there is strong heritability in schizophrenia with identical twins having 80% concordance (Sullivan et al., 2003). Based on this, genomic studies have looked at genes that pertain to these regions of the brain and results show that more than 100 loci are associated with schizophrenia in a statistically significant way. Some genetic syndromes are associated with increased risk of schizophrenia. For example, the microdeletion syndrome 22q11 is associated with a 30% chance of developing schizophrenia (Basset & Chow, 2008). All of these genetic links combined show how interconnected schizophrenia is with genes. It is particularly noteworthy that genetic mutations for schizophrenia have already been identified in individuals with greater susceptibility, not just in individuals who already carry a diagnosis of schizophrenia. This knowledge, which as time goes on can be sharpened and developed with greater accuracy, can be helpful for genetic counselors in guiding patients on how to prevent disease in people who test positive for pathogenic variants and therefore have an increased susceptibility. For example, the probability for the onset of schizophrenia increases when environmental conditions include living in urban environments, cannabis use, as well as exposure to maternal stress or nutritional deficiency in utero. All of these conditions increase the prevalence of schizophrenia in

susceptible individuals (Morgan, 2007). In the future, as the genetic research and information on the biological processes contributing to schizophrenia continue to develop, genetic counseling can be instrumental in identifying higher risk individuals, and working with them to prevent the onset of this mental illness by controlling life choices in their surrounding environment.

Attention deficit hyperactivity disorder (ADHD) is another mental illness, and it is characterized by extreme levels of overactivity, impulsivity, and inattention which are inappropriate to the context and environment (Tripp & Wickens, 2009). These characteristics can cause tremendous impairment in adults and in children. Furthermore, prevalence in children is around 5% and 65% of those individuals continuing to exhibit symptoms throughout their lives (Faraone et al., 2006). On a biological level, ADHD is associated with differences in the frontal lobe of the brain, caudate nucleus, cerebellar vermis and fluctuating dopamine levels when it comes to reinforcing activities and choices. Studies show that people with ADHD have overall smaller brain volume and a decrease in white matter compared to people without ADHD (Greven et al., 2015). Additionally, the cerebellum, which is crucial for sustained attention in adults, shows reduced volume and connectivity in people with ADHD (Valera et al., 2007).

Taking all of these biological factors into account, heritability for ADHD seems to be a key factor in its development. Familial studies show that the risk of first degree relatives developing ADHD is between 4.0 and 9.0, and twin and adoptee studies, used to separate environmental from genetic influences, shows that people are more similar to biological relatives than adoptive relatives when it comes to ADHD (Chen at el., 2008). These studies show that there is a strong connection between ADHD and genes, and the biological knowledge about the disease in terms of brain structure and neurotransmitters can point to particular genes that influence the onset of disease. For ADHD, chromosomal regions 5p13, 16p13 and 17p11 have

shown significant linkage amongst people with the disorder (Thapar & Steriakouli, 2008). When it comes to the analysis of ADHD development based on genes that reflect susceptibility, environmental factors that influence how those genes are expressed include low birth weight along with exposure to contaminants such as lead and polychlorinated biphenyl (Hack et al., 2009). This is important information for genetic counselors to know when dealing with patients in the realm of ADHD. Therefore, as the understanding of genes and mental health continues to sharpen, deepen and expand, parents who are expecting children, as well as individuals who have known susceptibility to ADHD due to genetic testing that may be available in the future, can consult with genetics professionals to discuss lifestyle changes that can prevent the disease or lessen the symptoms in themselves and their children.

Another mental illness with strong genetic links is bipolar disorder, which is a chronic mood disorder where people experience intense changes in their energy levels and mood. While individuals with unipolar depressive disorder present symptoms of episodes of only depression, people with bipolar disorder present symptoms where their mood fluctuates between similar depressive episodes, but also moments of increased elation (Grande et al., 2016). This mental illness affects around 1% of the world's populations and can be divided into two categories of bipolar I and bipolar II (Alonso et al., 2011). The difference between the two bipolar disorders lies in how severe the manic episodes become. Bipolar I disorder is when a person experiences full, severe manic episodes, whereas a person with bipolar II disorder will have a much lower energy, less exhaustive episode. Bipolar I disorder affects both men and women equally, where bipolar II disorder affects women more than men. Both disorders, however, have the same characteristics of fluctuations between the manic state and the depressive state (Nivoli et al., 2011).

Bipolar disorder is one of the mental health disorders that is known to have the strongest biological underpinnings. In a study done, twenty four patients with bipolar disorder were subject to neuroimaging so that their brain structure could be compared to people without bipolar disorder. The subjects were scanned with a three dimensional radio-frequency spoiled Fourier acquired steady state acquisition sequence on a 1.5 magnetic resonance imaging scanner. The scanner imaged the prefrontal, thalamic, hippocampal, amygdala, pallidal, and striatal structures. Results from this study showed that patients with bipolar disorder, compared to people without bipolar disorder, showed significant differences in all of the brain structures that were imaged in this test. What stood out the most was how enlarged the amygdala was in bipolar patients (Strakowski et al., 2019). One of the functions of the amygdala is emotion perception to stimuli, which directly connects to the symptoms of bipolar disorder where emotions are extreme and fluctuating. Additionally, many neural pathways that help regulate emotional functioning are found to be abnormal in bipolar patients (Cummings, 1986). Finally, many cases of bipolar disorder have been found in people who experienced brain injuries in the left prefrontal cortical and basal ganglia regions, as well as lesions of the orbitofrontal and basal temporal cortices, the head of the caudate and the thalamus (Robinson & Starkstein, 1990).

Based on numerous findings of the strong biological underpinning of bipolar disorder, it is only fitting that a tremendous amount of research has been done on its connection to genes. While findings are certainly complex, research has been expansive and also replicable. Bipolar disorder has been found to be connected to variants in genes such as CACNA1C, ODZ4 and NCAN; this mental illness seems to stem from many risk alleles that by themselves are small in effect. Interestingly enough, there seems to be an overlap between susceptibility for the development of bipolar disorder as well as schizophrenia. This in itself is valuable for genetic

counselors working with patients who have family histories and genetic markers linked to both mental illnesses, and can ultimately help with clinical treatment and possible prevention (Kujawa & Nemeroff, 2000). The link between bipolar disorder and genes has been strengthened through studies that show that as genetic relatedness decreases, the risk to the mood disorder decreases as well. Also, family, twin and adoption studies all overwhelmingly point to the fact that genes are at the forefront when it comes to bipolar disorder (Craddock & Jones, 1999). While the rates are strong, monozygotic concordance is still between 40-70% which shows that genetic factors are not the only factors at play.

Another mental health disorder that has links to genes is alcohol use disorder. Alcohol use disorder is an illness where people undergo harmful drinking patterns that interfere with their life and wellbeing. These drinking habits often lead to poor emotional, physical and mental health, as it has the power to destroy relationships, careers and more. According to the Centers for Disease Control and Prevention, alcohol use contributes to 88,000 deaths annually in the United States of America (Stahre et al., 2014). Furthermore, alcohol use disorder often correlates with other mental illnesses such as anxiety, depression and post traumatic stress disorder (Regier et al., 1990). People who suffer from alcohol use disorder have often been viewed as at fault for their poor choices, but more and more research points to biological underpinnings that point to the way that people consume alcohol regularly versus people who suffer from alcohol use disorder. However, twin studies point to the strong heritability that accompanies alcohol use disorder. In fact, recent studies point to the fact that for monozygotic twins heritability ranges between 40% and 70% (Enoch & Goldman, 2001).

When alcohol enters the body, ethanol is converted to acetaldehyde and catalyzed by alcohol dehydrogenase (ALDH) in the mitochondria. Alcohol dehydrogenase therefore serves as

the primary enzyme for the conversion of ethanol to acetaldehyde. Acetate is then broken down into carbon dioxide and water for elimination from the body (Zakhari, 2006). On a biological level, chemicals that are involved with the body's processing of alcohol differ between individuals without alcohol use disorder and individuals with alcohol use disorder. Studies show that certain genes that code for the enzyme alcohol dehydrogenase protect a person from developing alcohol use disorder (Elisabeth, 2016).

Bearing this in mind, linkage genes have been sought after as underpinnings for this mental illness. One particular study pointed to chromosome 4q as a location for risk; the locus in particular that was identified is related to the formation of alcohol dehydrogenase. When there are problems with alcohol dehydrogenase, there can be an accumulation of acetaldehyde which causes physiological symptoms such as flushing and nausea. It is the genes that control for alcohol dehydrogenase that determine how and when acetaldehyde is produced. Individuals with genes that oxidize ethanol faster and acetaldehyde builds up and is broken down at a slower rate are usually less likely to develop alcohol use disorder due to the adverse effects they experience due to accumulation of acetaldehyde; it's these adverse effects that make people with these genes avoid consuming so much alcohol (Elisabeth, 2016).

Although the genetic links are strong, like most genes and especially genes that code for mental health disorders, the environment is at play too. This is all extremely important information for genetic counselors to share with patients who are suffering or who have family histories of people suffering from alcohol use disorder to help people make better choices. When individuals have lifetime histories of drinking, they are at risk for developing alcohol use disorder, and particular factors that come into play include the number of drinks they consume in a day and how many years they have spent drinking heavily (Grant, 1998). Furthermore, early

life stressors such as trauma or abuse increase risk later on in life for the development of alcohol use disorder (Enoch & Goldman, 2001). And finally, people who display high levels of anxiety and other mental illnesses are at risk for the development of this disease. Taking all of this into account, people with family histories of alcohol use work with genetic counselors on alcohol consumption choices and dealing with anxiety traits and habits.

Finally, eating disorders are another group of mental illnesses with a hereditary component. Eating disorders (ED) disrupt a person's physical health and emotional well being. A person with an ED usually shifts their eating habits and restricts themselves from certain foods. An individual's view on weight, body type and eating habits can contribute to exacerbating the effects of this mental health challenge, views that are easily influenced by sociocultural norms. There are six main categories of eating disorders, each with a distinct approach towards eating, body image and more. They include anorexia nervosa, bulimia, binge eating disorder, avoidant-restrictive food intake disorder, pica and rumination disorder (Treasure et al., 2020).

For a long time eating disorders had been viewed as stemming from one's own will or desire to eat in a particular fashion or look a certain way, but recent findings in the realm of genetics and heredity indicate otherwise. In terms of heredity, the risk for anorexia susceptibility is 4 times greater in family members of those with the illness, and females related to someone with anorexia are 11 times more likely to develop it as well (Strober et al., 2000). In twin studies, the heritability is high for twins and siblings that are raised apart from one another thereby showing the strength of genes in impacting this mental illness (Klump et al., 2009). This shows that it isn't always necessarily a choice for individuals who suffer, and a component of onset is sometimes out of people's control.

With all of these heritability factors showing there is no separating eating disorders and genetics, linkage studies point to particular genes associated with eating disorders. One example found from the first linkage analysis for eating disorders is that chromosome 1-34.2 with D1S3712 is a possible locus that correlates with anorexia (Grice et al., 2002). The genes that are studied in these analyses stem from eating disorders on a biological level. Serotonin, for example, plays a big role in eating behavior and genes related to this have been studied tremendously. Furthermore, dopamine is involved with many brain functions such as eating behaviors and genes related to dopamine and its receptors have been studied as well (Yilmaz et al., 2015).

Just like OCD, schizophrenia, ADHD, bipolar disorder and any mental illness for that matter, eating disorders are also known to be a product of genes combined with the environment. It has been found that societies that promote thinness as an ideal can lead to overexpression of genes that suppress weight and appetite in individuals who are thereby susceptible to eating disorders. Furthermore, diets that include high rates of fats and carbohydrates increase the expression of adiposity related genes in people who are susceptible to eating disorders, thereby increasing the likelihood of their development (Rokholm et al., 2011). Bearing in mind these environmental factors, when the understanding of genetic risk eating disorders is more clear, changes to societal and environmental conditions can help prevent onset of disease, thereby saving the lives of many.

While it is much easier to identify causative genes for Mendelian traits, complex diseases such as the mental illnesses discussed, generally have not been linked to particular genes just yet. Due to the complexity of these mental illnesses, a lot of these linkage genes are called “candidate genes' ' and serve as educated suggestions as to what areas of the genome may be contributing to

risk (Purty et al., 2019). Scientists often use what we know about the biological bases of these diseases and find which genes can be linked to the biological differences in people with the mental illnesses. While this is, of course, light years away from the validity and certainty we have about physical ailments and diseases today, in addition to the fact that the 'links' and 'candidate'' factors connecting mental health to genetics can seem ambiguous, this whole field can seem limiting to some who see the long road ahead of us in the mental illness field as daunting. However, these candidate genes and links are also promising, and serve as the beginning seeds that are planted for a future world where more precise understandings of genes and mental health will exist; the 'links' and 'candidate' genes just point to the fact that this future is a possibility. When that possibility becomes a reality, as science progresses and becomes more concrete, genetic counseling will take the forefront for these disorders in a very real way.

For all of the mental illnesses discussed, as well as the thousands not discussed, genes and heritability are very telling as to whether a person is susceptible or not, and if they are susceptible what that level of susceptibility could be. As stated, in the future, when genetic knowledge and its connection to mental health is a lot more fine tuned and advanced, people who have family histories for particular mental disorders can then discuss with genetic counselors, and based on the disorder, discuss whether something can be done about it. For example, prenatal discussions for someone with a family history of schizophrenia can use genetic testing to be more aware of how the mother should act during pregnancy. Also, people who live in OCD prone homes and get genetically tested, can meet with genetic counselors in order to possibly make some changes to religious or home life habits, changes that can be crucial to the onset of illness. Families that have ADHD in the family can get genetic testing and pregnant mothers can work to control babies' birth weights, and have careful measures in order to prevent exposures to

particular toxins. When eating disorders run in families genetic testing can be done, and then decisions can be made to make changes in diets and home life in order to prevent onset of disease. These are all ways genetic counseling can change the landscape of genes and mental health with a focus on the environment.

While this is certainly a futuristic way of thinking, there is one genetic counseling clinic in Vancouver, Canada that invests its time and its energy into genes, mental illness and helping people live healthier lives by avoiding the onset of mental diseases. It is the existence and success of this clinic that proves the possibility for this thesis statement's potential success. This clinic, called the ADAPT Clinic at B.C. Women's Hospital and Health Centre, is the first clinic in the world to give genetic counseling to people suffering from mental illness or who believe they are susceptible to it. Jehannine Austin, the founder of ADAPT, was inspired to go into research about the link between genes and mental health based on her own personal family experiences, and then realized she could use her research to start a counseling clinic to help others. ADAPT works with individuals to collect their family's mental health histories and work with them on what Austin calls the "mental health jar" or the way people's mental health is a jar composed of genes as well as environment. Counselors work with patients to develop strategies and smart life choices that revolve around sleep, nutrition, exercise and social networks. Austin believes that psychiatric genetic counseling can, "help people make meaning of genetic information… and can lead to important outcomes, including improved knowledge, more accurate understanding of risk, and increased empowerment and self-efficacy" (Bulik et al., 2019).

Based on ADAPT, Jehannine Austin herself has published many works reflecting on its success, success that can be used as representative of a future when we know more about genes

and mental health. Some examples include an analysis on the effects of genetic counseling when it comes to mental illnesses where onset increases with cannabis use. In this study, Austin discusses how people with a specific genetic variant in the ATK1 genes have an increased risk for psychosis with cannabis use (Zwicker et al., 2021). Information like this is derived from genetic testing and can be useful to patients as they work with genetic counselors to determine and construct different life choices. In another article, Austin, along with other researchers, ran a study to test the relationship between psychiatric patients and outcomes of genetic counseling on their mental health in particular. The study results showed that patients, regardless of sex, age and ethnicity, benefit from psychiatric genetic counseling (Gerrard, 2020).

The way ADAPT treats patients is first by drawing out a detailed psychiatric family history dating back three generations. This family history is used as a primer to have open and honest discussions and determine what genetic tests to send for. This is followed by open dialogue between the patient and the genetic counselor, in which the genetic counselor needs to pick up on emotions and concerns driving the patient's questions. Based on this model, Austin did a tremendous amount of research on genetic counseling's impact on those with eating disorders, as discussed above. Austin discusses how she particularly focuses on eating disorders because for so long it has been viewed as a disorder in which a person chooses what they are doing to their body, but more and more genetic research shows that the debilitating choices a person with an eating disorder makes is not necessarily always in their control. She suggests that now that we see what a big role genetics plays in eating disorders it is crucial for clinicians treating patients to be in touch with patients and their families amidst the difficult process. She believes that it is important for clinicians to know how for eating disorders in particular, environment and genetics are tightly intertwined, how mental illness is not just inherited but is a

complex web of a range of susceptibility and vulnerability, and finally that there is no single gene that is the cause for eating disorders. Austin hopes that as clinicians and genetic counselors work together, a much more holistic approach can be achieved when treating psychiatric patients and understanding where they are coming from (Bulik et al., 2019).

Another area Austin delved into based on her research and work at ADAPT is genetic counseling and its effect on alcohol addiction, another mental illness that is often viewed as the person with the mental illnesses' fault. Austin ran a study where people with personal or family histories of alcohol addiction were asked to fill out a survey about their thoughts on alcohol addiction and their perception of genetic counseling as an avenue for help. The survey showed that 62% of people thought genetic counseling would be helpful for people with personal and family histories of substance abuse, and this 62% was mostly people who were worried about falling into the same trap a family member fell into with alcohol addiction. This shows how in a general sense, people with psychiatric disorders within their family histories are open to growth and development and learning within the field of genetics to ensure that their life is optimally lived when bad choices can make that otherwise (Kalb et al. al., 2017).

Even though there are promising results that come from ADAPT, there are still genetic counselors who are skeptical of this realm of thought combining genetics and mental health. Surveys show that on a regular basis, genetic counselors rarely receive referrals about mental health, and an underlying reason is that there is a stigma surrounding mental health in the genetic counseling world, as was seen by a survey sent out from the National Society of Genetic Counselors to board-certified genetic counselors in order to test their stigmatization of mental illness (Brooke et al., 2020). However, according to the article, "should this mindset persist, without the intervention of psychiatric education and training, the field of genetic counseling

risks continuing to inadequately serve a historically underserved population." Therefore, it is clear that while skepticism is only natural when new fields and groundbreaking ideas emerge, if this skepticism continues, it can override the future to help the mental health population in the field of genetics in a very real way.

By focusing on how ADAPT serves to give patients advice, it can ultimately reflect on what a world with more advanced genetic testing and research in mental health and genetics would be able to provide for patients. First off, the understanding that genetic counseling helps patients tremendously with their treatment plans when it comes to understanding diseases and disorders and how it manifests itself in oneself and in their family is key to approaching the mental illness head on. After careful review of a patient's family mental health history, in addition to genetic testing which in the future will be more precise, a patient who is already suffering from symptoms of the disorder can work with the genetic counselor to map out a life plan for understanding how to mitigate how their illness manifests itself.

In addition, patients who approach a doctor before they've developed a mental illness, or patients with mental illness who want to help family members who have not yet developed mental illness, can work with the genetic counselor on ways to live life with preventative measures. Unfortunately, many clients who have mental illness running in the family feel that their chances of escaping the disease are slim. Jennifer Behm, who is a licensed professional counselor at MindSpring Counseling and Consultation in Virginia, discusses how clients who come into her office with mental health history, come in already feeling defeated and that "there is little or nothing they can do because it runs in the family." Theresa Shuck is another mental health professional who talks about how mental health family history can often result in a lot of shame and stigma because people think there is something wrong with themselves as well

(Phillips, 2019). However, genetic counseling is an effective tool at combining education and counseling in order to inform patients of the real situation at hand, one where it's both genes and the environment that work hand in hand in order to determine onset of disease.

Firstly, genetic counselors can assess how susceptible a patient with a family history of mental illness is to developing the disease based on the results of their genetic testing. This will give both the patient and the genetic counselor a clearer picture of the issues they are dealing with at hand, and help point in the right direction of where they should be going. Theresa Shuck explains how in this way, susceptibility for mental illness can be viewed in a similar way to susceptibility for physical ailments such as high blood pressure or diabetes where a person with a family history such as that would go to a genetic counselor as well. Shuck also used the jar analogy, similar to Jane Austin, in order to explain to patients how their susceptibility manifests in their life. The marbles in the jar are representative of the genetic factors that are at play, and while some people have one or two marbles, others have handfuls. The differences here are already telling to patients and can be a form of getting through to people and showing what they can do in their particular circumstances. Then, Shuck explains how the environment can be added to the jar as well, and only when it is filled with the marbles and the environment can mental illness manifest itself (Phillips, 2019). It is getting this message across to patients and family members that can instill hope in people and motivate them to take control of their lives and their situations via the suggestions of the genetic counselor.

Next, the genetic counselor can map out exactly what kind of lifestyle decisions and changes should be made to the individual's life. In particular circumstances, when young children are involved where older families sought help for their mental illnesses, discussions about preventing particular experiences, drug use and trauma can enable a child like this to grow

up in a completely mentally healthy way. Furthermore, pregnant mothers who seek genetic counseling can have discussions with the genetic counselor about ways to best go about their pregnancy to protect the fetus in utero from undergoing environmental circumstances that would turn genes for mental health on. An in utero understanding of genetics is very telling as can be seen by pregnant mothers who lived in Nazi occupied areas in 1944-1945. Their children were followed years later and it was found that the harsh environment of cold and starvation that the mother and fetus faced during those years was especially damaging to the fetus; now many of those grown children face mental health challenges such as depression, schizophrenia, anxiety disorder and various dementias (Phillips, 2019). A really big way that genetic counselors have worked with patients with family histories of mental health is by explaining neuroplasticity and showing how existing neural pathways that insinuate bad habits can in fact be turned around to cultivate new ones.

One of the major fears surrounding the progression of science where psychiatric disorders are understood much more precisely through a genetic lens is that such complexity in genetics at hand could result in shallow understanding and therefore potential harmful stigmas. However, that is why genetic counseling in itself is one of the most beneficial ways to combat this because not only will scientific knowledge be used to prevent onset of mental illness and to help people live more fulfilled lives, but patients who are nervous, scared and fearful of the unknown will have a counseling professional at hand to guide them, teach them while simultaneously straddling their fears and their doubts. Another fear is that learning about precise family genes and susceptibility levels could be a scary, trauma inducing experience in itself; this is an experience that can lead to increased environmental stressors, such as parent-child hostility, and can serve as the environmental factors themselves that turn genes on and cause mental illness to

come to the forefront. However, this fear must be taken in stride because the whole point of genetic counseling is that there is someone there emotionally while this kind of news is shared and processed. Additionally, when the time comes perhaps it can be a patient's decision as to what news is made public to them, and how much they would like to proceed in terms of life choices without full knowledge of their situation. And finally, knowledge of genes, though there is the risk for trauma, also comes in a circumstance where the benefits far outweigh the costs, both for patients and their families.

While psychiatric disorders are complex and involve multiple genetic variations and environmental factors, the future looks promising in a way that people with heavy family histories can really be helped in the field of genetics. Although today, genetic testing is limited and what we know about genes and mental health isn't as absolute as it could be, ADAPT shows a glimpse of what the future can look like for patients when we know more. The fact that there already has been interest in genetic counseling amongst people who have psychiatric illnesses running in their families, shows that there is a need for something that might just not be perfected yet (Nurnberger et al., 2018). What we know today about the connection between genes and mental health is only the foundation for future, more advanced research that is more concrete, and specifically targeted for each particular gene and it interplays with each mental illness in a complex way. Just like it is done now for physical ailments, ultimately people can be screened for family histories and genetic counselors can send for genetic testing for mental illnesses as well. Based on results that reflect various levels of susceptibility, genetic counselors can work with patients, including parents and pregnant mothers, in the realm of mental health. Together they can work to control and make changes to environmental conditions that greatly impact the onset of disease. In this way, mental health, which for so long has been viewed as an abstract,

other worldly concept that is almost untouchable, can be brought into a world where things can be done to make change and prevent the internal familial tied suffering of so many.

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