SciWISE

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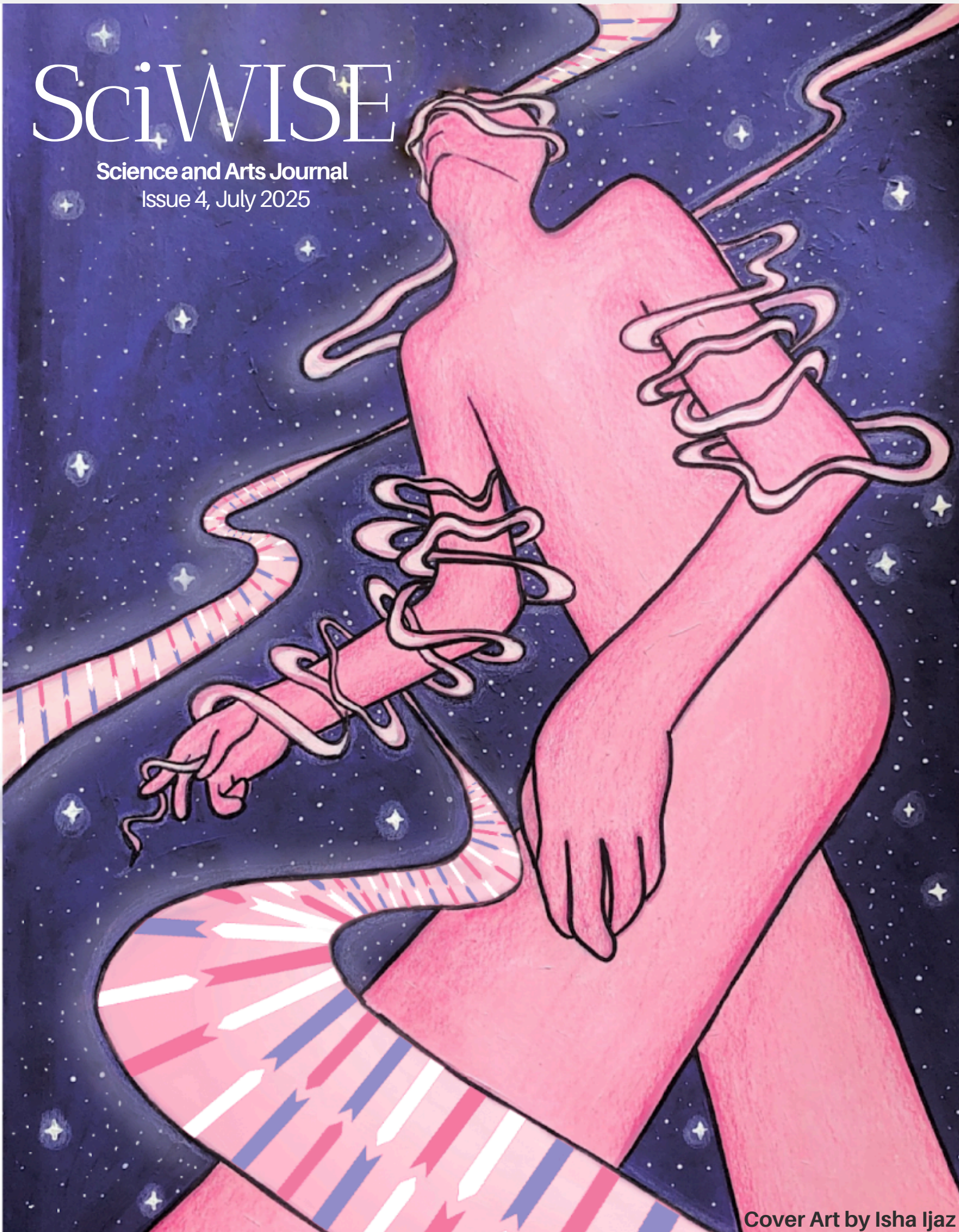
Issue 4, July 2025



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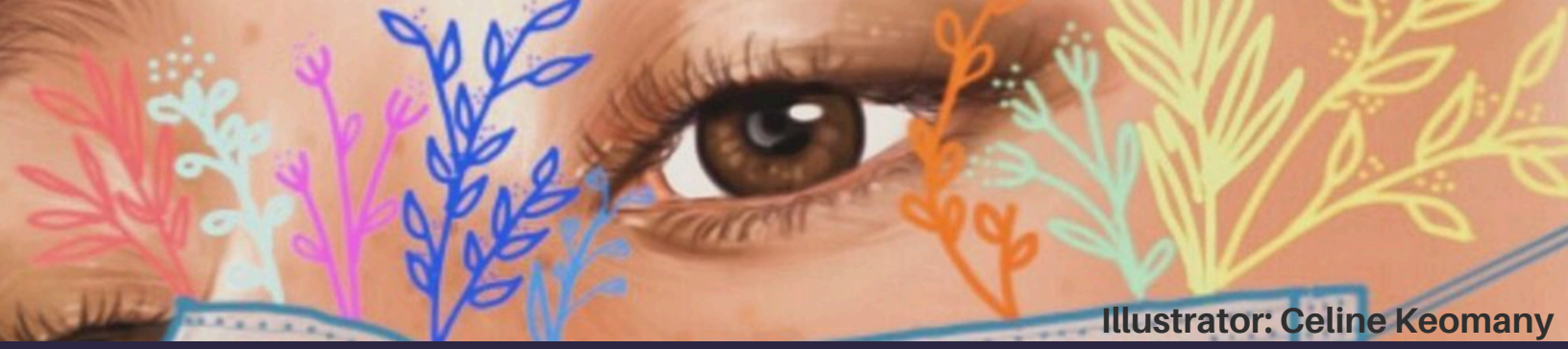

Illustrator: Celine Keomany

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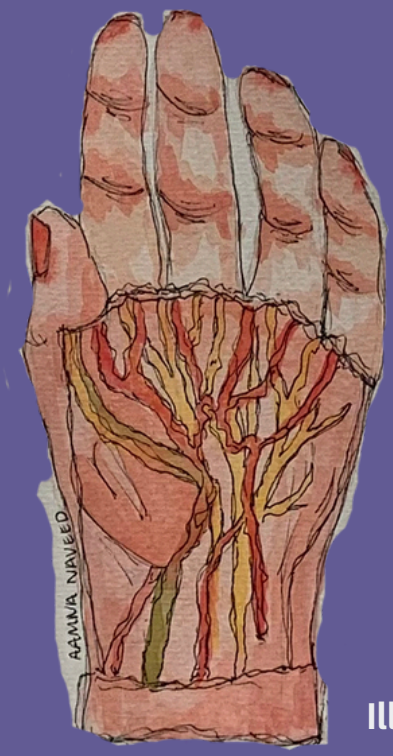


Illustration by Aamna Naveed

SciWise is a student platform for creative works with a scientific theme. Our goal is to create a space that celebrates and accommodates creativity in scientific works and allows for students from all faculties to contribute to the interdisciplinary scientific community.

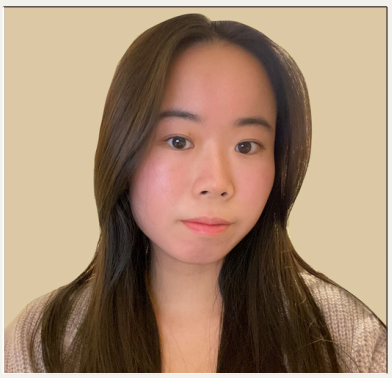
In this issue, we feature a diverse range of pieces: from exploration of new treatments for diseases such as bipolar disorder and osteoporosis to submissions that raise awareness of global diseases and systemic bias in public health, our journal aims to highlight the many intersections between science and art and the ways science and art can inform and advocate. Furthermore, visual storytelling in the form of artistic submissions and accompanying illustrations to our written pieces reminds us of how creativity can make science more accessible.

On behalf of the SciWise Team, we hope you enjoy this issue and feel inspired to embrace creativity in your scientific works!

Sincerely,
Mariyam Niaz
Editor-in-Chief and Director, *SciWise*

Director and Editor-in-Chief: Mariyam Niaz

Senior Editor: Muzzammil Hooda



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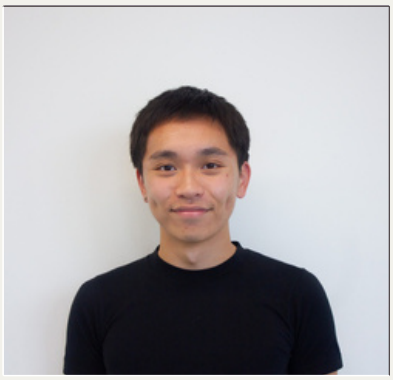

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Secretary: Rayhane Rebaine

Meet the Team

SCIWISE

DENGUE TRANSMISSION

Author: Haniyyah Mahmood
Honours Bachelor of Science in Life Sciences

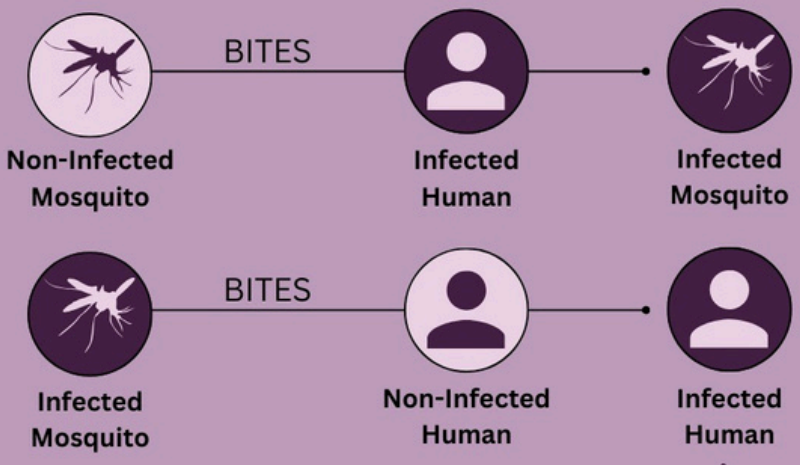
QUICK FACTS

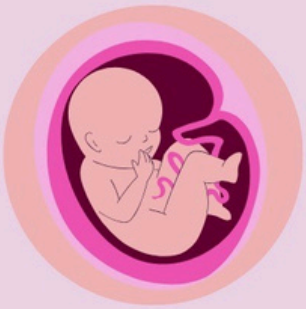
1. Dengue can be diagnosed through a blood test.
2. Dengue is a RNA virus from the family Flaviviridae.
3. One of the primary illnesses contracted by international travellers.

WHAT IS DENGUE?

- Dengue is a virus based illness that is caused by infected Aedes Mosquitos.
- Currently, there are no direct treatments or vaccines for a Dengue infection,

Transmission:





Pregnant women who have contracted Dengue have the potential to pass the virus to their fetus.

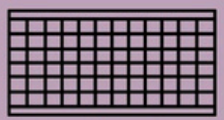
Preventions

If traveling keep the following preventative measures in mind:

Apply mosquito repellent frequently

Wear clothing that covers arms and legs

Use mosquito nets while sleeping in hotels and/or any types of accommodations.



High-Risk Populations

People living and/or traveling to tropical areas such as Southeast Asia, the Western Pacific Islands, Latin America, Africa, the Middle East, and the Americas are at high risk for infection.

OUTBREAK: 2021

1, 182, 721 cases

Cases mainly from: Brazil, Vietnam, Peru, Philippines, & Reunion

1 in 4 people infected with Dengue will get sick

There are 100-400 million infections each year

With 40,000 deaths every year

Symptoms include:

- Fever
- Headache
- Rash
- Muscle & joint pain
- Eye & bone pain
- Nausea/ Vomiting

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Author: Haniyyah Mahmood
Illustrators: Jennifer Do, Isha Ijaz
Editors: Danny Nguyen, Julia Nigro, Muzzammil Hooda, Mariyam Niaz

Lithium's Mechanisms of Action in the Treatment of Bipolar Disorder

Research Article
Author: Kelei Xiao
Honours Bachelor of Health Sciences
Class of 2027

Editors: Julia Nigro, Danny Nguyen, Haroon Ahmad, Muzzammil Hooda, Mariyam Niaz

Illustration by Jennifer Do

Abstract

Bipolar disorder (BD) is a severe psychiatric disorder involving alternating and persistent episodes of depression and mania or hypomania, impacting approximately 1% of Canadians (4). Lithium is one of the many pharmaceutical treatment options for BD, with its first recorded usage in psychiatry dating back to the mid-nineteenth century(2). Despite its widespread use, lithium's definitive mechanisms of action in the treatment of BD have yet to be fully understood (18). Current theories involve lithium's neuroprotective properties, ability to decrease demyelination, stimulate remyelination, and potential to resynchronize disturbed circadian rhythms (18). As scientific research continues to explore lithium's effects on various factors impacting the development of BD, limitations in existing research leave areas for further clarification and exploration.

Introduction

In 1881, a well was drilled in Palo Pinto County, Texas (1). This well would later be named the Crazy Well, attracting visitors from around the city after its water supposedly cured an elderly woman suffering from manic symptoms (1). While this urban legend may not be true, it was later found that the Crazy Well's water contained a significant amount of lithium, an element with mood-stabilizing properties which is now commonly used in the treatment of various mood disorders such as bipolar disorder (1,2).

Bipolar disorder (BD), which affects approximately 1% of Canadians, is a category of mood disorders characterized by alternating, abnormal, and persistent mood episodes which typically last more than one week (3,4). According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), manic episodes may be demonstrated by symptoms such as hallucinations and/or delusions, decreased need for sleep, and excessive involvement in risky behaviours (5). Hypomanic episodes do not involve psychotic symptoms. However, they may consist of similar symptoms, such as an increase in psychomotor agitation, inflated self-esteem, and distractibility (5). Depressive episodes may consist of symptoms such as decreased appetite, fatigue, and feelings of worthlessness (5). Lastly, mixed episodes may consist of features from both manic and depressive episodes (5).

Though the definitive etiopathology for BD remains unknown, scientists believe that a multitude of genetic, neurochemical, and environmental factors cause BD (6). Recent research has demonstrated that several neurobiological factors are linked to BD, including changes in neuroplasticity and neurotrophic signalling, mitochondrial dysfunction, and oxidative stress (6). Neurotrophins are a category of proteins responsible for regulating numerous processes necessary for neuronal growth and survival (7). The most studied neurotrophin which relates to BD is brain-derived neurotrophic factor (BDNF); multiple studies have shown a positive correlation between chronic antidepressant and mood stabilizer (i.e. lithium) use and BDNF levels in rat brains (8-11). Additionally, mitochondrial dysfunction has been linked to the triggering of mood episodes in BD.6 The mitochondrion is an intracellular organelle responsible for energy production (12). In the brain, it is essential to modulate neuronal activity through potentiation and other functions that support neuroplasticity and cellular resilience (6). A study by Fries et al. has linked oxidative stress — the overproduction of unstable reactive chemical oxygen species — to the induction of point mutations, significant deletions of mitochondrial DNA, restricted DNA repair ability, and an absence of histones — proteins which structurally support chromosomes — in mitochondria (13). Circadian rhythm abnormalities are another factor associated with BD (6). Specifically, abnormal secretion of the hormones melatonin and cortisol at different times of the day often causes sleep disturbances for those with BD (6). Furthermore, circadian genes such as CLOCK and ARTNL1 are associated with BD's development, suggesting that BD may be inheritable (15,16).

There are numerous pharmaceutical treatments for BD (17). However, this article discusses current theories on lithium's mechanisms of action as a mood stabilizer in the treatment of BD, and provides a critical analysis of related studies to explore areas for further research.

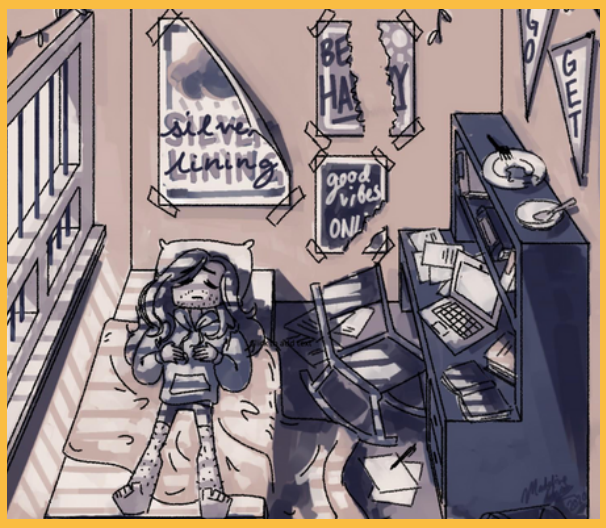

Illustration by Madeline Chen

Neuroplasticity and Apoptosis

Lithium is thought to have neuroprotective effects on cellular targets of BD, which subsequently leads to mood-stabilizing effects (18,19,22,23). The GSK-3 signalling pathway regulates neuroplasticity and apoptosis (programmed cell death), with increased activation promoting apoptosis (20,21). In a study conducted by de Sousa et al., it was demonstrated that phosphorylated GSK-3β levels significantly increased in subjects during bipolar depression compared to healthy controls after six weeks of lithium treatment at the therapeutic level (22). This inhibition of the GSK-3 pathway is observed with an improvement in symptoms through lowering the effects of neuronal hyperexcitability (18,22). This suggests GSK-3β as a potential biomarker in BD, as higher GSK-3β levels are associated with a higher risk of mood episodes (22). However, this study involves a small sample size, with 27 bipolar depressive subjects and 22 healthy controls (22). Due to this small sample size, further studies must be conducted to investigate the role of GSK-3β in the treatment response of BD and as one of its biomarkers. Furthermore, the connection between lithium monotherapy and GSK-3β levels has never been studied in human subjects, prompting a need for such studies to better understand this potential correlation (22).

Mitochondrial Dysfunction and Oxidative Stress

Lithium has been demonstrated to decrease lipid peroxidation and stimulate remyelination in demyelinated neurons, reversing the effects of oxidative stress (18,24,25). Lisdexamfetamine dimesylate (LDX) is a drug used to induce hyperlocomotion, simulating bipolar mania in animal models through oxidative stress (24). In a study by Macêdo et al., LDX was administered to two groups of rat models (24). One group of rats received lithium treatment before LDX, simulating the effects of lithium on the prevention of bipolar mania (24). Another group of rats received lithium after LDX, simulating the effects of lithium on the reversal of bipolar mania (24). Lithium was shown to prevent and reverse the effects of neuronal lipid peroxidation and subsequent hyperlocomotion in rat models (24). A limitation of this study is that bipolar mania often does not present as hyperlocomotion alone (24). As BD holds several complexities and varies in its presentation, further studies should explore lithium's effects on animal models with a more complex simulation of bipolar mania to improve its generalizability to human subjects.

Circadian Rhythm Abnormalities

Lithium has demonstrated an ability to resynchronize disturbed circadian rhythms through the modulation of circadian genes, as well as inhibition of excessive cortisol release by modulating adrenal gland activity (18,27,28). A meta-analysis conducted by McCarthy et al. found that several circadian genes were lithium-responsive, including the CLOCK gene network and ARTNL1 (27). This has led to a hypothesis that variation within the CLOCK gene network may contribute to the development of psychiatric illnesses such as BD, as circadian rhythm disturbances are common in many psychiatric illnesses (27). However, several limitations exist in this study. The technique used in the meta-analysis only utilizes genetic data published before 2009. Thus, it may not accurately reflect the most recent and updated information relevant to the genes and disorders of interest (27). Additionally, the data in this study primarily came from subjects of Caucasian ancestry, meaning these findings may not generalize to non-Caucasians (27). Furthermore, several gene expression studies involving rodent brains analyzed in this study gave conflicting results, suggesting that these differences in results may come from experimental conditions (27).

Conclusion

As a drug that has been in use since the mid-nineteenth century, lithium has earned its recognition as a reliable mood stabilizer (2). Despite its widespread use, scientific research has yet to find a definitive mechanism of action for lithium in the treatment of bipolar disorder. Current theories surrounding its mechanisms of action involve lithium's neuroprotective properties, ability to decrease demyelination, stimulate remyelination, and potential to resynchronize disturbed circadian rhythms (18). However, several connections are still subject to clarification as advancements continue to explore lithium's fascinating capabilities in alleviating the suffering of thousands of Canadians affected by BD (29).

Acknowledgements

The author would like to thank the authors of the studies discussed in this article for their pioneering efforts in expanding current knowledge on the topic.

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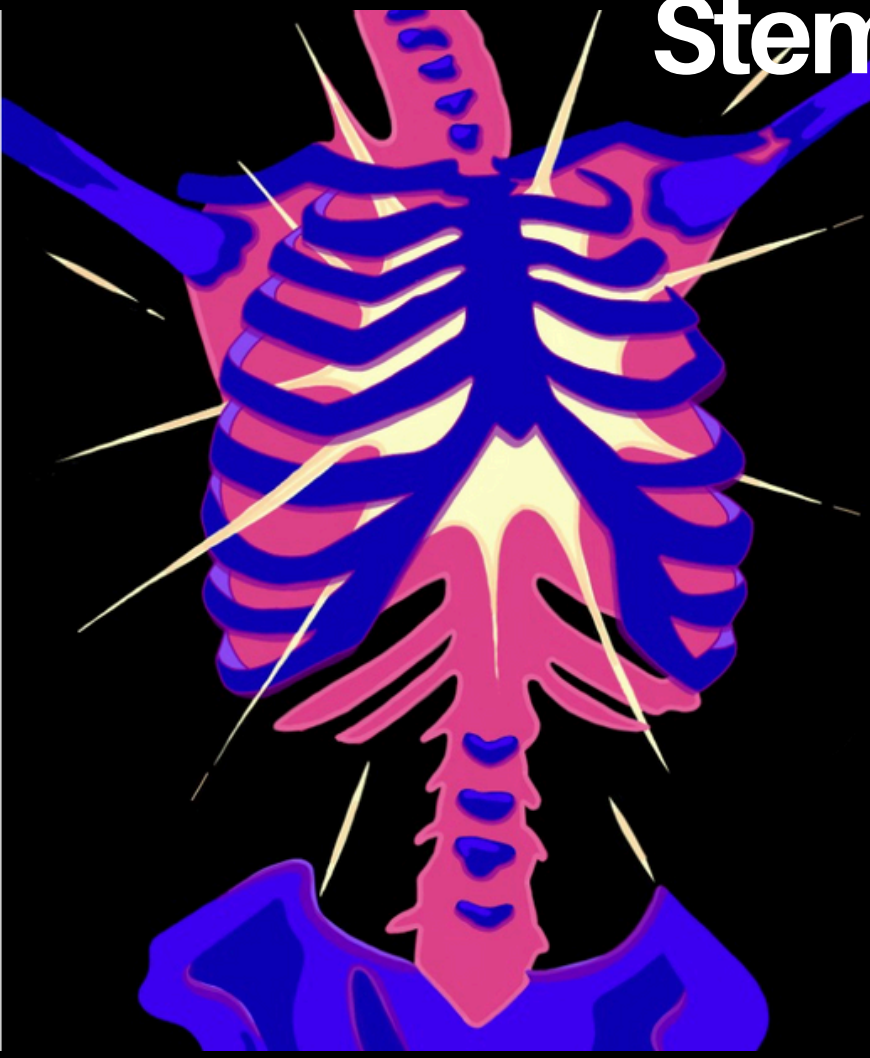
Unlocking Healing Power: How Umbilical Cord Extracts Supercharge Stem Cells to Fight Osteoporosis

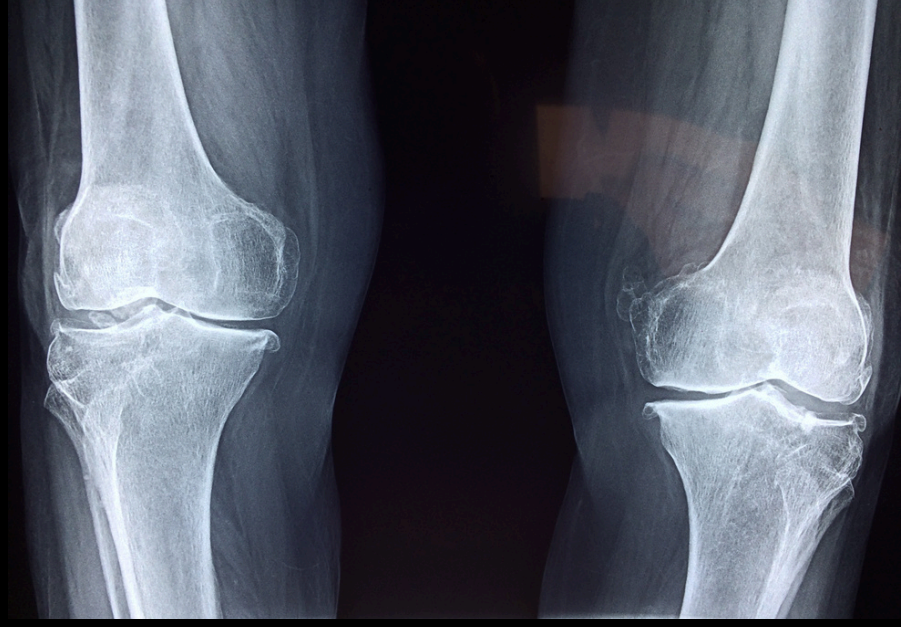


Research Article
Author: Isha Ijaz
Honours Bachelor of Science
Class of 2024

Editors: Danny Nguyen, Julia Nigro, Haroon Ahmad, Muzzammil Hooda, Mariyam Niaz

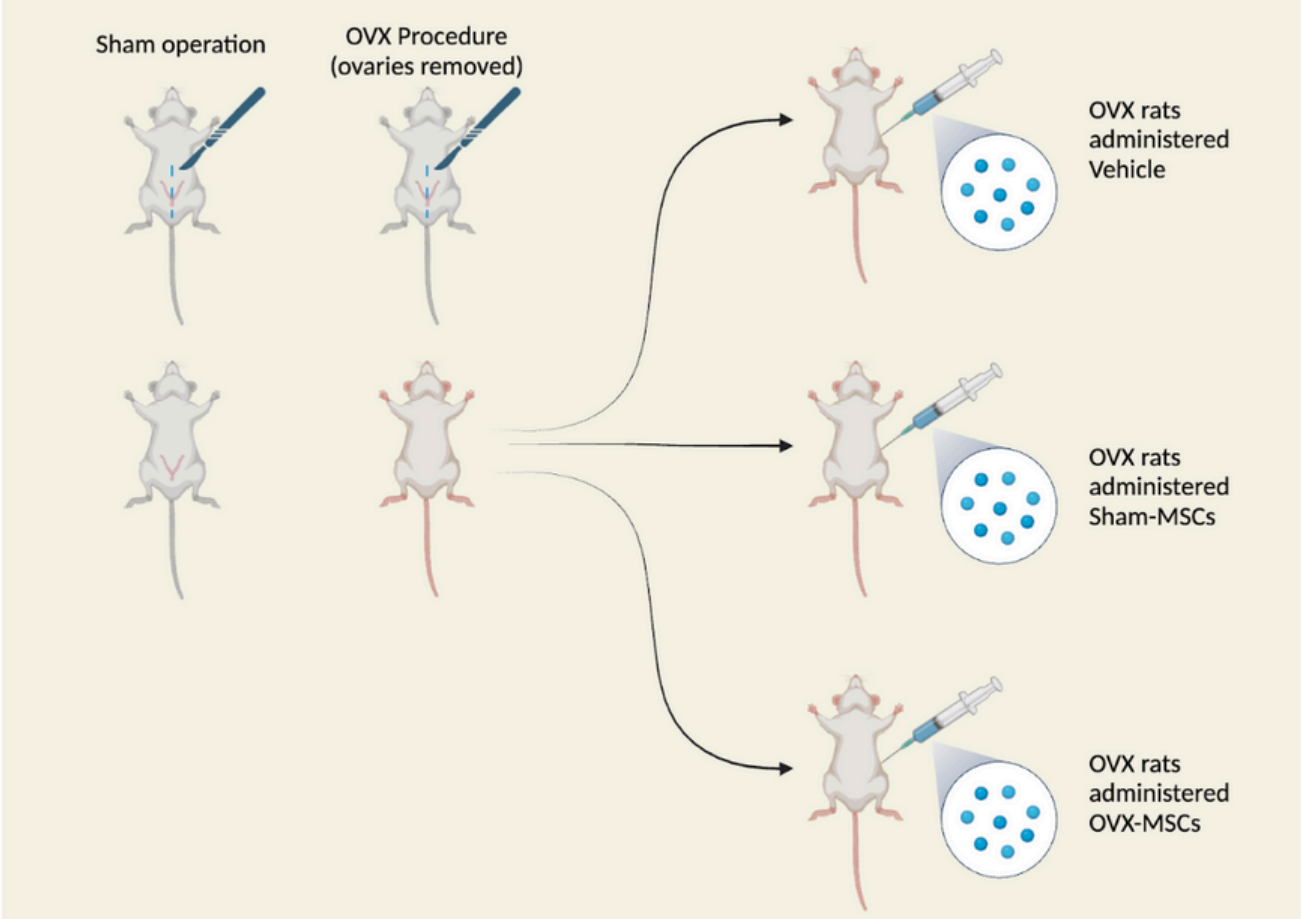
Illustration by Isha Ijaz

Osteoporosis is a disease that causes bones to break down and become brittle, leading to decreased bone strength. It affects over 2.3 million Canadians and is often called “the silent killer” because it progresses without symptoms until a fracture has occurred (1). Fractures caused by osteoporosis happen more frequently than heart attacks, strokes, and breast cancer combined (1). As women get closer to menopause, they experience a faster loss of bone density ranging anywhere from 2-3 percent per year (1). Because of this, one of the most common forms of this disease is postmenopausal osteoporosis. In fact, one in two postmenopausal women will develop osteoporosis (2). In postmenopause, low estrogen levels and decreased ovarian function heavily contribute to the changes in bone density observed in osteoporosis (3-5).



MSCs have an important role in the maintenance and repair of the bone when functioning normally

Mesenchymal stem cells (MSCs) in the bone marrow are unspecialized cells that have the ability to divide and differentiate into many of the skeletal tissues of the body, including bone and cartilage. MSCs have an important role in the maintenance and repair of the bone when functioning normally. However, their regenerative ability is reduced in postmenopausal osteoporosis patients (6). Because of their ability to divide into many different cell types, there is a great deal of interest in using MSCs in regenerative medicine by transplanting the cells, especially in the cases of diseases causing breakdown of tissue. In practice, this would involve stem cell transplants. Sourcing stem cells from the same individual is ideal since those cells are compatible with the person's body. This process is known as an autologous transplant (coming from the same individual), as opposed to an allogeneic transplant (from a different individual). Normally an autologous transplant is preferred, but in the case of osteoporosis patients, their stem cells are not able to repair bone the way healthy stem cells are able to, so an autologous transplant would simply be reintroducing the same impaired stem cells into the body.



The researchers Saito et al. found a way to activate these autologous MSCs using a human umbilical cord extract called Wharton's jelly extract supernatant (WJS) using rats as a model organism. WJS is made up of embryonic tissue, umbilical vessels and amniotic membranes. It contains a variety of growth factors, cytokines, extracellular matrix proteins and micro-vesicles (6). Saito et al. developed this activator after identifying the unique abnormalities in MSC function. To model postmenopausal osteoporosis in rats, researchers ovariectomized (OVX) them, meaning they removed their ovaries to create an estrogen-deficient rat model. Collection of stem cells from these rats (OVX-MSCs) revealed that OVX-MSCs had decreased therapeutic effects as well as reduced cell proliferation, mobilization, and regulation of osteoclasts, which are responsible for bone degradation (6).

The rats either received a sham operation or an OVX procedure under general anesthesia; both surgical procedures were identical, but the OVX rats had their ovaries removed. A sham procedure here means that the surgery is mimicked but without removal of the ovaries. The experimental setup involved these rats being split into several groups: (1) Sham rats, (2) OVX rats administered Vehicle (an inert solvent with no therapeutic properties), (3) OVX rats administered Sham-MSCs, and (4) OVX rats administered OVX-MSCs. Among the rats that received OVX-MSCs, some were not activated with WJS, while others were activated.

Being able to activate MSCs from an osteoporosis sample for effective transplantation has significant implications for the future of patient-related research.

Saito et al. found that OVX rats given Sham-MSCs inhibited the progression of osteoporosis in comparison to those given the Vehicle, and OVX-MSCs also did not show a significant therapeutic effect on their own. Abnormalities observed in the OVX-MSCs included an altered cell morphology (altered cell size and shape), including short and dull cell protrusions, enlarged areas, flat shapes, and disordered orientation (6). When cultured with WJS, OVX-MSCs showed an improvement in morphology as well as a significant increase in cell growth compared to OVX-MSCs cultured without WJS. Culturing OVX-MSCs with WJS improved osteoporosis in the OVX rats. These findings suggest that the WJS activator has the potential to enhance impaired MSCs to facilitate autologous transplant procedures.

Being able to activate MSCs from an osteoporosis sample for effective transplantation has significant implications for the future of patient-related research. Previous findings indicated that MSCs from rats with osteoporosis exhibited lower proliferation ability and reduced expression of genes associated with pluripotency, which is the capacity of a cell to differentiate into various cell types (1,6,7). Despite this, WJS was able to improve morphological and functional abnormalities that occurred due to reduced estrogen levels. In order to be able to use abnormal MSCs from patients for transplantation, they need to be functional, which is what the activator WJS is able to do. With further development, this method has great potential for enhancing the therapeutic capabilities of MSCs from postmenopausal osteoporosis patients for transplantation. The activation of MSCs in osteoporosis patients is a promising improvement upon current treatment options and opens up the ability to improve the quality of life for countless people suffering from this debilitating disease.

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Thanks For The Hand; Block Specimen Depicted in Watercolour

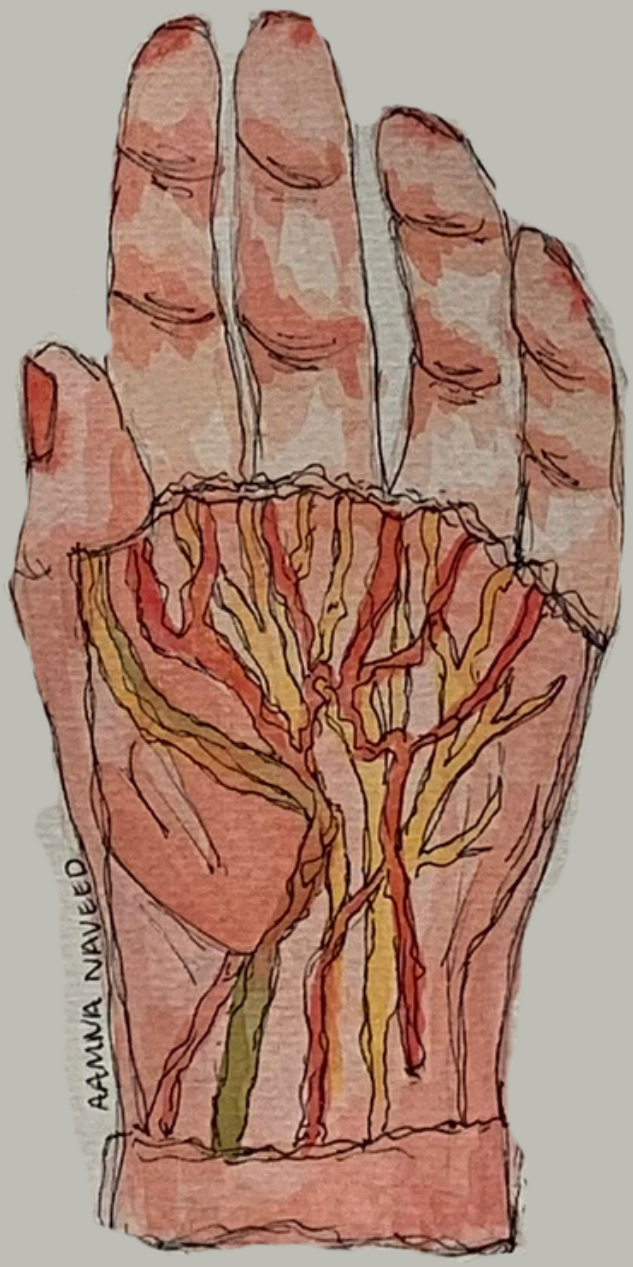

Illustration by Aamna Naveed

Illustration by Jennifer Do

Opinion Piece
Author: Julia Nigro
Honours Bachelor of Science in Life Sciences

Editors: Danny Nguyen, Haroon Ahmad, Muzzammil Hooda, Mariyam Niaz

Elder Abuse in Ontario during the Covid-19 pandemic

Imagine being an elder, confined to your room, unable to leave and barred from seeing your loved ones for 15 months (1). Your mental health is deteriorating from the social isolation and loneliness. Shouldn't you have the same rights to dignity and autonomy as everyone else? (2) To make matters worse, you live in a place with such limited help that they cannot even provide you the basic necessity of enough water to stay hydrated (3). Meanwhile, you hear about how this strange virus is disproportionately killing people like you (4). Adding insult to injury, people in your country, province, or city are taking to social media, mocking elders while they disregard pandemic protocols despite the danger (5). They have the privilege to ignore these protocols while you are afraid of catching this disease and dying before having the chance to say goodbye to your loved ones (1). Is that not terrifying?

The goal of long-term care facilities is to provide elderly residents of Ontario with adequate housing, care and support services (6). However, it has been proven prior to and over the course of the COVID-19 pandemic, that ensuring access to accessible housing may come at the cost of infringing on other human rights (7). During the pandemic, evidence indicated that these retirement facilities violated Ontario's long-term care home safety legislation, many of which many were repeated offenders (8). These violations include issues such as inadequate infection control, unsafe medication storage, inadequate hydration, and poor skin and wound care, among others (8). The study which collected this data identified that 538 out of the 632 homes in the Ontario database were repeated offenders, amounting to a shocking 85 percent (8).

What is the cause of the lack of preparation and support in Ontario's long term care homes and our healthcare system at large?

These violations appeared to be more prevalent during the pandemic, as families were unable to enter facilities under the pandemic safety protocols (3). In 2021, amid the COVID-19 pandemic, the Augmented Civilian Care team confirmed a number of disturbing cases. For example, at Downsview Long Term Care Centre, 26 residents died due to dehydration (3). Other reports identified that patients with "ulcers and soiled sheets were left bed-bounded" as caregivers "moved unit to unit in contaminated gear" (3). Some have reasoned these issues have been due to a lack of staffing support (3). A common theme in all these long-term care facilities is the isolation faced by residents (1). Nursing home residents were confined to their rooms for up to 15 months and separated from communication with their family (1). This, too, has been linked to staffing shortages (1). What is the cause of the lack of preparation and support in Ontario's long term care homes and our healthcare system at large?

The events that took place during the COVID-19 pandemic reflect a broader systemic issue within Ontario's healthcare system. It is important to note that Ontario has approximately 2.3 hospital beds for every 1000 people, 9 with these beds being four times as likely to go to another individual than a person in a long-term care home, according to a study conducted by the University of Toronto and Public Health Ontario (9,10). This reality leaves a disproportionate amount of elderly people dying alone in their beds at the nursing home. But why does this occur? Why is it happening specifically to them? The underlying assumption is: why should an elderly person be provided with equal access to this limited resource – like health care access – when they no longer benefit society as much as a younger individual? Should they not sacrifice their health and safety for the generations that replace them? The pandemic has brought attention to how little we as Ontarians value and respect our elderly population. Do we believe it would be any different when it is eventually our turn?

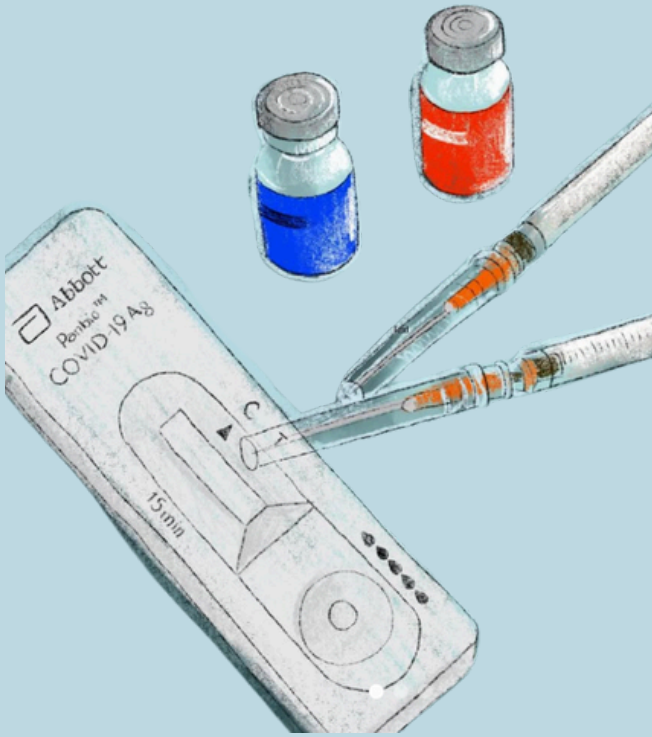

Illustration by Celine Keomany

Illustration by Jennifer Do

Elder abuse, and the human rights it violates, is a result of ageism (5). Ageism in its loosest definition is a bias against an individual based on age (5). Ageism brings about stereotypes that change the way Western society treats older individuals. An example of ageism is a common flattering phrase usually stated: that a person "does not look their age," intended to be a compliment and yet insulting an entire group of people's appearance (11). We can see concrete examples of the fear of looking 'old' in how the beauty industry markets its products and the rise of the 'anti-ageing' industry in Canada (12). This insult is one of many stereotypes associated with older people. Older people are often viewed as incompetent in the modern world and unable to care for themselves and make their own decisions (5). According to the national senior's strategy, 80% of Canadians agree with the statement: "older adults 75 and older are seen as less important and are more often ignored than younger generations" (13). But where does this bias come from? One belief is that ageism lets younger people distance themselves from becoming old (5). If you alienate older individuals, making a sharp distinction between 'us' and 'them,' you can no longer envision yourself as eventually becoming 'them:' if I am a human being, and they are so different from me, then they could not possibly deserve the same rights as I do. This division then can be seen to infringe on the rights of the dehumanized 'other'. Those with these biases create a box of stereotypes to shove the older generation in and gradually prevents us from identifying our elders as human beings (11). Because the younger generation stops seeing their elders as someone to respect, they allow for these abuses to occur (11).

Many actions must be taken to right this wrong. Those who experienced trauma as a result of long-term care homes (whether during, before, or after the pandemic) should be contacted and asked if they wish to share their experiences and opinions. Those voices should be valued. Since many inadequacies were a result of lack of staffing, studies should be conducted to identify why this occurred. Was it solely due to insufficient funding? However possible, there should be a way to increase this funding and explore options to bring more workers into this field. Knowing that there are laws such as Ontario's long-term care home safety legislation that are supposed to protect elderly individuals from these abuses, why did the abuses continue to happen so frequently? Going further, how can we improve our healthcare system to increase the number of beds per hospital and ensure that everyone gets equal access to them? When the next pandemic occurs, there should be a plan in place to protect the health of elderly individuals and make sure they receive the help they need. This will require a fundamental change in the way our society views elderly people.

Why does our society disrespect elders? These questions are formulated with the intent of understanding how to stop the abuse of older people, starting with those who live in long term care facilities in Ontario. Another possibility coming out of the Covid-19 pandemic is that people in power – those who had the ability to impact how the elderly were and continue to be treated – will believe that this could be the new normal. If no one is trying to change it or bring attention to it, then why should we improve it? This possibility is terrifying for those currently living under these conditions. It should be terrifying to us because we will eventually live in the conditions they are subjected to.

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