



CANADIAN  
JOURNAL  
*of* UNDER  
GRADUATE  
RESEARCH

## Coral Collaboration

*“using coral to explore an interdisciplinary approach allows scientists and the public to see what each discipline can bring to the table in determining how to effectively proceed in conservation efforts” (p.31)*

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### Medical School Aspirations

*“These students carry a significant burden of stress and the COVID-19 pandemic carries great propensity for a long-ranging impact – lasting possibly years – as it disrupts processes and career aspirations.” (p.17)*

### All-you-can-eat in Reality

*“the sunk cost fallacy justifies why people irrationally continue to consume food even when they are already full or the food tastes mediocre – only to make up for the price they have paid.” (p.27)*

# CANADIAN JOURNAL *of* UNDERGRADUATE RESEARCH

*A student-led publication that aims to highlight  
research by undergraduate students of all  
disciplines*

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This issue is published on the traditional, ancestral, and unceded territory of the Coast Salish Nations, including x<sup>w</sup>məθk<sup>w</sup>ə́yəm (Musqueam), Sk̓w̓x̓wú7mesh (Squamish), and sə́lilwə́taɬ (Tseil-Waututh).

# Letter from the editor-in-chief



Dear readers,

Once more I'm incredibly proud to be presenting research performed by a vastly talented group of undergraduate students, this time in CJUR Volume 7 Issue 3.

Our articles this issue range from environmental and endocrine sciences to conservation and criminal justice, reflecting the huge breadth of undergraduate research happening across the country and beyond. If your work is one of the papers contained in this issue, my sincerest congratulations! It has been an honour to work with all of you.

Every time we receive new manuscripts we are excited to discover another niche area of research being explored by our fellow undergraduates, and even more excited to see them come to fruition through the peer-review process. To this end, each submission has undergone two stages of double-blind peer review performed by graduate students, post-graduates, and professors, before being copyedited and typeset by our wonderful editors to create the final product you now see.

The level of dedication from our editorial team is unmatched, as is that from our wide range of reviewers. A huge thank you goes out from my team to everyone who has had a role in bringing these manuscripts to fruition. Without the countless hours that these volunteers put into the editorial and peer review process, publications such as this one would not be possible.

Yours sincerely,

**Imogen Porter**

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# Psychological Explanations: The Terri Lynne McClintic Case

Megan Davidson<sup>1</sup>

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**ABSTRACT** Research about early- and mid-childhood factors that lead to criminality has been studied across many countries and demographics. However, the rare occurrence of a Canadian woman participating in a rape and murder of a child has not been explored. This article will address the 2009 kidnapping and murder of eight-year-old Victoria Elizabeth Stafford, committed by Terri-Lynne McClintic and Michael Rafferty, as well as a discussion around the nonconformist perspective on human nature and social control theory and a psychological discussion around the formative years of McClintic's youth. Within this paper, McClintic's psychology will be explored from a nonconformist perspective, where it is shown that she lacks the social controls to restrain her from committing crimes. Specifically, early- and mid-childhood factors offer insight into McClintic's antisocial and deadly behaviour. The peer rejection by those at the many schools McClintic attended and early exposure to substance abuse by her adoptive mother, Carol McClintic, led to a higher likelihood of criminal and antisocial behaviour, as well as mood and anxiety disorders. While the exact factors that caused Terri-Lynne McClintic to murder Stafford remain speculative, understanding her childhood risk factors and their psychological effects offers insight into a unique and rare occurrence of the rape and murder of Victoria Elizabeth Stafford by Terri-Lynne McClintic and Michael Rafferty.

## INTRODUCTION

Many desire to understand why crimes are committed and the developmental factors surrounding criminal behaviour in the criminal justice field. Research into the stacking factors and potential causes of criminality is essential for developing resources and family support systems to foster success in the first years of a child's life and aids in the prevention of future crime; however, agreeing on the specific causes of criminality is complex (Bartol & Bartol, 2016). This multifaceted psychological puzzle is demonstrated in the case of Terri-Lynne Ruth McClintic, an 18-year-old woman who was a part of the duo that kidnapped and murdered eight-year-old Victoria Elizabeth Stafford. We will never know the exact reasons behind why McClintic participated in the murder of Stafford. However, examining her childhood may offer a glimpse into the past of a distraught girl who lacked societal and parental support leading to non-existent ties to society and drug abuse. While the instance of a criminal incident such as the rape and murder of a young girl by a couple is a rare occurrence, the factors that McClintic faced in her formative years of early childhood into adolescence are still of value to study as they grow the body of research around the formative years of childhood and also offer insight to the select few others who have committed such acts (see Paul Bernardo and Karla Homolka, Judith and Alvin Neelley, and Charlene and Gerald Gallego). In this paper, the following topics will be explored: a case summary, a discussion on the nonconformist perspective on human nature and social control theory, and a psychological discussion around the formative years of Terri-Lynne McClintic's youth as it relates to the continued criminality that culminated in the murder of Victoria Stafford.

## REVIEW

### Case summary

On April 8, 2009 in Woodstock, Ontario, residents were shaken when eight-year-old Stafford did not arrive at her mother's house after walking a few blocks home from Oliver Stephens Public School by herself for the first time (R v McClintic, 2010). Stafford was reported missing later that evening at 6:04 p.m., and the search for Stafford commenced (R v McClintic, 2010). Police retrieved the surveillance video from College Avenue Secondary School on April 9 and later released the footage to Southwestern Ontario media (R v McClintic, 2010). The video's release resulted in multiple tips pertaining to McClintic from several people within the community (R v McClintic, 2010).

According to McClintic, in the early afternoon of April 8, 2009, Michael Thomas Christopher Stephen Rafferty – who was 28 years old at the time – picked up McClintic and proceeded to outline how Rafferty wanted McClintic to help "snatch a little girl" (R v Rafferty, 2012a). Rafferty

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dropped McClintic off near a public school where she proceeded to lure Stafford into a parking lot of a nursing home by telling Stafford that she had a Shih Tzu named 'Precious' that Stafford could see (R v McClintic, 2010; R v Rafferty, 2012a). McClintic and her boyfriend, Rafferty, took Stafford to a secluded wooded area outside of Guelph, Ontario, where Rafferty assaulted Stafford in his car and then stomped on and beat the girl with a hammer (Canadian Lawyer, 2012; R v McClintic, 2010; R v Rafferty, 2012a). Stafford died from blunt force trauma to her head and body, including a lacerated liver, fractured ribs, and skull fractures (Blatchford, 2012; R v McClintic, 2010; R v Rafferty, 2012b).

At the time that McClintic confessed to kidnapping Stafford, the girl's body was yet to be found (R v McClintic, 2010). Stafford's body and her mother's butterfly earring she had worn to school, which was used to identify her, were found on July 19, 2009 (Blatchford, 2012). The body was found in an advanced state of decomposition to the point where some skeletonization was seen (R v Rafferty, 2012b). For identification, Stafford's earring and clothing, as well as dental records, were used (R v McClintic, 2010). First-degree murder was added to McClintic's charges, and the kidnapping charge was dropped (R v McClintic, 2010). McClintic's boyfriend, Rafferty, at the time was also charged with sexual assault, first-degree murder, and kidnapping, to which he pled not guilty but was found guilty on all charges (R v Rafferty, 2016). McClintic pled guilty and was convicted of first-degree murder on April 30, 2010 (R v McClintic, 2010). Rafferty still asserts that he was not guilty of his charges, that McClintic was the one to orchestrate the attack and that he was, at most, an accessory after the fact of the murder (R v Rafferty, 2016). However, McClintic asserts that Rafferty was the one to beat the girl; in her testimony in R v Rafferty, McClintic claims that she walked away from the vehicle where Rafferty had Stafford and was called back to the car when the girl's body was gone (R v Rafferty, 2012a). From this it is unclear whether it was a joint decision to abduct and murder Stafford or if either offender led the other to commit the crimes. Regardless, McClintic has admitted to murdering Stafford (R v McClintic, 2010).

### The nonconformist perspective on human nature and social control theory

Nonconformist perspectives follow the assumption that humans are unruly (Bartol & Bartol, 2016). This perspective argues that without social controls and rules and regulations to hold individuals in check, they would commit crimes without any regard for society (Bartol & Bartol, 2016). From this nonconformist perspective, Travis Hirschi's social control theory further perceives humans with weak or non-existent ties to society and attachment to society's normative standards as uncontrolled and more likely to commit a crime (Chriss, 2007; Church et al., 2009; Hirschi, 1969). As defined by Huebner and Betts (2002), societal bonds can come in the form of attachment and affection towards significant individuals and social institutions – such as parents, peers or schools – or investments an individual has to conventional lines of action or a goal common to society; the amount of time invested into conventional activities and buy-in to common or conventional values also creates stronger societal bonds (Huebner & Betts, 2002; see also Anderson et al., 1999; Chriss, 2007). Through these four elements of attachment, commitment, involvement, and belief, an individual's conformity to society is formed (Wiatrowski et al., 1981). Huebner and Betts (2002) found that within the four above mentioned main attachment bond variables, weak bonds between peers and adults, low quality of the paternal relationship and lack of time spent in the family, held a significant correlation to antisocial behaviour. Relationships with parents form a solid base for an individual's attachment as parents teach appropriate behaviour and act as role models (Wiatrowski et al., 1981).

Social control theory can be highlighted in the case of Terri-Lynne McClintic due to her difficult childhood and lack of positive parental influence, which arguably impacted her ties to society

and normative standards. McClintic lacked not only attachment but also commitment, involvement and belief in common societal functions, values, and goals. The court noted this disconnect in the *Vetrovec* warning proceedings in 2012 regarding McClintic's testimony against Rafferty (R v Rafferty, 2012c). Her childhood criminal background, letters written in detention centres, and musical choices expressed vicious imagery including an enchantment with death rap, which showed her extensive history of violence and pugnacious tendencies (R v Rafferty, 2012c). Anderson et al. (1999) found that the delinquent behaviour of young girls was reduced with greater attachments to school and friends. Due to the transient and high-risk nature of McClintic's adoptive mother and her mother's past career as a stripper, she faced bullying and alienation from her peers (The Canadian Press, 2012).

McClintic was known to consistently skip school and stopped attending school full time when she was roughly 13 (The Canadian Press, 2012), which may have pushed McClintic further towards a life of antisocial and risky behaviour. Further, Anderson et al. (1999) note that the strength of attachment to parental figures affects the attitudes towards and amount of alcohol that an adolescent may consume as the children would not have been taught to socialize appropriately and would increase recklessness. Forming strong familial ties became impossible for McClintic as her adoptive mother Carol McClintic as well as her mother's boyfriends engaged in drugs and alcoholism, and abused McClintic (The Canadian Press, 2012). Chriss (2007) found that weakened parental attachments in children are one of the most reliable predictors of future delinquency, as can be seen in McClintic's case by her use of alcohol and drugs at a young age (Wiatrowski et al., 1981). At the same time, this may be attributed to the added direct supervision given and time spent together when a parent and child have a strong bond (Chriss, 2007).

Rafferty was sent to live with his aunt and uncle in adolescence (The Canadian Press, 2012). This separation from his close family would indicate that he, like McClintic, did not have a strong parental relationship nor attachments. Like McClintic, Rafferty also had a drug problem and was known to take OxyContin and Percocet (The Canadian Press, 2012). Rafferty showed his violent tendencies through the sexual acts; during the trial 13 women reported that he would enjoy choking them during intercourse (The Canadian Press, 2012). Similarly, McClintic was known to fantasize about torturing of people, which was highlighted through her music tastes and the letters she wrote in which she detailed her fantasies (The Canadian Press, 2012). When McClintic's fantasies met Rafferty's aggressive and sexually violent tendencies, the antisocial and criminal activity of the two increased dramatically (The Canadian Press, 2012).

Rafferty and McClintic acted as catalysts to increase each other's delinquent behaviour. Herrera et al. (2010) found that intimate partners can facilitate and provide support for criminal behaviour and further reinforce antisocial tendencies. Many people enter relationships with other individuals who engage in similar activities and have shared characteristics (Carbone-Lopez & Kruttschnitt, 2010). For McClintic and Rafferty, these shared characteristics included criminality, drug use, and violent tendencies. Those involved in delinquent behaviour are more likely to be attracted to similar individuals and continue to increase their criminal actions with the escalation of the relationship (Carbone-Lopez & Kruttschnitt, 2010; Lee et al., 2020). This acceleration can be seen in McClintic's escalation from assault to murder with her relationship with Rafferty.

### Terri McClintic's youth

When McClintic was born, she was given to her mother's best friend, Carol McClintic, for reasons unknown to the public (The Canadian Press, 2012). They moved around Ontario for most of McClintic's early and middle childhood years. McClintic also moved through several foster homes (The Canadian Press, 2012).

Carol McClintic was a stripper before she adopted McClintic, a profession known for its transient and unstable nature. Carol McClintic also had a history of drug and alcohol addiction that led her to have violent outbursts towards McClintic. Due to her adoptive mother's lack of appropriate parental support or guidance, McClintic lacked connections to her peers and was further alienated (The Canadian Press, 2012). A critical developmental factor within the social control theory is positive parental influence and modelling, which was not present for McClintic (Hirschi, 2002, as cited in Church et al., 2009). Herrenkohl et al. (2000) noted that in violent environments, children model the behaviour of their close family members, such as parents, as violence is normalized as acceptable behaviour (see also Mallet et al., 2013). Church et al. (2009) show that ineffective parenting also increases the likelihood of creating aberrant behaviour in children (see also Brannigan et al., 2002; Barnhart & Maguire-Jack, 2016; Benda & Tollett, 1999). At the age of seven, McClintic started her stays with the Children's Aid Societies, in the Ontario foster system, and detention homes, which continued into her teen years (The Canadian Press, 2012). Studies have shown that youth who are incarcerated tend to have higher recidivism rates in later years (Benda & Tollett, 1999; Corrado et al., 2015; Mallet et al., 2013);

Due to her lack of positive relationships and connections to society –which may have potentially furthered her aberrant behaviour (Church et al., 2009) – McClintic was alienated from a young age, which made her more susceptible to delinquency and drug use. These extreme familial and relational stressors directly affect criminality and delinquent behaviour (Barnhart & Maguire-Jack, 2016; Church et al., 2009;), and as such, may have led to many of McClintic's criminal actions. As a child, McClintic was also physically and sexually abused (The Canadian Press, 2012; Tryon et al., 2012;), which furthers the potential for childhood isolation and future substance abuse (Bartol & Bartol, 2016; Cohen et al., 2003). Violence in the family, along with specific family characteristics, such as a lack of emotional availability, can increase the risk of problems in childhood, and some children with several risk factors can become more prone to future violence (Rutter, 1994). Furthermore, substance abuse, personality disorders, partner violence, and developmental delays can come from a high-stress environment, such as an abusive household, which can alter biological, psychological, and neurological functioning (Margolin, 2005; Corrado et al., 2015). High-stress environments can also be created by avoidant attachment styles of parenting and neglect (Corrado et al., 2015). Exposure to violence has been noted to cause subtle changes that can lead to children being less able to understand social cues, resolve interpersonal problems and recognize emotions in others (Margolin, 2005). As research indicates, abuse, alienation from peers, and neglectful parenting were all very strong factors in McClintic's functioning and future behaviour.

The constant movement, isolation, and lack of parental support caused McClintic to face harsh peer rejection in her early school years. Peer rejection at an early age has been linked to adolescent substance abuse and antisocial behaviour (Mounts, 2001; Prinstein & La Greca, 2004). In their study, Higgins et al. (2011) note that youth who have been rejected by their peers may have reduced social skills, lack the ability to develop social networks and hold negative feelings of loss (see also DeRosier et al., 1994). Rejected children have an increased likelihood of responding in an antisocial and aggressive manner with less ability to use coping or de-escalation techniques when met with peer conflict (Chen et al., 2015; Coie et al., 1992). This aggressive response to conflict is seen in McClintic's many convictions for assault as a teenager (The Canadian Press, 2012). McClintic's first recorded incident with the police service was at the age of ten when she was caught stealing from a hardware store. Theft further increased into assault after

punching her adoptive mother in the face at the age of 15, where she fractured her adoptive mother's cheekbone (The Canadian Press, 2012). This escalated into four more assault charges, one in a youth residence and three more in the youth detention centre (The Canadian Press, 2012). Two years before McClintic and Rafferty murdered Stafford, McClintic mugged two men and stabbed one in the back; she then hit a police officer in the back of the head during her arrest (The Canadian Press, 2012). Unless countered, social rejection by peers can serve to be one of the leading causes for the start of criminal behaviour (Higgins et al., 2011). Youth who commit crimes between the ages of 7 and 12 are two to three times more likely to become chronic, violent offenders, than those with a later onset of their criminality (Loeber & Farrington, 2000). This can be seen in the increase in criminality in McClintic, from theft to assault to murder.

As noted by Mounts (2001), peer rejection can lead to adolescent substance abuse, which is seen in the case of McClintic, who started using marijuana at the age of eight and then advanced into harder drugs, such as OxyContin, ecstasy, morphine, and antidepressants (The Canadian Press, 2012). At the age of 13, McClintic lost a portion of her memory due to an overdose (The Canadian Press, 2012). Carol McClintic was also an alcoholic and drug user and introduced McClintic to many of the substances that she would grow to abuse in her teens (Tryon et al., 2012; The Canadian Press, 2012). These risk factors culminated after February of 2009 when McClintic met Rafferty, and the couple committed the horrific murder of Stafford on April 8, 2009 (The Canadian Press, 2012). Substance use is considered a disorder when the drug use interferes with a large portion of life, such as work, relationships, or education (Barlow et al., 2018); this is seen in McClintic's educational performance and lack of peer relationships. Substance use disorder is considered an addiction due to the physiological dependence and withdrawal symptoms that a user experiences (Barlow et al., 2018). McClintic's drug use interfered not only with her school attendance and grades but also with her relationship with her adoptive mother (The Canadian Press, 2012). Substance use disorders are highly comorbid with other psychological disorders such as mood and anxiety disorders (Barlow et al., 2018; Quello et al., 2005). Youth who use illicit substances are more likely to have poor academic performance and participate in high-risk and antisocial behaviours (Bartol & Bartol, 2016; Crowley & Riggs, 1995). The path to substance abuse can be started as young as in toddler years if behavioural problems are not corrected (Sitnick et al., 2013). In the case of McClintic, due to her adoptive mother's drug and alcohol addiction (Tryon et al., 2012), her behavioural problems were not corrected, and instead were encouraged through positive reinforcement of antisocial behaviour.

McClintic's vulnerability and escalation to criminality are caused by the stacking risk factors in her life. When looking at a child's vulnerabilities and resiliency to stressors in their life, the adaptations to functioning give markers for each of these variables and the child's success (Margolin, 2005). Being able to shield oneself from a stressor and to have a healthy recovery from a said stressor is thought of as resiliency (Margolin, 2005). McClintic's drug use and lack of positive peer influence is an indication that her coping skills and resilience to stressors did not work to protect her from the negative stressors in her life.

## CONCLUSIONS

McClintic's motivation for antisocial behaviour that coalesced in the murder of eight-year-old Victoria Elizabeth Stafford is an intricate puzzle of a plethora of factors that make up McClintic's psychological state. Her lack of peer and parental support, non-existent ties to society and drug abuse demonstrate the risk factors stacked against McClintic. These extreme stressors have a direct effect on criminality and delinquent behaviour (Coie et al., 1992).

The McClintic case demonstrates how a lack of social controls can lead to criminality in adolescences. Implementing more social control mechanisms can assist in halting criminality before adolescence. While there is no way to know what would have happened to McClintic if her mother or adoptive mother were given the supports needed to provide a more nurturing life, reducing the many of the risks that she faced would have created more positive first years of life and, thus, would change the person whom McClintic would become.

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## Conflicts of interest

This author declares no conflicts of interest

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# Assessing Knowledge Status on Comfort Positioning in Pediatric Care: A Narrative Review

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**ABSTRACT** Pain prevention and comfort positioning are vital components of pediatric care, as they can help improve the experience of pediatric patients undergoing painful and/or traumatic medical procedures. A search of the literature was conducted for the purpose of assessing current best practice for comfort positioning and pain prevention in pediatric care facilities. Databases used in the search included CINAHL, US National Library of Medicine, National Institute of Health, and PubMed. The synthesis of findings from this search suggested a reaffirmation of the benefits of comfort positioning. It also suggests that pain prevention in pediatrics is extremely vital, as painful procedures without adequate comfort measures have been connected to the development of a fear of treatments and subsequently, avoidance of medical care. Outpatient clinics were observed for the purpose of assessing current practices to further assess healthcare workers' current knowledge of comfort positioning and determine next steps to further enhance pain prevention methods in pediatric care through practice standards. The observational findings highlight that there is an informal standard for comfort positioning within this hospital, despite no formal policy or practice guideline. It was observed that comfort positioning seems to be less effective for older children. Instead, they tend to prefer to be thoroughly educated on the procedure with open and honest communication to implement a feeling of having control. This suggests that comfort measures should expand beyond physical positioning, and instead expand into the way that healthcare professionals approach and speak about the procedures. These themes highlight a need to implement a set of guidelines for comfort positioning and pain prevention in pediatric facilities. Formal guidelines would encourage standardized and evidence-informed practice for pain management strategies.

## INTRODUCTION

Pain prevention and comfort positioning are vital in improving the experience of pediatric patients undergoing painful or traumatic medical procedures, as they can result in trauma and many long-term effects. This can include reexperiencing the event through flashbacks, avoidance of reminders of the trauma, and hyperarousal (Lerwick, 2016). Medical trauma can result in mistrust in healthcare systems leading to less adherence to treatment in the future, and thus causing poorer health outcomes (Kassam-Adams & Butler, 2017). Avoidance of healthcare can result in the patient allowing their condition to worsen significantly before having no choice but to access care (Kassam-Adams & Butler, 2017). Mistrust in the healthcare system is a major factor in the avoidance of healthcare as an adult (Leyva et al., 2020). This illustrates the need for preventing healthcare trauma, even in early childhood, as this can have lasting effects. Healthcare avoidance can cause delays in symptom presentation and treatment. Healthcare avoidance is also associated with increased morbidity and mortality, thus yielding adverse health consequences (Leyva et al., 2020). The majority of the literature examined suggests that practices like comfort positioning and pain prevention can prevent medical trauma in the pediatric population. The purpose of this project is to assess the current knowledge of comfort positioning and pain prevention in health literature, as well as assess practices at a pediatric hospital in Nova Scotia, Canada to assess current knowledge of comfort positioning and determine next steps to encourage standard practice.

Comfort positioning is a series of measures taken to provide a sense of emotional, as well as physical, security by limiting behaviours which can worsen the experience for the patient, caregiver, and healthcare professional (Children's Hospital of Philadelphia, 2017). Comfort positioning is a way of positioning the patient so they cannot interfere with care, similar to a restraint; however, comfort positioning tends to include resources which give the sense of safety rather than immobility, and avoids the exacerbation of a situation that restraint may cause. Intense negative reactions can be distressing for the parent to watch, for the child to experience, and for the healthcare worker to facilitate or observe. Pain prevention methods in pediatric care, as outlined by the Canadian Paediatric Society (2019), involve the encouragement of minimally invasive approaches and simple strategies to improve the healthcare experience. They suggest the use of topical analgesics for procedures which are necessary but may be acutely painful, as well as combining physical, psychological, and pharmacological pain minimization strategies (Canadian Paediatric Society, 2019).

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## LITERATURE REVIEW

### How knowledge was assessed

To begin the assessment of current knowledge, a literature review was conducted by using various databases such as CINAHL, US National Library of Medicine, National Institute of Health, and PubMed. The general consensus supported the practice of comfort positioning as a way to prevent medical trauma in the pediatric population. The literature review served as an introduction to comfort positioning and pain prevention, as well as a precursor to the observational aspect of this narrative review to assess the current knowledge of pain prevention in a tertiary care centre.

For the assessment of knowledge in a Halifax hospital, data were collected through observation and, in some cases, family or patient interviews. Data was observed – with verbal consent from the family, staff, and patients – in the following units: Ear Nose and Throat (ENT) Clinic, Orthopedic Clinic, Hematology/ Oncology Clinic, and Pediatric Assessment Clinic. A day for observation in the Dentistry Clinic was not possible due to scheduling conflicts, but the nurse educator was interviewed regarding the typical measures used. Observations were made regarding the patient's age, the procedure being done, the location in the Health Centre, the position of the patient during the procedure, the level of caregiver involvement, any prior educating, and the use of Child Life services if applicable. All interviews were conducted during routine appointments in the ENT clinic. The families were interviewed about past procedures, as most of the children had chronic illnesses and had undergone many procedures over the past few years. The family and patients were asked what they found helpful or unhelpful from the staff, in terms of minimizing pain and encouraging as much comfort as possible. Interview transcripts were compiled, and identifying factors were removed to anonymize the data.

### Findings of comfort positioning and pain prevention in existing literature

The literature found regarding comfort positioning suggests a reaffirmation of the benefits of comfort positioning. A study by Skaljic et al. (2020) involved pediatric patients on a dermatology unit. This study found that various methods of comfort positioning were shown to reduce patient stress and improve cooperation. A similar study by Piazza et al. (2019) focused on pediatric patients in need of blood draws and pain management methods used by phlebotomists. The most frequently used measures were verbal communication (explanations, reassurance, etc.), comfort positioning, and other means of distraction. This also tends to create a sense of familiarity and security, as opposed to restraints which may have the opposite effect. Piazza et al. (2019) used a survey style questionnaire to get patient/family feedback on comfort positioning used and found these measures greatly improved patient satisfaction. Improvement of patient satisfaction can re-establish the patient's trust in the healthcare system and prevent future health issues related to avoidance of healthcare.

The literature also suggested that pain prevention in pediatric care is extremely vital as childhood medical-related pain has been connected to the patient developing a fear of treatments, and thus an avoidance of future medical care (Ali et al., 2016). Unfortunately, a significant knowledge-practice gap exists wherein evidence-based interventions to manage such pain and distress are under-utilized (Shave et al., 2018). A study by King et al. (2011) highlights that chronic pain is a significant problem within pediatric medicine; however, the prevention and treatment of pain in pediatric patients is often inadequate and infrequent (Friedrichsdorf & Goubert, 2019). Friedrichsdorf & Goubert (2019) advocate for the prevention and treatment of pain in children with recommended analgesic starting doses.

### Observations of comfort positioning and pain prevention in the Halifax hospital Pediatric Assessment Centre (COVID-19 Testing Facility)

In the Pediatric Assessment Centre (PAC), nasopharyngeal swabs on children aged 6 months to 12 years were observed. For these procedures, they first assessed if the patient can independently tolerate the swab. Then, they placed the child on the caregiver's lap so the caregiver could hold their child. Children who needed positioning were typically under 6 years old, so they were on their caregiver's lap. The caregiver hugged the child with one arm so that they were keeping both the child's arms down and out of the way. Their other hand was used to hold the child's head still. Older children did not require positioning during this round of observation and tolerated the procedure well. Caregivers were instructed on how to position their child, and the nurse would explain the procedure in age-appropriate terms (using phrases like "I am going to tickle your nose", "I need to get some boogers from you", etc.). If the comfort position did not work, the next step would be to have the patient remain in the caregiver's lap, but have a nurse perform the hold. If this was unsuccessful, they would have 1-2 additional nurses assist with the hold and have the parents comfort the child after the procedure.

### Hematology/Oncology Clinic

In this clinic, Port-A-Cath accesses in children ages 4-6 years were observed. In one procedure, the caregiver was sitting behind the patient in bed with the patient in their lap, as per comfort positioning. Additionally, the caregiver put their legs over the child's legs for safety. In another procedure, the caregiver was beside the bed on a chair holding the child's hand. Topical anesthetic was used in most cases and some patients preferred distraction methods such as chewing gum, watching videos on the iPad, and more.

### Ear Nose and Throat Clinic

In the Ear Nose and Throat (ENT) Clinic routine appointments involving otoscopes and nose/throat exams for trajectory of pre-existing ENT conditions for children ages 3-8 years were observed. In these assessments, the methods of comfort positioning were the same for many different assessments. The first step was to have the patient sit on the caregiver's lap. The caregiver used one hand to stabilize patient's head, and the other hand to hold the patient's arms down. After one appointment, the parents were interviewed and since both their children underwent many frequent procedures in the last several years, they were accustomed to different tactics of positioning and knowledgeable as to what was most helpful. Upon being asked what made the procedures more comfortable and the caregiver said they appreciated the nurses doing the positioning and letting them comfort their child afterwards, as positioning can be traumatic for the caregivers as well. Patients who were interviewed stated things like "I appreciated being told 'this likely will hurt but I will be here for you to help any way I can.', instead of saying it will not hurt when they know it will hurt". They also stated appreciating receiving education prior to the procedure, so they feel like they "have a sense of understanding of control."

### Orthopedic Clinic

In this clinic, Peripherally Inserted Central Catheter (PICC) line removals were observed. During this procedure, the patient was sat on another nurse's lap with PICC arm stabilized and the other arm held down. In this case, the caregiver opted to not be involved in positioning, instead providing comfort after the procedure. The patient was shown how a PICC line will be removed on a doll and then was offered the chance to take the doll's "PICC line" out. This was to give the child some understanding of the procedure to limit

fear. Cast removals were also observed in this clinic. In this procedure, the patients were offered earmuffs to mute the noise of the cast cutter. The patient was sitting on the edge of the bed with casted arm on a pillow. The caregiver was beside the bed providing emotional support and holding other hand.

### Dentistry clinic

In this clinic, observation was not possible due to scheduling conflicts; however, the nurse educator was contacted and was available for interview on positioning used in the clinic. They mentioned that typical positioning included having the patient sit facing their caregiver, then lean back and lay their head into the working space for the dentistry staff.

### Limitations

The main limitation for this project was the lack of diversity in the age of the children. Many of the children observed were under the age of 12, because the older children generally did not require positioning. This results in many of the comfort measures listed being catered to children who are young enough to still feel comforted by their caregiver's embrace. Many of the comfort measures surround being held by the parents, but for an older child to be held down, this may feel more restraining than comforting. The lack of older children undergoing observed procedures for the duration of this project limits this project from providing care guidelines for positioning an older child and could be a direction for future studies.

Another limitation was the hesitancy to interview families following a traumatic procedure. The interviews were limited to one clinic and may not have applicable information to other clinics in the Health Centre. A future project which should include patient and family input and may benefit from a survey style questionnaire that could be done at home by the patient and family. This procedure would allow patients and family to answer the questionnaire in the comfort of their own home.

The final limitation noted for this review was the limited timeframe, and thus limited number of units observed. Future studies may benefit from assessing more units to access a larger sample population, and consequently observe a wider variety of practices.

### Discussion of current practices

The observational findings in this study suggest that there is a standard for comfort positioning within this hospital, despite the absence of a formal policy or practice guideline. The literature review and observational findings led to the establishment of practice guidelines for the Health Centre that are awaiting approval and implementation. Overall, a central theme noted was that comfort positioning is effective for younger children but may be less effective for children over the age of six, as they were observed to refuse comfort positioning methods, and instead preferred to be thoroughly educated on the procedure. One patient even stated they felt it gave them a "sense of understanding or control". This suggests that comfort measures should expand beyond physical positioning and be incorporated into the way healthcare professionals approach and speak about the procedures with children 12 and older.

### Implementation of new comfort measures practice guidelines

The observational findings in this study suggest that there is a standard for comfort positioning within this hospital despite the absence of a formal policy or practice guideline. The literature review and observational findings led to the implementation of practice guidelines for the Health Centre. We used the existing

practices (such as: placing the patient in the caregiver's lap, having the care giver "hug" the child to hold them still, having the caregiver hold the head still if the procedure involved the face, and other previously mentioned observations) as a template for formal guidelines and supplemented the guidelines with existing literature from other hospitals and what their standards are. These guidelines are now publicly accessible and can be used to support change and implement guidelines in other establishments. These guidelines can also be used to support future pain management policies. Furthermore, the discussion of comfort positioning is now used for the training of all clinical staff at this hospital, and these guidelines can help assist this training. All these uses will ultimately contribute to minimizing pain and encouraging comfort in painful procedures.

### Incidence and impact of pediatric medical trauma stress

Current literature suggests that pain prevention and comfort positioning are vital to preventing medical trauma which can result in many negative long-term effects. Kassam-Adams and Butler (2017) define pediatric medical traumatic stress (PMTS) as "psychological and physiological distress responses related to their medical event and subsequent medical treatment experiences—which can lead to symptoms of posttraumatic stress disorder (PTSD) and suboptimal health outcomes". These reactions can include reexperiencing, avoidance of reminders of the trauma, hyperarousal, and more (Lerwick, 2016). Painful or frightening experiences in care can be psychologically traumatizing for pediatric patients. Trauma symptoms related to medical events are often associated with poorer health outcomes including decreased adherence to treatment or poorer health-related quality of life for up to two years posttreatment (Kassam-Adams & Butler, 2017). An additional systematic review by Price et al. (2016) extracts literature around PMTS and suggests that it is involved in many pediatric medical cases, across a wide variety of illnesses and acuity. This suggests that PMTS is not localized to one type of care intervention but present throughout. Lerwick (2016) also found that a variety of episodes of care – including preventive clinic visits, acute care, medical procedures, and hospitalization – can all be just as traumatizing for pediatric patients for a variety of reasons. Restraint, painful procedures, unknown environments, panicked looks from healthcare professionals and parents, expressions of grief without explanation, and so many more factors can all contribute to the experience leaving a negative memory in the pediatric patient's mind.

These traumatic events and negative memories have many long-term effects as well. Adams & Butler (2017) highlight in their article that medical trauma can result in mistrust in healthcare systems leading to less adherence to treatment in the future, and thus causing poorer health outcomes. This underscores how vital it is to maximize patient satisfaction whenever possible. Avoidance of healthcare can result in the patient allowing their condition to worsen significantly before having no choice but to access care. Leyva et al. (2020) performed a data analysis on the reasonings for medical care avoidance in older adults. They found that mistrust in the healthcare system was a catalyst in the avoidance of healthcare as an adult. This illustrates the need for preventing healthcare trauma, even in early childhood, as this can have lasting effects. Healthcare avoidance can cause delays in symptom presentation and treatment and is associated with increased morbidity and mortality, thus yielding adverse health consequences (Leyva et al., 2020).

### Specific challenges in pediatric care

The main challenge within pediatric care is the involvement of the family and involving them in care. Painful or stressful events can result in high levels of post-traumatic stress among not only the

patients, but the family as well. This highlights the importance of family-centered care and considering the effect that treatment may have on the family. Viewing a loved one experience a traumatic event may also result in stress. Family-centered care can also ensure the child has adequate supports post-treatment to help them heal. The National Child Traumatic Stress Network (2017) outlines the many barriers to healing from trauma including: financial or economic struggles, scheduling conflicts (school), lack of access to transportation, or lack of access to childcare. They also indicate that family engagement can help significantly improve the likelihood of success in trauma treatment. Similarly, having the parent be a person of comfort following a painful procedure can have a similar effect. Therefore, engaging the family, whenever possible, in their child's care can ultimately benefit the patient and improve their experience.

Further complicating this aspect of pediatric care are the restrictions involved with the COVID-19 pandemic. Nova Scotia Health Authority (2021) has established restrictions on who can accompany a patient into their care. If procedures are reoccurring, the patient may have gotten used to specific person joining them. With these restrictions, significant changes to routine may also be a factor of stress with medical procedures. Additionally, if a patient feels secure with both parents but is only allowed one support person, they may feel distressed and focused on the caregiver that cannot join them. Younger kids who may not understand the implications of the pandemic and the reasoning behind the restrictions may also feel confused which can add further stress (Virani et al., 2020).

## CONCLUSIONS

Pain prevention is a vital aspect of pediatric care, involving many aspects, including comfort positioning which had been observed in this study to increase patient satisfaction. Comfort positioning should include the way that healthcare professionals approach and speak about the procedures. These procedures play a vital role in preventing significant trauma for both the patient and their families, which can result in several negative long-term effects. These all help improve healthcare experiences, not only for the patient, but also for their family or accompanying caregivers as well as healthcare providers.

Implementing these measures and creating a formal practice guideline can help improve patient satisfaction and reduce medical trauma in pediatric care. Continuing to use existing pain prevention methods, and to create a focus of trauma prevention in pediatric care, can help prevent negative associated health risks and future healthcare avoidance.

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## Conflicts of interest

This author declares no conflicts of interest

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# Impact of the COVID-19 Pandemic on Medical School Aspirants: A Narrative Review

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**ABSTRACT** Applying to medical schools in North America is a highly competitive and complex process which requires years of preparation. With the widespread implementation of lockdowns and restrictions to curb the spread of COVID-19, medical school aspirants faced additional hardships applying to medical schools in North America during the pandemic. This review examines the impacts of the COVID-19 pandemic on North American medical school aspirants based on literature published before July 2021. Medical school applicants in North America faced disruption to elements of the medical school application, including the Medical College Admission Test (MCAT), non-academic activities, and the diminished ability for physical interaction and attendance of classes. Multiple aspects of the medical school application process have been drastically impacted and augmented by an increase in financial stress, with a ripple effect on mental health in the student population. These effects are being addressed by eliminating MCAT rescheduling and cancellation costs, offering virtual volunteering opportunities, holistically evaluating medical school applicants, and raising awareness about mental health services.

## INTRODUCTION

Medical school aspirants, commonly known as pre-medical students, are enrolled in an undergraduate program with hopes of pursuing medical school education (Adams O'Connell & Gupta, 2006). In North America, the pursuit of medical school education requires the acquisition of strong grades, top MCAT scores, and ongoing engagement with extracurricular activities (Lin et al., 2013). Additionally, North American medical schools have their own unique eligibility requirements for admission.

The impacts of COVID-19 on this student population, and subsequently medical school entrance, are likely to be long-ranging and bear the need for detailed analysis. This narrative review examines the impact of the COVID-19 pandemic on medical school aspirants, specifically the effect on undergraduate training, exam preparation, extracurricular activities, financial hardships, and mental health. It aims to evoke awareness and initiate discussion for this population, which will potentially help drive policy changes.

## LITERATURE REVIEW

### Impact on Undergraduate Training

Efforts to curb the spread of COVID-19 included the switch of nearly all post-secondary institutions in North America to remote learning (Ortiz, 2020). This unprecedented change required instructors to modify their course content, along with some lectures and laboratories being suspended. Zoom, a collaborative video conferencing service, has been primarily used by many institutions and instructors to convey the lecture content and course material to the students (Serhan, 2020). The features of Zoom, such as a virtual white board with annotation capability, breakout rooms, polls, chats, and recording for future reference, allow online learning to be interactive. To examine the American students' perception of Zoom, Sehran (2020) conducted a qualitative study through a survey. Despite the advent of such a collaborative tool making remote learning convenient, he concluded that students were dissatisfied with their online learning experience amid this pandemic. Students faced greater number of distractions, a lower quality of interaction with others, poor education quality, and technical difficulties. His study showed that students preferred a traditional learning environment that involved face-to-face interaction with the instructor and felt an overall negative impact on their learning. His findings are in concordance with another study that demonstrated similar findings of undergraduate students favoring a traditional learning platform rather than online (Roy et al., 2020). This dissatisfaction in remote learning has been shown to negatively affect learners – medical school aspirants in this context – as they need a strong foundation of learning in their undergraduate courses to excel on the MCAT exam, and hence gain acceptance into medical school. It is important to consider that medical school aspirants are also undergraduate students being impacted by online learning. As such, the findings of these studies (Sehran, 2020; Roy et al., 2020) can be applied to them as well.

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The closure of in-person laboratory courses, which are arguably central components of applied learning, impacted pre-medical undergraduate students (Vasiliadou, 2020). Many faculties require laboratory courses for students to learn different techniques and the crucial skills needed for their future endeavours in academia, along with fulfilling their graduation requirements. The MCAT exam also tests the individual's knowledge on laboratory techniques, for which some medical school aspirants prepare by taking laboratory courses (Steed & Kadavakollu, 2019). In addition, medical schools in the United States have science prerequisites, making both Canadian and American students take science courses prior to applying to American medical schools, which include laboratory classes. To compensate, post-secondary institutions introduced virtual laboratory courses, so that undergraduate students could progress towards a fulfilling education with minimal disruptions. These, however, cannot fully emulate physical experiments and ensure the same level of learning which were previously attained in a physical laboratory, putting undergraduate medical school aspirants at a great disadvantage.

Furthermore, an online poll determined that 49% of undergraduate students felt that the pandemic negatively impacted their ability to complete their bachelor's degree (Jagannathan, 2020). Crowdsourcing data collection by Statistics Canada (2020) (Doreleyers & Knighton, 2020) with students enrolled in a post-secondary institution showed that approximately 26% had some of their courses delayed, or even cancelled, because of the pandemic. The data depicted that 41% of individuals in programs related to health-care fields faced one of the highest disruptions in their education (Doreleyers & Knighton, 2020).

### Impact on the MCAT Exam and Preparation

The MCAT is an important metric that medical school admissions use to evaluate an applicant (Association of American Medical Colleges, 2020a). This standardized test is developed and administrated by the Association of American Medical Colleges (AAMC), with the purpose of helping the medical school's admission committee determine if the applicant is academically prepared and capable of succeeding in medical school. Medical school aspirants spend, on average, 264 hours studying for this exam (Wynn, 2020). A survey by AAMC (2020a) reported that 56% of these students use the Khan Academy MCAT collection to prepare, while 41% (Association of American Medical Colleges, 2020a) take university courses or a paid preparatory course to prepare for the exam (Association of American Medical Colleges, 2020a). The COVID-19 pandemic impacted the quality of MCAT preparation for medical school aspirants, as paid prep courses adopted an online learning format rather than teaching in person. Despite it, some students still took the online prep course with goals of doing well on the MCAT (Prep101, 2021).

The COVID-19 pandemic led AAMC to adopt changes to the MCAT exam (Association of American Medical Colleges, 2020a). Considering the severity of this pandemic, public health officials implemented various measures to reduce the spread of COVID-19 in the context of the MCAT. This resulted in AAMC cancelling all MCAT testing dates for the months of March and April, and resuming on May 29, 2020 (O'Connell, Kemp, & Alam, 2020). Individuals planning on taking the MCAT exam were requested to reschedule (Marr, Wooten & Sandhu, 2020). The AAMC waived rescheduling and cancellation fees to provide individuals with the flexibility of making changes to their MCAT schedule as needed. In order to accommodate the many cancellations, the AAMC added several more dates throughout the summer months; on each day, the MCAT exam was provided three times. In addition, the AAMC introduced a shortened version of the MCAT exam of 5 hours and 45 minutes, rather than the regular 7 hours and 30 minutes (Association of American Medical Colleges, 2020a). While the content in the shortened version of the MCAT exam remained the same, the results were reported within 14 days rather than the regular 30 days, with attempts to prevent further delay of medical school applications (Dowd, McKenney, & Elkbuli, 2021).

The shortened version of the MCAT exam was to be taken in person, at testing centers within the individual's state or province, which placed the individual, their families, and the employees at a greater risk of contracting the virus (Marr et al., 2020). This led to many students making the difficult choice of taking the MCAT exam and incurring the risk, in order to complete their application process. Otherwise, they would have been deemed ineligible to apply to most medical schools. For those individuals who did take the MCAT exam, they reported that not all testing centers implemented ideal COVID-19 screening protocols. A survey as stated by Marr et al. (2020) mentioned that 58.2% of the individuals that took the COVID-19 MCAT exam reported no screening at testing centers, thereby increasing the risk of individuals contracting this virus.

The shortened MCAT exam consisted of fewer breaks and no tutorial for the test-takers (Marr et al., 2020). Individuals were not given preparation material that was modified to reflect the shortened version of the MCAT, therefore putting these individuals at a disadvantage compared to the individuals that took the exam prior to the pandemic. Although the AAMC provided flexibility by adding multiple test dates and times, the increased stress and anxiety, greater financial burden, and a higher risk of contracting the virus, in addition to the drastic change to remote learning and overall disruption to the process, carried a significant – yet unmeasured – impact on both the MCAT preparation and the exam score. In 2021, the MCAT exam will take the regular 7.5 hours with results provided in 30-35 days (Association of American Medical Colleges, 2021). The AAMC only offers full-length exams that simulate the actual test day conditions of 7.5 hours, rather than the COVID-19 exam of 5.5 hours.

### Impact on Extracurricular Activities

Along with academic assessment, medical schools also evaluate the strength of the application based on their passion for medicine as demonstrated through extracurricular activities (Marcus, 2020). These broadly encompass community service, volunteer work, research experience, and employment endeavours. Extracurricular opportunities are not only important for the medical school application process, but they also help students determine whether medicine as a career is a good fit.

Most medical school aspirants volunteer at a hospital, a care home, a research lab, or other places that offer hands-on experience to gain exposure to the medical field (Bhatt & Bhatt, 2020). The COVID-19 pandemic resulted in the cancellation of many potential or planned extracurricular opportunities, along with the suspension of current positions, as these required in-person contact with front line staff and/or patients, including critically-vulnerable populations (Bhatt & Bhatt, 2020). As a result, numerous aspirants were faced with potentially career-altering challenges. Since this student population straddles multiple disciplines and undergraduate programs, due to medical schools actively seeking diverse undergraduate experience in their candidates, robust data on the impact on this student population is difficult to compile.

Nevertheless, new extracurricular opportunities arose (Bhatt & Bhatt, 2020). Virtual volunteering became a way for medical school aspirants to give back to the community in a safe manner. For instance, some aspirants started online tutoring while others volunteered as translators (Moon, 2020). While virtual volunteering is a rewarding opportunity to give back to the community, it does not substitute the in-person volunteering experience that allows for exposure to the medical field in a more direct manner (Bhatt & Bhatt, 2020).

Many medical school aspirants utilize the summer break to take part in extracurricular activities (Marcus, 2020). However, the COVID-19 pandemic significantly disrupted these plans. A survey mentioned by Marcus (2020) reported that for 52.4% of students, COVID-19 resulted in cancellation of their extracurricular positions in the summer. Extracurricular activities were altered to adapt to the new normal for 35.7%.

The medical school admission committees do acknowledge these challenges, and therefore decided to evaluate applicants holistically (Kowarski, 2020). A survey by Kaplan reported that 93% of medical school admissions committee are understanding and therefore flexible with the application process, allowing students to explain the impact of the pandemic on their lives

(Czajkowski, 2020). Alongside, medical schools are looking for applicants that have stepped up and made a difference in their community during this difficult time (Moon, 2020). The admissions dean of medical schools discussed adjusting expectations by evaluating records of extracurricular activities performed throughout the student's overall journey, as opposed to the COVID-19 year(s) in isolation (Murphy, 2020).

### Impact on Mental Health, COVID-19 Infection Risk and Financial Health

Mental health is a prominent issue among medical school aspirants as they face tremendous levels of stress, anxiety, and uncertainty of gaining admission into medical school (Espinal, 2020). Studies have shown that prior to COVID-19, undergraduate medical school aspirants faced higher levels of burnout (Sahu, 2020) and depression (Fang et al., 2010) as compared to non-medical school undergraduate aspirants. Although the pandemic resulted in a greater impact on mental health for population at large, including that of undergraduate students, it is likely that the mental health of medical school aspirants may have been affected more compared to non-medical school aspirants (Fang et al., 2010). This is because medical school aspirants have still taken on a heavy workload both academically and non-academically, in their desire to gain admission into medical school (Espinal, 2020). Furthermore, medical school aspirants are known to be well-accomplished in terms of having high marks, strong MCAT scores, along with unique extracurriculars, and therefore often compare themselves to other medical school aspirants. During this pandemic, individuals – including medical school aspirants – lost their jobs and faced financial hardships, and with the increase in cost of undergraduate tuition at some universities, this contributed to detriments in mental health (The Canadian Press, 2020).

Current medical students are looking into the option of collaboration within the culture of prospective medical students, with aims of having a positive impact on the mental health of these aspirants (Espinal, 2020). Their idea of collaboration refers to increased group work in courses, as this is a longitudinal aspect of the medical career. While medical students tend to be part of tighter-knit programs with extensive well-being resources, medical school aspirants may not have access to these processes provided by post-secondary institutions, hence there is an acute need to create awareness and encourage this student subpopulation to seek help. The use of social media and networking is prominent among medical school aspirants (Kind & Evans, 2015), allowing them to reach out to other like-minded students and create an online prospective medical society.

### Measures Being Considered or Adopted, Aimed at the Medical School Aspirant Population

This pandemic changed the outlook of life and affected medical school aspirants. Medical schools adopted a holistic file review, which includes the applicants' opportunity to explain their life situations and the impact of them on their journey, such as the discussion of COVID-19 (Espinal, 2020). Virtual interviews were conducted, providing medical school interviewees with more safety against the virus and greater accessibility. Some healthcare professionals believe that the pandemic has laid bare both the uncertainty and unpredictability of the medical field (Herzog, 2020; Liu, 2020) and the importance of training aspirants to embrace the unknown. This, however, must reliably mirror actionable endeavours to reach out to those who will become eventual medical school candidates.

### CONCLUSIONS

Medical school aspirants carry out efforts on multiple levels to accomplish admission into medical school. This involves a high level of academic achievement, accompanied by exceptional MCAT exam results and extensive extracurricular activities, often ranging over the course of multiple years. The COVID-19 pandemic has affected students at all levels and of all interests. In the context of medical school aspirants, this is exemplified by the changes in the MCAT exam and timeline, extracurricular activities, and mental health. Efforts to address some of the impacts involve waiving the rescheduling and cancellation fees of the MCAT exams, introducing virtual volunteering opportunities, evaluating

medical school applicants holistically, and increasing awareness about mental health resources. These students carry a significant burden of stress and the COVID-19 pandemic carries great propensity for a long-ranging impact – lasting possibly years – as it disrupts processes and career aspirations. This is a student population that may also take on a greater risk to personal safety during the COVID-19 pandemic in order to accomplish their career goals, and hence require additional supports.

### Conflicts of interest

The author declares no conflicts of interest.

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# Leptin and estrogen signaling crosstalk in the brain modulates energy metabolism

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**ABSTRACT** Leptin and estrogen are key hormones in regulating feeding, metabolic health, and body weight. In this review, we explore how the interaction between leptin and estrogen may modulate body weight through changes in metabolism and feeding behaviour. A significant proportion of arcuate neurons co-express receptors for leptin and estrogen, providing ample opportunity for signal crosstalk to occur in the brain. We conducted a narrative literature review and identified the major mechanisms through which leptin and estrogen interact, with a focus on signal transduction pathways. G-protein coupled receptor 30 (GPR30) is a good candidate for an inter-pathway connection because it interacts with estrogen receptors and affects the activation of signal transducer and activator of transcription (STAT3), an important downstream factor in both estrogen and leptin signaling pathways in the hypothalamus. Evidence suggests that estrogen and leptin receptors both utilize hypothalamic STAT3-activating pathways to modulate appetite and lipid storage, and that these pathways may depend on one another for adequate activation. While there are some physiological results to support this point of connection, the cellular and biochemical details remain unclear. Better understanding how leptin and estrogen interact will better inform the treatment of metabolic disorders, including type 2 diabetes, obesity, and post-menopausal weight gain.

## INTRODUCTION

Energy balance is key for homeostasis and is the net result of energy intake through feeding minus energy expenditure through exercise and metabolism. When energy intake chronically exceeds energy expenditure, obesity results, which can lead to comorbidities such as type 2 diabetes (T2D), atherosclerosis, and some cancers (Apovian, 2016). Due to the availability of high-calorie, inexpensive processed foods, obesity has become an epidemic worldwide, contributing to healthcare overburden and patient suffering (Di Cesare et al., 2019). Increasing exercise and decreasing caloric intake can ameliorate obesity but these outcomes have proven difficult to attain and understanding why this is so remains an important question in health research. This uncertainty is due, in part, to the complexity of energy-regulating circuits in the brain (van Swieten et al., 2014). Characterization of the neuroendocrine action of hormones such as leptin and estrogen may provide the insight needed to better understand and manage metabolic diseases, thus reducing the burden of obesity and its associated comorbidities on healthcare.

Leptin stimulates orexigenic and inhibits anorexigenic neurons, and therefore plays a critical role in reducing food intake, regulating body weight, and controlling energy homeostasis (Pellemounter et al., 1995). Studies have reported that patients with rare homozygous leptin gene mutations have low blood leptin levels and increased obesity (Strobel et al., 1998). However, when patients with such leptin deficiencies are treated with leptin therapy, food intake is reduced and metabolic decompensation resolves, demonstrating that leptin plays an integral role in regulating body weight in humans (Farooqi et al., 1999). Paradoxically, leptin is replete in obesity, though its signaling pathways appear to be disrupted by negative feedback mechanisms such as SOCS3 (Ernst et al., 2009). Like leptin, estrogen contributes to decreasing food intake and increasing energy expenditure (Farooqi et al., 1999; Asarian & Geary, 2002). Studies have indicated that treating ovariectomized rats with estrogen therapy results in decreased body weight (Babaei et al., 2017). This illustrates the importance of estrogen in managing body weight and raises the possibility of signaling overlap with leptin.

This review aims to better characterize the relationship between estrogen and leptin at the level of STAT3 activation in hypothalamic neurons. To achieve this, we searched for peer-reviewed articles containing the keywords “estrogen,” “leptin,” “STAT3,” and “hypothalamus” using Medline, PubMed, and Google Scholar. Though it is well-established that leptin and estrogen have overlapping metabolic roles in reducing food intake and body

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weight, it is not yet clear if leptin and estrogen interact with each other's signaling pathways to regulate energy metabolism. Therefore, we will discuss the roles of estrogen and leptin in health and metabolic disease, their effect on the signal transducer STAT3, and how this molecule may link the pathways of these two important hormones.

## LITERATURE REVIEW

### Leptin's role in energy metabolism

Leptin is a 167-amino acid hormone that is produced in adipose tissue and acts as a master regulator of metabolism (Zhang et al., 1994). Leptin maintains energy homeostasis by informing the body about its energy stores and subsequently mediating neurological and metabolic changes to modulate body weight and appetite accordingly (Park & Ahima, 2015). To perform these functions, leptin primarily targets hypothalamic neurons, which then signal to peripheral organs of metabolic import including the liver, skeletal muscles, and pancreas. However, leptin also functions outside of the central nervous system (CNS) to affect rates of glucose and lipid metabolism in adipose, liver, and the immune system (Pereira et al., 2021; Denroche et al., 2012; Gray et al., 2010). Importantly, this includes maintaining insulin sensitivity in adipose and skeletal muscle, which is likely a key component of leptin's gluco-regulatory effects (Bates et al., 2005) and ability to regulate body weight.

The majority of leptin's weight-regulating effects are mediated by its action on neurons of the energy regulating centres in the brain. Once leptin travels through the bloodstream and crosses the blood brain barrier, it binds to leptin receptors (LepRs) present on hypothalamic neurons such as those in the arcuate nucleus (ARC). Leptin activates anorexigenic (appetite suppressing) neurons, which are responsible for the production of neuropeptides such as pro-opiomelanocortin (POMC) and cocaine- and amphetamine-regulated transcript (CART) (Cowley et al., 2001). Conversely, leptin inhibits orexigenic (appetite inducing) neurons, which are responsible for the production of agouti-related peptide (AgRP) and neuropeptide Y (NPY) (Cowley et al., 2001). When circulating leptin is deficient, AgRP and NPY are secreted by orexigenic neurons, while anorexigenic neurons decrease their expression of POMC and CART (Park & Ahima, 2015). Several metabolically important peptides, such as insulin and glucagon-like peptide-1, can alter leptin's ability to activate hypothalamic neurons and highlight the importance of hormonal interactivity in regulating energy homeostasis (Williams et al., 2006).

The concentration of circulating leptin is directly proportional to the amount of adipose tissue, suggesting that obese individuals produce more leptin as their bodies are less sensitive to the peptide hormone (Cowley et al., 2001). However, recent findings have suggested that restricted leptin entry to the CNS provides a novel method of leptin resistance (Duquenne et al., 2021). There are several other mechanisms, such as soluble leptin receptors in the blood, that decrease leptin availability and may dampen leptin's ability to reach the CNS (Tu et al., 2006). Any processes that significantly alter the body's perceived level of leptin invariably show metabolic disruption.

Leptin's homeostatic importance is illustrated by metabolic perturbations that are exhibited in conditions of leptin excess or deficiency. For example, obese subjects can have ten-fold higher than normal levels of leptin due to the linear relationship between adipose mass and serum leptin, which drives resistance to both leptin and insulin and further exacerbates weight gain (Zhao et al., 2019). Excess serum leptin in obesity may cause leptin resistance by increasing SOCS3, a negative regulator of the leptin signaling pathway (Ernst et al., 2009). Conversely, leptin deficiency seen in lipodystrophy syndromes induces insulin resistance and hypertriglyceridemia. Leptin replacement therapy in lipodystrophic patients restores metabolic functions such as glycemic regulation and fat metabolism (Oral et al., 2002; Chong et al., 2010). Leptin likely mediates this effect by restoring the adipose tissue, which is a key target for insulin action. In rodent models of type 1 diabetes, leptin corrects high plasma glucose

levels by lowering hepatic glucose production and by increasing tissue uptake of glucose independently from insulin (Paz-Filho et al., 2012). These examples show the importance of serum leptin concentration to metabolic health.

Leptin is also a key regulator of appetite and leptin deficiency causes hyperphagia and obesity in humans as well as animal models. This can result from the inadequate production of leptin, as seen in the obese (ob/ob) mice, or from leptin resistance, in db/db mice, caused by leptin receptor gene mutation (Paz-Filho et al., 2012). Dyslipidemia is commonly the earliest risk factor of atherosclerotic cardiovascular disease in obesity and is due to abnormal cholesterol and lipid levels seen in hyperleptinemia (Tsai et al., 2017; Du et al., 2016). Ravussin et al. (1997) have indicated a correlation in humans between low concentrations of leptin in the plasma and abnormally high gains in body weight over short periods of time, which ties together the body weight regulating activity of leptin seen in animal models to human physiology.

### Estrogen's role in energy metabolism

Estrogen is another important energy regulating peptide that acts in the hypothalamus. It may have functional overlap in intracellular signaling with leptin, allowing the two hormones to integrate nutrient information and together mediate changes in behaviour and metabolism. Estrogen is a sex hormone derived from cholesterol and not only affects the gonadal organs but also impacts liver, heart, muscle, and bone tissue in both sexes (Cui et al., 2013). Estrogen is mainly produced by the ovaries, and less in testes, adipose tissue, and brain. Four types of estrogen exist: estrone (E1), estradiol (E2), estriol (E3), and estrane (E4), with estradiol being the most potent and common form. As a steroid hormone, estradiol can freely diffuse across the plasma membrane to interact with the estrogen receptors (ER) located in the cytosol.

The two main subtypes of estrogen receptors, ER $\alpha$  and ER $\beta$ , are coded by genes located on different chromosomes (6 and 14, respectively) but both consist of six domains with distinct functions. Starting from the N-terminus, the A/B domains contain activation function 1, which acts as a regulator for ER's transcriptional activity. The C domain is responsible for ER's binding to specific DNA sequences to regulate their expression. The D domain is a hinge region containing a nuclear localization sequence and is where post-translational modifications occur. At the E domain, or ligand-binding domain, estrogen binds and interacts with co-regulators. Lastly, the F domain at the C-terminus modulates the receptor's activity. When estradiol binds, ER is phosphorylated, dimerizes, and travels into the nucleus to bind estrogen response elements in DNA, facilitating assembly of the transcription complex (Figure 1) (Lee et al., 2012). Transcriptional modification by ER shifts metabolism towards increased energy expenditure, increased proliferation, and improved cell survival (Charpentier et al., 2000).

On a macroscopic level, there are estrogen-dependent systemic differences that exist between the sexes. There is a higher prevalence of obesity among females compared to males, though males have been shown to be more likely to develop obesity-associated comorbidities which may be a result of how estrogen differs in men and women (Ng et al., 2014; Meyer et al., 2006; Onat et al., 2016). It has been established that healthy, pre-menopausal females exhibit a defense against metabolic dysfunctions compared to men, primarily ascribed to the activity of estrogen (Sharma & Prossnitz, 2021). In a study conducted to identify the sexual dimorphism in inflammation in obese mice, it was found that although the females had more adipose tissue compared to the males overall, they were also more tolerant to glucose. This finding supports estrogen's ability to protect against metabolic defects, including insulin resistance, diet-induced obesity, and similar disorders (Nickelson et al., 2012; Varghese et al., 2017). However, it is important to note that for estrogen, murine models are limited in their generalizability to humans and as a result, mouse models should be interpreted with caution (Elsea & Lucas, 2002; Springer & Murphy, 2007; Rader, 2004).

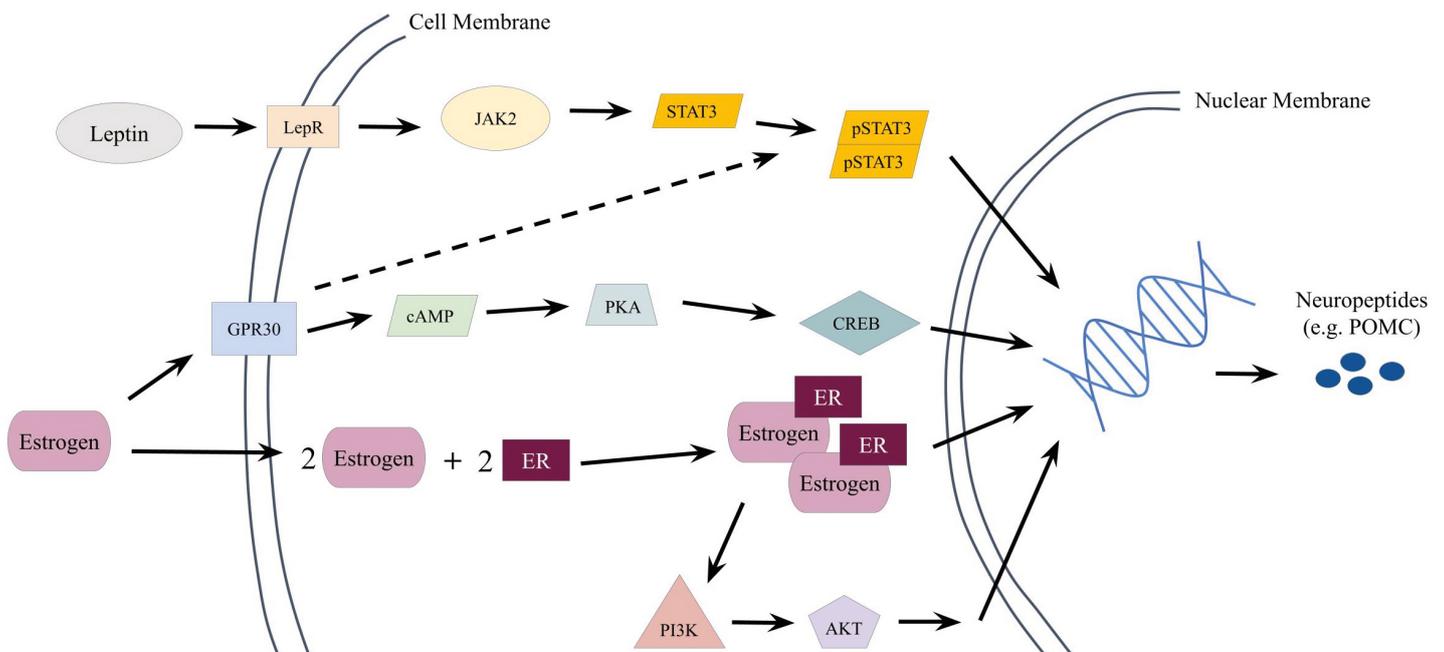


Figure 1 Signaling pathways of leptin and estrogen in hypothalamic neurons to indicate the proposed site of interaction between these hormones, indicated by a dashed arrow. All leptin and estrogen signaling pathways presented here are able to increase the mRNA expression of the orexigenic neuropeptide POMC, which can be translated into proteins such as alpha-melanocyte-stimulating hormone (not shown) to decrease appetite. Abbreviations: LepR, leptin receptor; JAK2, Janus kinase 2; STAT3, signal transducer and activator of transcription; p, phosphate group (some excluded for clarity); POMC, pro-opiomelanocortin; GPR, G protein-coupled receptor 30; cAMP, cyclic adenosine monophosphate; PKA, protein kinase A; CREB, cAMP response element-binding protein; ER, estrogen receptor; and PI3K, phosphoinositide 3-kinase.

A study conducted on 20 postmenopausal women attempting to identify the mechanisms related to T2D found that the people living with T2D have significantly higher estradiol concentrations compared to non-diabetics (Phillips et al., 2000). Moreover, elevated levels of estradiol have been implicated in being positively correlated with adiposity, further substantiating the relationship between estrogen, body weight, and T2D (Longcope et al., 1986).

A study by Varghese et al. (2017) proposed that as estrogen levels decline with age, menopause increases the proportion of testosterone in women, leading to increased visceral adiposity. Through the activity of testosterone, males store fat in visceral adipose tissue (VAT) preferentially to subcutaneous adipose, a pattern similarly seen amongst postmenopausal women (Bloor & Symonds, 2014). VAT is implicated in elevated inflammation as well as insulin resistance, and as VAT increases, the risk factor for metabolic disorders, such as obesity and T2D, increases as well (Smith et al., 2001; Meyer et al., 2011). Likewise, in a depressed estrogen state such as menopause, it has been identified that fat is redistributed in the body and the composition of VAT changes (Varghese et al., 2017; Pedersen et al., 2001). Heine (2000) showed that mice with knocked-out estrogen receptors had more white adipose tissue than control mice, as well as a significant reduction in energy expenditure. White adipose tissue functions as an energy storage depot by accumulating fatty acids and triglycerides after meals, and then releasing them when the body requires energy (Trayhurn & Beattie, 2001). Increased visceral adiposity, hyperinsulinemia, and overall increase in white adipose tissue may explain the weight gain experienced in a hypoestrogenic state.

Ultimately, it is evident that estrogen plays a critical role in body weight and energy homeostasis, as both an over- and under-production of the hormone result in metabolic disorders.

### STAT3: the link between leptin and estrogen?

Whether estrogen and leptin cooperate and if this interaction affects body weight has not yet been definitively concluded. Research conducted by Clegg et al. (2006) found that rats with higher circulating estrogen levels had increased sensitivity to

leptin and lower body weight. Furthermore, ovariectomy female rats injected with estradiol had lower body weight, highlighting estrogen's important role in regulating body weight. The authors found that, in the presence of estrogen, leptin sensitivity was high despite lower LepR isoform b (LepRb) protein expression in the hypothalamus. It was also suggested that estrogen potentially acts downstream of LepRb's signal cascade in ARC neurons, where ER $\alpha$  and LepRb are coexpressed (Clegg et al., 2006). Although Clegg, et al. (2006) were able to establish a correlation between estrogen and leptin, they were unable to confirm the pathway by which estrogen mediates body weight in the leptin signaling pathway.

The mechanism through which leptin regulates body weight has been heavily studied and a clear mechanism by which it functions has been determined. Once leptin is released from adipose tissue, it travels through the bloodstream and crosses the blood brain barrier and binds to leptin receptors present on hypothalamic neurons in hypothalamic nuclei including the ARC (Figure 1). LepRb is the most common isoform and is highly expressed on hypothalamic neurons. (Couce et al., 1997). Binding of leptin to LepRs activates Janus kinase 2 (JAK2) (Banks et al., 2000). Upon ligand binding, JAK2 phosphorylates three specific tyrosine residues located on LepRb, and when tyrosine 1388 is phosphorylated, STAT3 is transported to the LepRb-JAK2 complex (Gao & Horvath, 2008). JAK2 then phosphorylates STAT3. Following phosphorylation and dimerization, STAT3 travels to the nucleus where it binds to the promoter regions of genes to modulate their expression. In response to activation by leptin, STAT3 increases POMC and CART expression and decreases AgRP and NPY expression, thereby increasing food intake (Gao & Horvath, 2008; Ernst et al., 2009; Mesaros et al., 2008).

Estrogen acts through multiple signal pathways to mediate its metabolic effects and alter cell survival in neurons. It can act on cell surface receptors or pass through the cell membrane to bind ERs in the cytoplasm. Intracellular ERs bind estrogen in the cytosol, forming a complex, and can then utilize two separate pathways. In the best-characterized mechanism, the ER-estrogen complex binds to another ER-estrogen complex in a process called dimerization and together they translocate to the nucleus and act as a transcription factor (Figure 1). Alternatively, ER can act

through the phosphoinositide 3-kinase (PI3K) pathway to mediate changes in neuropeptides such as POMC (Malyala et al., 2008). G-protein coupled receptor 30 (GPR30) is a cell membrane-bound estrogen receptor that initiates the cyclic adenosine monophosphate/protein kinase A (cAMP/PKA) pathway and ultimately increases STAT3 activity, which may serve as the link between estrogen and leptin signaling (Kwon et al., 2014). The exact method of this interaction remains to be elucidated, as indicated by the dashed arrow in Figure 1.

## DISCUSSION

Identifying the specific pathway where estrogen and leptin interact to regulate body weight is an important factor in developing therapeutics that target them. Gao et al. (2007) aimed to determine whether estrogen influences anorexigenic POMC hypothalamic neurons in experimental mouse models. They found that estradiol is dependent on the STAT3 pathway to alter body weight and that its mechanism of action on POMC tone may be to increase the number of excitatory synapses, paralleling leptin's effect on these neurons (Gao et al., 2007). With regards to body weight, it was seen that exogenous administration of estradiol significantly reduced body weight gain – a finding seen across both the ob/ob and db/db mouse lines as compared to wildtype controls (Gao et al., 2007). Estradiol caused no reduction in body weight in STAT3-knockout mice when compared to controls, supporting the dependence on the STAT3 pathway for estradiol's ability to alter body weight (Gao et al., 2007). Furthermore, estradiol mediates the phosphorylation of STAT3 in a similar manner to JAK2 (Ma et al., 2020).

Kwon et al. (2014) found there may be two distinct pathways through which estrogen initiates the STAT3 signaling pathway and modulates body weight. Along with the known pathway of ER $\alpha$ -mediated STAT3 activation, GPR30 may be involved. As a member of the G-protein family, GPR30 has 7 transmembrane domains with an extracellular ligand binding site. Previous research has demonstrated that estradiol is a ligand for GPR30 (Revankar et al., 2005). Interestingly, Kwon and colleagues (2014) also found that when a GPR30-specific antagonist was added, the STAT3 signaling pathway was inhibited. Estrogen was found to bind GPR30 and thereby initiate pSTAT3 formation, resulting in the activation of the anorectic pathway in the ARC, leading to weight loss.

More recently, it has also been proposed that no STAT3-dependent interaction exists between ER $\alpha$  and LepRb with respect to estradiol's ability to modulate body weight via the hypothalamus (Kim et al., 2016). Administration of estradiol did not increase the leptin-dependent phosphorylation of STAT3, which indicates a lack of potentiation of the hypothalamic leptin signaling pathway by estradiol but may not necessarily suggest a lack of connection between ER $\alpha$  and LepRb signaling pathways in the modulation of metabolism. This study indicated that the knockout of either STAT3 or ER $\alpha$  from LepRb-expressing cells did not significantly alter estradiol's ability to reduce body weight, suggesting that STAT3 of the LepRb pathway is not necessarily required for body weight homeostasis. This finding seems to contradict the putative position that the interaction between LepRb and estradiol is crucial for the STAT3-mediated regulation of body weight.

There are several important caveats related to the results in the Kim et al. (2016) study. Immunohistochemistry was used to determine the overlap in the number of LepRb- and ER $\alpha$ -coexpressing cells, estimated to be less than 15%. Counting of coexpressing cells was performed by hand and perhaps not blinded to experimental groupings, which may have introduced bias. Furthermore, in the representative images, there are coexpressing cells that were not indicated and appear to have been missed in the analysis. Lastly, knocking down ER $\alpha$  in LepRb-expressing neurons causes significant changes in feeding, suggesting that ER $\alpha$  plays a role in the intracellular pathways related to feeding behaviour, which are also acted upon by leptin. Taken together, these data seem to indicate a fairly large and metabolically important population of cells that coexpress ER $\alpha$  and LepRb and run counter to the conclusions presented in the study.

Kim and colleagues (2016) failed to report the circulating estrogen levels in their estrogen device implant studies, and therefore the dose of estrogen released from these uncontrolled devices may be above physiological levels, which would preclude the interpretation of physiological phenomena. Furthermore, Cre recombinase-mediated excision of genes can be unpredictable, and Kim et al. (2016) did not report the efficacy of the STAT3

knockdown in LepRb neurons, which is an essential step to ensure that STAT3 expression was adequately reduced. Interestingly, estrogen treatment significantly decreased pSTAT3 in leptin neurons, presenting another piece of evidence that suggests these pathways do, in fact, interact with one another.

## CONCLUSION

The understanding of neuroendocrine regulation of body weight by key hormones such as estrogen and leptin is paramount to combating the obesity epidemic. Currently, the ER $\alpha$ -mediated and GPR30-mediated STAT3 pathway both provide compelling evidence to support the assertion that estrogen pathways interact with leptin pathways to regulate body weight. The Kim et al. (2016) study discussed here contradicts this idea but suffers from experimental caveats and conflicting data. It is also possible that leptin and estrogen may interact indirectly through the modulation of many other factors known to affect STAT3. Therefore, we believe this finding is interesting, but not sufficient to contradict the larger body of literature supporting the existence of a relationship between estrogen and leptin in hypothalamic signaling. As such, the currently available evidence supports the claim that the STAT3 pathway is central to body weight modulation, mediated by the relationship between estradiol and leptin. We believe that both ER $\alpha$  and GPR30 are capable of initiating STAT3-activating pathways, though it is not clear whether one pathway predominates over the other or whether these pathways depend on one another for adequate STAT3 activation. We conclude that by identifying the site of interaction between leptin and estrogen signaling, future research will further our understanding of this site's role in metabolic disorders such as obesity and T2D.

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## Conflicts of interest

The authors declare no conflicts of interest.

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# All-You-Can-Eat in Reality: You Eat what You Choose

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**ABSTRACT** All-you-can-eat buffet is a long-standing favourite for gourmands and restaurateurs. In behavioural economics, literature shows mixed findings in how price interacts with customers' perceived food quality and consumption. Some research found that lower payment led to higher food consumption and worse ratings, while others found that this phenomenon to be associated with higher payment. This inconsistency may be due to the difference of experimental design; namely, whether participants were aware that different prices are available to choose from. If individuals can choose between two sets of two different prices, individuals who choose the cheaper set may consider their meal more cost-effective and will not push themselves to consume more, only to make up for the price. This study proposal aims to use Korean BBQ buffet to understand how the presence of choice impacts consumers' behaviour. We hypothesize that individuals in both the standard and the premium set condition will show similar results in all three variables — number of dishes ordered, level of perceived food quality, and level of satisfaction in dining experiences — when a choice is given. Conversely, when individuals do not have a choice, those who are assigned with the standard set will consume more food and give more negative ratings than those assigned to the premium set. If this hypothesis is confirmed, results will have strong implications for food industries and government policymakers. For businesses, this implies that choice architecture can nudge consumers to make decisions that both lower operation costs and maintain customer satisfaction. For public welfare, the presence of choice can encourage an autonomous attitude in consuming healthy food.

## INTRODUCTION

The sunk cost fallacy refers to the notion that individuals will continue in an investment due to previous efforts (Roth et al., 2015). In an all-you-can-eat (AYCE) buffet context, the sunk cost fallacy justifies why people irrationally continue to consume food even when they are already full or the food tastes mediocre – only to make up for the price they have paid. One paper proposed three possible models to understand the relationships and interaction between price, food quality and consumption (Just & Wansink, 2011). These three models justify three possible scenarios on how price can influence the amount of food consumption and perceived food quality. In the first scenario, price has no significant impact on consumer's behaviour; the greater the amount of food consumed, the more cost-worthy the meal is perceived to be. In the second scenario, the amount of food consumed depends on the price; the higher the cost of the meal, the more consumption is required to make the meal feel cost worthy. This is because if individuals perceive that their level of consumption meets the price paid, a low-cost buffet is equally satisfactory as a high-cost buffet (Thaler, 2004). In the third scenario, high cost implies higher quality, which sets taste expectation higher in accordance with the price. This idea is supported by a study on price-perceived quality relationship in the U.S. cheese market, which found that higher price is associated with higher perceived quality (Yu & Du, 2019). In other words, higher price may lead to lower food satisfaction because the anchor point is set higher.

Literature findings were inconsistent in testing the above three models. In one experiment at an AYCE pizza restaurant, researchers offered half of their participants a 50% off discount coupon (Just & Wansink, 2011). Results revealed that individuals who did not receive the discount consumed more pizza, and higher consumption was associated with lower ratings of food taste. When the pizza was perceived as lower quality, more pieces was consumed to make the money worth, which corresponds to the transaction utility model (second scenario). Just & Wansink (2011) concluded that higher payment leads to higher food consumption and more negative ratings. Sigirci and Wansink (2015) conducted a similar study where participants were charged either \$4 or \$8 for a pizza lunch buffet at a pizza place. Researchers replicated the relationship between consumption and dining experience – those who consumed more pizza rated their experience more negatively, with stronger feelings of guilt and physical discomfort. Researchers failed to replicate the relationship between price and consumption – the \$4 condition consumed more pizza than the \$8 condition. The \$4 condition also rated the food less tasty and less satisfactory (Sigirci & Wansink, 2017). Sigirci and Wansink (2015, 2017) concluded that lower payment leads to higher food consumption and a more negative rating.

Current literature fails to explain why these contradicting findings occur. One possible explanation may be the difference between the two experiment designs, which lies in whether the participants in the experiment condition were aware of another option. In the first study,

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participants were presented with a 50% off coupon, which implied that they were aware of the original price (Just & Wansink, 2011). In the second and third studies, participants were given flyers that only marked one price; hence, the \$4 condition were not aware of the price of the \$8 condition (Sigirci & Wansink, 2015, 2017). If the mere presence of options could produce such significant effect, what would happen if individuals were given the chance to make their own choice? One research study investigated this question with a repeated measures forced choice paradigm. In this study, participants were first asked to estimate the prices for a list of snacks. They then went through a decision phase where they were forced to choose between a series of two random snacks. Finally, they went through the list of snacks again where they re-indicated how much they would be willing to pay for those snacks. Findings showed that in the re-indication phase, participants were willing to pay more for the item they selected, compared to before the choice was made (Voigt et al., 2019). This brings to the question whether the presence of choice can eliminate the sunk cost fallacy. Specifically, if individuals can choose between two sets of two prices, will they consider their meal more cost-effective than normal, such that they would not need to increase consumption to make up for the price?

In the present study, we will use a Korean BBQ AYCE buffet setting to understand how the presence of choice impacts individual's consumption behaviour. The objective of this study is to resolve contradictions in previous literature by suggesting how the role of choice can potentially eliminate the phenomenon of the sunk cost fallacy. Our proposed methodology incorporates a 2x2 design where we have two independent variables: set (standard or premium) and choice (with or without). The experiment group will have a choice of either standard or premium set; whereas the control group will be assigned to either a standard or premium set without know the other choice exists. Our study design has three dependent variables: level of consumption (number of orders), level of food satisfaction (food quality rating), and level of dining experience (physical and psychological discomforts). We hypothesize that when a choice is given, individuals in both the standard and the premium set condition will show similar results in all three variables. Conversely, when individuals do not have a choice, those who are assigned to the standard set will order more dishes, rate the food quality lower and their dining experiences less satisfactory, as compared to those assigned to the premium set.

## METHOD

### Participants

The methodological frame of this study is adapted from previous literature that studied the relationship between AYCE and consumption behaviour, with modifications to include the provision of choice. A G power analysis with an effect size of 80% suggests a sample of 64 adult participants, excluding confederates. Using the University of Toronto's internal mailing system, individuals will be recruited from the Toronto population, which includes a variety of individuals in terms of ethnicity, age, and gender.

Participants will be assigned to one of the four conditions: standard set with choice, standard set without choice, premium set with choice, premium set without choice. The differences between standard set and premium set lies in how much they cost, and the food types offered in the menu. The difference between with and without choice implies whether the participants can choose their set, which comes with a minimal priming procedure. Lab members will take turn to play the role of confederate in each with-choice condition.

### Materials

#### Setting

An experiment room will be set up for the distraction task. It will contain a table, two chairs, some stationary, materials on different AYCE menus, and an information sheet which participants will fill in. The restaurant is at the centre's basement where the experiment is conducted. One room is allocated for the dining task, with a portable BBQ grill plate and a menu on a table. Food ingredients are provided by the restaurant and delivered by a server.

#### Menu

The design of two sets explicitly ties the price and the quality of food together. The price of each set is referenced from one famous Korean BBQ AYCE Restaurant in Toronto. The standard menu has a fixed price of \$15. It covers vegetables, starch, and meat, but only offers chicken for the meat section. The premium menu has a fixed price of \$25. It has a wider variety of options for all three categories; especially for meat, where it offers chicken, beef, and pork.

### Questionnaires

Two customer surveys ask about participants' agreements with statements on a 9-point Likert scale (1 = strongly disagree; 9 = strongly agree). The questionnaire on food focuses on the quality of food (e.g., taste, temperature, appearance). It also highlights the cost-performance ratio, i.e., if the food is good value for the money they paid. The questionnaire on dining experience is adapted from Sigirci and Wansink's (2017) study. Questions highlight physical and psychological perceptions, such as level of satiety, guilt, and physical discomforts. Apart from the two surveys, personal information (e.g., age, gender, body mass index, diet), participant's experience with AYCE, and their level of hunger will be collected on a separate demographic questionnaire.

### Procedure

#### Distraction Task

Participants are first brought into the experiment room and told that we are interested in studying how different individuals code data. Demographics are collected before the task. During the task, participants read six AYCE menus from different restaurants. They then write down each of their prices, sets, and food items onto a separate information sheet. This task has two objectives. First, we want to distract them from our actual study purpose. Second, we want to familiarize them with AYCE and anchor them to the normal pricing standard of different sets.

A minimal priming procedure is additionally included for individuals assigned to the with-choice conditions before the distraction task. The participant first fills in some demographic information, including food interest, in a room on their own. After the participant hands in the form, an experimenter enters the room along with a confederate, and announces that both the participant and the confederate belong to the same group because of their common food interest. The confederate then initiates a conversation with the participant that highlights their similarities. The participant will then proceed with the distraction task as described above.

#### Dining Task

After the distraction task, all participants are given a \$30 coupon to the AYCE restaurant in the experiment centre. They are told that the remaining amount can be converted to cash. Participants in the no-choice conditions will only receive the set (standard/premium) based on their assignment. Participants in the with-choice conditions can choose between the standard and the premium set. They will observe the confederate they met earlier choosing the set at the restaurant. The set which the confederate will choose depends on the condition that the participant was assigned to. At the same time, a new confederate will come in and choose the opposite set. Because the participant finds themselves more familiar and similar with the first confederate, they are more likely to follow the choice of the first than the second confederate. This scene aims to direct the participant to choose their assigned set.

All participants will be led to the dining room individually and place their orders through an electronic tablet, which records the number and variety of items ordered. Participants would have 90 minutes to order and consume as many foods on the menu as they want. Immediately after these 90 minutes, participants will need to stop eating and will complete a customer survey on both the food quality and their dining experience.

Since our study involves deception, a debriefing session will be arranged. Researchers will explain our purpose of study, answer questions, and provide resources for counselling.

## EXPECTED RESULTS

A 2 (set: standard or premium) x 2 (choice: with or without) independent-factorial analysis of variance (ANOVA) on test scores will reveal a significant main effect of choice and a significant interaction between set and choice for all three dependent variables.

For the main effect of choice, participants who cannot choose between the sets will order more dishes, rate the food quality lower and their dining experiences less satisfactory. On the

contrary, participants in the with-choice condition would order fewer dishes, rate the food quality higher, and their dining experiences more satisfactory than their counterparts in the without-choice condition. There will be no significant main effect of set.

An interaction effect will show larger mean differences in all three variables — number of dishes, level of perceived food quality, and level of satisfaction in dining experiences — between sets in with-choice conditions than without-choice conditions. The with-choice conditions will show no significant difference between the standard and the premium sets for all three outcome variables. In without-choice conditions, those who has the standard set will order more dishes, rate the food quality lower and their dining experiences less satisfactory than those who has the premium set.

## DISCUSSION

This study expects to confirm the hypothesis that the presence of choice eliminates the effect of sunk cost fallacy on the relationships between price, quality, and consumption. Specifically, when individuals are presented with a choice, the consumption and quality ratings will not differ between having a standard or a premium set; whereas when individuals do not make a choice over the food they consume, those with the standard set will consume more food, perceive the food quality lower, and their dining experience less satisfactory.

The role of choice in the meal set, and thus how much people pay for one meal, can be explained by the action-based model of the cognitive dissonance theory (Harmon-Jones et al., 2015). In the original theory, individuals change their attitudes to reduce the psychological discomfort due to inconsistencies between thoughts and actions (Festinger, 1957). A deeper interpretation of this theory implies that the internal conflict between an action and why this action is taken can also create negative arousals. Since individuals have already committed to the course of action, they need to change their attitudes to help them follow through with the behaviour (Harmon-Jones et al., 2015). This theory helps us understand why participants in the with-choice condition will rate their chosen set more favourably regardless of the food they consume, resulting in no difference in evaluations towards the standard versus premium sets. Since the participants have already decided on which set to consume, they are motivated to rate it more favourably so that they can enjoy themselves throughout the meal.

Likewise, the concept of “the spreading of alternatives” illustrates how individuals shift their perceptions in a free-choice paradigm. After a difficult decision between two items, individuals feel more positive about the item that they chose and more negative about the one they gave up (Brehm, 1956; Ferrer & Shi, 2015). This concept has been replicated in several contexts, including the choice of apartment, paintings, and household appliances (Beckmann & Kuhl, 1984; Brehm, 1956). One study demonstrates how this concept responds to the sunk-cost fallacy. Compared to the easy-decision condition, individuals who had to write about implementing a difficult decision were more likely to change their evaluations in favour of their tasks (Harmon-Jones & Harmon-Jones, 2002). This suggests how the cost of action (e.g., effort) can make the chosen item more positive. Thereby, participants in the with-choice condition are more likely to evaluate their chosen set more favourably regardless of which set they chose.

## Strengths and limitations

These findings of the present study will have significant impact on both food industries and government policies. For business, this research implies that choice architecture can nudge consumers to make decisions that both lower operation costs and maintain customer satisfaction (Johnson et al., 2012). In buffet restaurants, simply providing a choice of set will guarantee less consumption after satiation, which not only reduces food waste, but also individual's feeling of guilt after meals due to overeating. For public welfare, the presence of choice can encourage an autonomous attitude in consuming healthy food. The notion of trigger food is defined as foods that increase or decrease the selection of other foods through their simple presence (Hanks et al., 2012). In one study, children were either required to consume carrots or given a choice between taking carrots or celery. In the former condition, only 69% consumed their given vegetable, while in the latter condition, where two choices were given, 91% consumed their vegetables (Just & Wansink, 2009). Integrating this with our findings, we see how the presence of choice increased positive attitudes towards the vegetables, thus higher voluntary vegetable consumption.

This study has two limitations. First, the choice satisfaction rating may be an effect of minimal priming rather than individual's deliberate decision. To ensure participants select the condition that they are randomly assigned to, we primed individuals to choose the set that their in-group correspondent has chosen. If the participant's choice expression is based on automatic rather than systematic processing, their evaluation may differ from choices made with careful thought. More future follow-up studies can introduce the sense of control in the decision as a mediating variable. For example, one research study has shown that when the notion of self-control is made salient, individuals are less likely to consider their choice as an authentic indicator of their preference (Sela et al., 2017). Since self-control implies a need to conform to norms, individuals perceive less subjective control over their choices. Second, most individuals familiar with AYCE belong to a middle-class population, making the results less generalizable to people from different social statuses. Future studies can use other consumption measures to see whether these findings are replicable with individuals who have less exposure to AYCE-like situations.

In conclusion, this proposed study hopes to show that the presence of choice will increase an individual's positive attitude towards their decision, thus attenuating the sunk-cost fallacy in making the most out of one's sacrifice. This finding will contribute to both business and government policies on food consumption behaviours if results are as predicted.

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# Conservation, Climate Change, and Interdisciplinary Collaborations

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**ABSTRACT** Human-caused pollutants are continuing to show their impacts on the environment. For decades, scientists have been studying these effects and what they mean for life on Earth. Such effects on nature include increased species extinction rates and climate change. However, these two elements are interconnected, and as a result, an interdisciplinary approach to conservation is necessary to solve these problems. Coral conservation is a prominent issue in both the media and the lab. Thus, using coral to explore an interdisciplinary approach allows scientists and the public to see what each discipline can bring to the table in determining how to effectively proceed in conservation efforts. Though generally there are a continually increasing number of scientific disciplines, this article will focus on marine biology, cell biology, ecology, physics, chemistry, conservation, environmental science, and climate science.

## INTRODUCTION

Climate has been an important area of study since as early as the 16<sup>th</sup> century (Fleming, 2014). Since then, the effects of anthropogenic pollutants became a significant concern for scientists (Fleming, 1998). By 1957, two groups were formed, both of which were dedicated to the study of different components of climate change (Corfee-Morlot et al., 2007). One group, run by oceanographer Roger Revelle of Scripps, focused on studying the carbon cycle. While the other, run by meteorologist and mathematician John von Neumann, dedicated its efforts to atmospheric modeling (Corfee-Morlot et al., 2007). From 1970 onward, these groups were fundamental to furthering climate change research. They helped unite world leaders to promote climate change research and action (Corfee-Morlot et al., 2007). As this research continued, there have been multiple indicators that global warming is having detrimental impacts on the environment, such as an increase in maximum annual temperatures, and precipitation changes, both of which increase species extinction rates (Cahill et al., 2013; Keith et al., 2014; Román-Palacios & Wiens, 2020).

The rising extinction rate of animals, plants, algae, and other organisms is a serious concern for scientists in multiple fields (Austin & Jr., 2016; Heard et al., 2013; Moat et al., 2019). There are many areas of concern as species loss has a variety of increasing negative effects: invasive species expansion (Burrows et al., 2014; Simberloff & Rejmanek, 2011), alterations in ecosystem processes, changes in productivity and decomposition (Gutiérrez-Salazar & Medrano-Vizcaíno, 2019; Zhang et al., 2008), loss of dependent species, food resource reduction within developing countries (Schuttenberg, 2000), preservation of indigenous livelihoods (Bonebrake et al., 2018), narrowing of potential resources, and effects on pharmaceutical research (Chivian, 2001; Hooper et al., 2012a). Besides these known effects of species loss, scientists are also concerned with the possibility of cascading effects, an unforeseen chain of events with negative impacts (Ceballos et al., 2017; Hooper et al., 2012b).

The efforts of conservation have been greatly impacted by the advancement of climate change (Lawler et al., 2015). Research fields have continually divided into increasingly narrower scientific disciplines (Coccia, 2020). This narrowing of fields also causes issues of narrow-minded researchers, believing their field superior and not stepping outside of its confines, in a time of climate change. This superiority complex has resulted in many eras of research based on the type of competition between scientific groups. The three main research eras indicated by Jonathan Adams are (Adams, 2013): 1) the individual, 2) the institutional and, 3) the national. However, research has entered a fourth era, and rather than being focused on competition it focuses on collaboration. Adams calls this period the age of international collaboration (Adams, 2013). Globalization has increased collaboration between different nations as well as collaboration between academic disciplines (Harvey, 2015). Studying the climate crisis through a variety of lenses strengthens research. Climate change does not affect just a few organisms, but rather, affects interconnected ecosystems. Drawing on the expertise of researchers from various fields is important for understanding the many facets of climate change. Thus, an interdisciplinary approach to climate research has the potential to be most effective in mitigating the climate crisis (Adams, 2013; Harvey, 2015).

One common goal addressed in this paper is the conservation of coral reefs, which will benefit from interdisciplinary research. Through many years of research, coral reefs have been found to be a cornerstone of the survival of tropical marine ecosystems (Hoegh-Guldberg, 1999). There are many components, both research and coral ecology based, that need to be

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addressed when focusing on aiding the survival of coral populations (Hoegh-Guldberg, 1999). Symbiotic relationships, organismal interactions, chemical reactions affecting the coral, the physiology of coral, water temperature change, and ocean currents are just a few factors affecting coral health (Hoegh-Guldberg, 1999).

In this review, the importance of an interdisciplinary approach to conservation in a time of climate change is demonstrated by describing how different scientific fields are working together to prevent coral bleaching due to climate change. Altogether, this work suggests that scientists of varying fields need to contribute information from their own expertise to determine how best to approach conservation, and that postsecondary education is an excellent way to introduce the interdisciplinary concept to future scientists.

## METHODS

A scoping search was done to locate sources that addressed climate change and conservation literature while leaning towards coral reefs as a case study. The articles used were all published in English. The main database used was Google Scholar, allowing a wide range of articles to be considered. Within the searches, the key words and phrases (including synonyms) used were “climate change,” “global warming,” “coral,” “conservation,” and “interdisciplinary.”

### Study selection

There was a wide range of articles found through the scoping research. These articles were first screened by their abstracts. Due to the broad reach of this review’s topic and the need to look at how research has changed over the years, the author was careful not to exclude articles based on their publication date. Special attention was given to articles having an interdisciplinary approach to the issues of climate change and conservation as well as those looking at coral reefs, which is the case study of this review.

## RESULTS

Species redistribution has led to dynamic changes at different hierarchical levels, from genes to ecosystems. To understand such changes, it is fundamentally necessary to have an interdisciplinary approach, which encourages the rethinking of our current paradigms in conservation science. The reformulation of new paradigms can allow for a better designing of conservation strategies, which includes changes in population connectivity, as well as adjusting to climate change (Bonebrake et al., 2018). Each scientific field of study has important concepts and information that they have developed over centuries of research. However, this information is of limited help to humans and nature unless scientists communicate with each other and see how their works interconnect and complement each other. Climate change and pollutants have combined impacts on the environment. Thus, to address the present-day issues in conservation, we need many scientists of different views and ideas to be in communication with one another (Shimizu & Clark, 2015; Weber, 2016). Figure 1 is the center of this article, portraying different disciplines and their contributions to an interdisciplinary approach to conservation in a time of climate change, all of which must be immersed in effective communication.

## LITERATURE REVIEW

### Marine biologists and their experience with coral

Coral reefs play an important role in marine habitats. The loss of these organisms will have a detrimental impact on life both in and out of the water. Live coral provides both food and shelter for other organisms and studies have indicated that coral loss correlates with a decline in marine organism number and species diversity (Cole et al., 2008; Wilson et al., 2006, 2008). Fish species that are supported by coral reefs and the complexity of coral habitats are important food sources for human communities and other land species (Wilson et al., 2008). In the El Niño-Southern Oscillation (ENSO) event of 1997-1998, severe mortality rates of coral were reported (Robbart et al., 2004). Earlier studies indicate varying resiliency levels among different coral populations and species, as well as the need for further research on this topic (Obura, 2005; Robbart et al., 2004). As research progressed, coral resilience was found to be more complex than what was previously believed, indicating that even more research is needed to better evaluate resilience (Bang et al., 2021). It is important to

understand the strengths and limitations of each approach to coral resilience, as well as its capacity to answer common management questions (Lam et al., 2020).

Coral bleaching occurs when a coral has been exposed to prolonged and extreme heat stress, which causes the coral to eject its alga symbionts, such as zooxanthellae (Cziesielski et al., 2019; Lesser et al., 1990). This ejection of their symbiont, which provides energetic requirements for its coral host and enables the host to calcify, will eventually result in the coral’s death (Cziesielski et al., 2019). Coral bleaching is a complex biological issue that spans multiple disciplines including marine biology, cellular biology (Weis, 2019), genetics (Cleves et al., 2018; Jones et al., 2018), computational biology (Mollica et al., 2018), and environmental sciences (Schuttenberg, 2000), among others.

Understanding the cellular and molecular basis of the symbiosis between corals and algae is a fundamental step to prevent coral bleaching (Weis et al., 2008; Weis, 2019;). To comprehend this phenomenon, coral biologists started working with cell biologists more than 10 years ago (Weis et al., 2008; Weis, 2019;). An initial stage for this interdisciplinary research was the development of appropriate tools that allowed cell biologists to dissect the pathways involved in coral bleaching (Baumgarten et al., 2015; Cleves et al., 2020; Weis, 2019). One important tool that has been developed is a coral model organism, which allows scientists to regularly test a hypothesis by performing experiments in the laboratory in ways that are impossible in nature (Weis, 2019).

The small sea anemone *Ecaiptasia pallida*, commonly referred to as *Aiptasia*, is the most studied of the model systems for studying coral symbiosis (Weis, 2019). It provides a tractable laboratory model for investigating mechanisms underlying cnidarian-dinoflagellate symbiosis (Baumgarten et al., 2015; Weis, 2019). The study of *Aiptasia* and other coral systems has fueled many discoveries, including a detailed understanding of how metabolic dysregulation contributes to dysbiosis and bleaching (Weis, 2019). However, the most important outcome was the involvement of other biological fields to study coral bleaching. For example, geneticists and molecular biologists are using CRISPR to develop mutations that will illuminate many aspects of coral biology and, thus, help to guide conservation efforts (Cleves et al., 2020).

The following is a step in the process of understanding how corals regulate heat stress. The gene HSP70 seems to be tightly coupled to coral symbiosis and health maintenance of coral (Traylor-Knowles & Palumbi, 2014).

### Cell biologists and understanding the effects and uses of HSP70

HSP is classified as a cytosolic heat shock protein (Rosic et al., 2011). HSP70 genes are involved in stress responses, which are important in the symbiotic relationship between coral and the symbiotic dinoflagellates (Leggat et al., 2011). The gene is located within both the corals and their symbionts (Leggat et al., 2011).

The amount of coral surface area exposed to sunlight is related to the levels of HSP60 and 70; an increase in light exposure increases the production of HSPs (Brown et al., 2002). The HSP70 transcriptional response to heat stress aligns with the species stress susceptibility (Franzellitti et al., 2018). The responses and resilience that a coral displays in response to stresses is found to change depending on the species’ growth modes, trophic strategies, and physiology (Franzellitti et al., 2018). Not only is the HSP70 gene expression attributed to stress responses of coral, but also to declining sponge populations in coral reef ecosystems due to increasing seawater temperatures (López-Legentil et al., 2008). There are also combined effects of increased temperature and pH changes on the HSP70 gene that need to be explored in future research (Franzellitti et al., 2018).

### Ecologists and understanding the relationships between organisms

Marine ecological studies are fundamental to the development of robust conservation plans, which allows for the sustainable exploitation of ocean resources by fisheries and tourism, among others. There are many essential relationships that occur between coral reefs and other distant marine ecosystems, where the health of one greatly impacts the health of the other (Cowen et al., 2006; Treml et al., 2008). However, despite its importance, the study of these relationships in marine ecosystems is not a simple task, displaying multiple technical challenges. For example, although many marine organisms display an adult sessile or sedentary life,

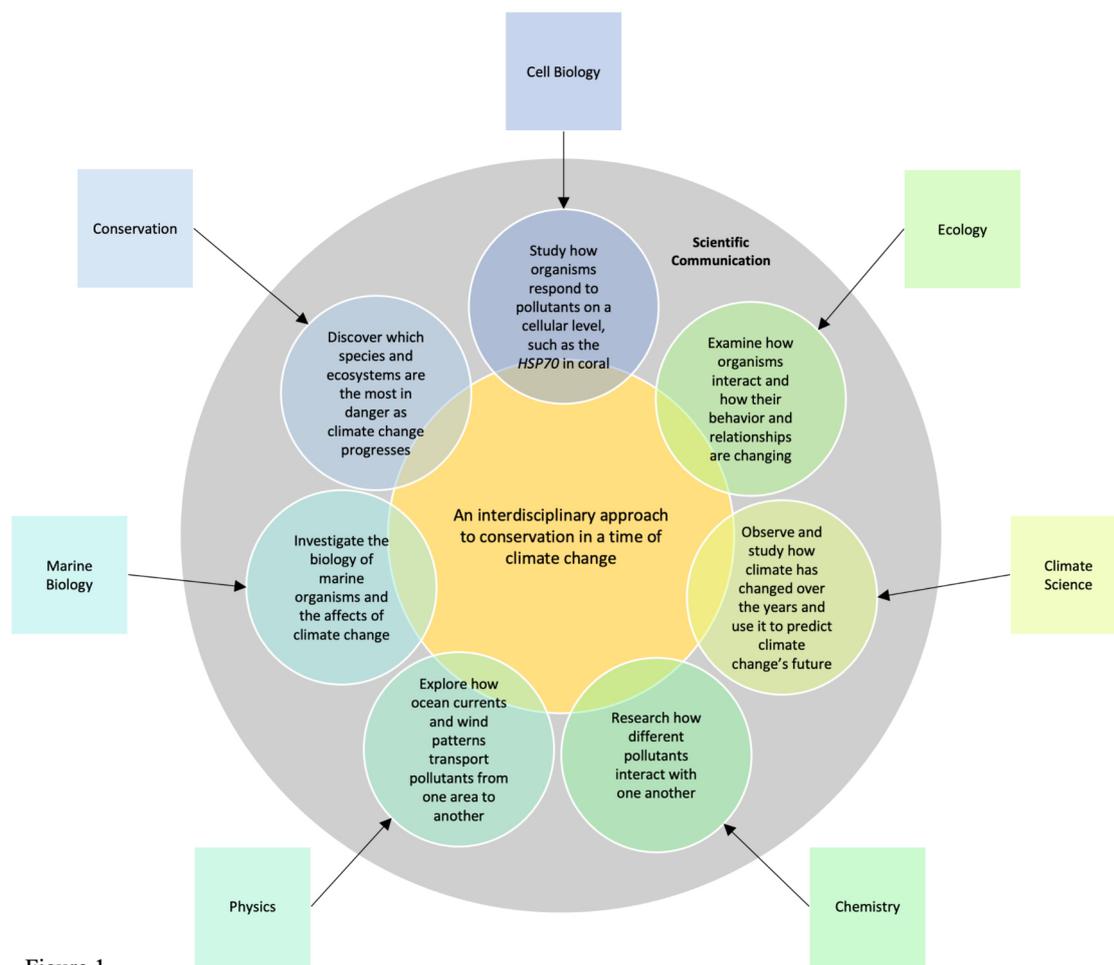


Figure 1

Figure 1: Contributions that different disciplines can make to an interdisciplinary approach directed towards conservation in a time of climate change.

the larval stages are mobile and travel via oceanic currents hundreds of kilometers away, connecting distant ecosystems. As a result, the quantification of the spatial and temporal patterns is only possible in a few marine species, and the dispersal of larvae was previously a neglected component of marine conservation efforts.

To solve this problem, ecologists have collaborated with other disciplines to work towards understanding the connections between species among marine ecosystems. For example, physicists have worked with biologists to explore the connectivity of distant coral populations through larva dispersal through ocean currents (Trembl et al., 2008). To do so, physicists developed a connectivity model based on the graph theory, which can quantify population dynamics of pelagic larval organisms in the Pacific (Australia and Melanesia). This collaboration provided better tools to determine which marine reserves should be addressed, focusing the scientists joint energy and resources (Gaines et al., 2003). In addition, to improve these types of models, marine biologists also collaborate with climate scientists to see how the currents are affected by global warming and the sea level rising (Benzie, 1999). This is another example of how an interdisciplinary approach is needed to save coral reefs.

### Physicists and Chemists: understanding the range and effects of climate change and anthropogenic pollutants

At first glance, it would appear unlikely that physicists would be integrated into the interdisciplinary study of coral conservation. However, physics is important in the understanding of currents that transport both chemicals and marine species' larvae and juveniles. Understanding the transport of these different components assists in the process of determining areas that should be prioritized for marine conservation efforts (Trembl et al., 2008). It is also vital to determine how these transported chemicals, specifically, will react with each other and the effects they may have (Wuebbles et al., 1989).

Physics is a major component of climate variability and climate change studies. A combination of chemistry and physics can be used in the understanding and study of the bioprecipitation cycle, which, combined with human pollutants, can affect Earth's bodies of water (Dominoni et al., 2020; Weber, 2016). Physics has been a key component of climate modeling for years, especially when combined with the invention of computers (Schmidt, 2007).

The chemicals within both the atmosphere and oceans can have important effects when they react with other elements present (Henson et al., 2016; Wuebbles et al., 1989). Examples of such concerns are chemical reactions causing the depletion of the ozone layer, which contributes to global warming (Wuebbles et al., 1989). Besides determining how anthropogenic chemicals will react in these natural environments, chemists also assist in an interdisciplinary approach by assessing how long individual chemicals will remain in the environment before breaking down (Wang et al., 1998). Chemistry is also an important collaborative voice for learning about natural sources of chemicals and sinks, which can have implications for life and climate change (Elderfield, 2010).

### Environmentalists studying the impacts of humans on the planet

Environmental scientists are continually researching the effects of anthropogenic pollutants on ecosystems. In reference to ocean habitats, environmentalists are sharing their research concerning the acidification of oceans due to increased CO<sub>2</sub> caused by human pollution (Godbold & Calosi, 2013; Nikinmaa, 2013). There are many ways that humans are impacting the oceans and, by extension, the coral reefs.

In 2004, there were contradictory findings on whether anthropogenic pollutants had any effect on climate change (Rosa et al., 2004). Scientists continued to study the impacts of humans

on the environment and found that the temperature changes they were seeing could not be explained by natural climate variation alone (Rosenzweig et al., 2008). In more recent years, there has been an overwhelming consensus among scientists that climate change is an issue that has been brought about by human activity (Bertoldo et al., 2019).

### Climate scientists studying and predicting the future of climate change

Climate scientists consider the past trends of climate change and the impacts that humans are having to determine the direction global warming is taking. By including climate scientists in the interdisciplinary approach, conservation scientists will be able to take preventative and adaptive approaches to conservation efforts.

Through the years, there have been “fingerprint” studies that have indicated a change in climate that scientists, as well as the public, should be aware of due to the larger impact that these changes can have on the environment and organisms (Epstein et al., 1998). Climate scientists, since they form climate models, must take into account the current state of the environment, the trends of anthropogenic pollutants, the interactions between greenhouse gasses, and other reactions (Arblaster et al., 2011).

### Scientific intercommunication

Communication is beneficial to approaching any type of problem. Communicating with other scientists from different disciplines can be difficult due to the fact that each group has different goals, theories, and concepts when looking at a problem (Heemskerk et al., 2003). It has been suggested that the best way to work towards interdisciplinary approaches is through communication with the aid of conceptual models (Heemskerk et al., 2003). Giving each group a chance to form their data into an easily understandable model for the other party to understand, and vice-versa, is valuable for approaching problems (Heemskerk et al., 2003).

An area that requires communication and collaboration of disciplines is the process of determining which marine ecosystems should be targeted for conservation. Coral reefs have been a major area of research within marine ecosystem restoration. However, seagrass communities are also a major component of marine ecosystems (Unsworth et al., 2019). Seagrass is home to many species of marine life. It filters coastal environment, aids in nutrient cycling, and reduces bacterial pathogens that can affect humans (Flindt et al., 1999; Lamb et al., 2017; Mtwana Nordlund et al., 2016). The fact that the funding for coral projects roughly doubles that of mangroves and seagrass research indicates a lack of communication between disciplines (Cullen-Unsworth et al., 2014; Duarte et al., 2013).

However, communication between scientists is not enough. To execute effective conservation plans and put them into action, scientists need to communicate with policy-makers, economists, sociologists, and others (Fox et al., 2006). To assist in effective communication, each group involved needs to define what specific terms mean so that there is not any confusion (Hess & Fischer, 2001). Another part of the issue with communication between groups is that they need to better understand the theory, methods, and context of other disciplines (Fox et al., 2006). One way of addressing the issue of broken understanding is to involve and promote researchers early in their careers to an interdisciplinary approach (Gornish et al., 2013). Thus, this raises the question whether an interdisciplinary approach can be introduced to undergraduate students.

Although integrative approaches are needed to address climate change, strategies to teach them efficiently can be equally important (Monroe et al., 2019). A potential problem when teaching interdisciplinary approaches is that undergraduate students are just learning the basis of their field, and a direct introduction to integrative studies may fail in its purpose of establishing a bridge of understanding among other communities about a shared problem. However, in the last decade, several studies have been published suggesting potential pedagogical approaches to include interdisciplinarity in undergraduate courses (Gornish et al., 2013; Leichenko et al., 2021), and future studies are needed to test their efficiency. A potential way to solve this problem is that the topic of interdisciplinarity can be raised by professors to students interested in research on climate change, rather than a key component of the curriculum. A good pedagogical environment to do so in can include journal clubs, lab meetings, and undergraduate research conferences. In addition,

upper-level courses, which focus on applications or specific topics, can also achieve this goal.

## CONCLUSIONS

Scientists over diverse fields have agreed that climate change is a grievous consequence of human activity, mainly due to human-caused pollutants. One major consequence of climate change is the continuing decline in biodiversity, calling for urgent action. However, climate change and conservation are two intricate issues that involve the complex interactions of various scientific fields. Through communication and collaboration between a spectrum of diverse disciplines, a mutually and universally beneficial approach can be proposed. Scientific disciplines must come together in an interdisciplinary approach to better assess conservation in a time of climate change and determine how to best address those issues.

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### Conflict of Interest

The author declares no conflict of interest.

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# Exploring Canadian News Media's Portrayal of Federal Penitentiaries and Prisoners During COVID-19

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**ABSTRACT** The media have often portrayed prisons and prisoners in a distorted manner. Prisoners are often portrayed as more dangerous and violent than they typically are, and prisons as necessary institutions that function effectively. Using a qualitative content analysis of 84 newspaper articles published online by Canadian news outlets, this study explores how the news media portrayed Correctional Service Canada (CSC) federal penitentiaries and prisoners detained in these institutions during the first 11-months of the COVID-19 pandemic. The results reveal that the media portrayed prisoners as human beings that are entitled to exercise their rights until they were prioritized for vaccinations, at which point there was a shift towards their portrayal as an undeserving dangerous underclass. CSC was portrayed as having failed to address and protect prisoners' needs and rights during the pandemic. The media ultimately portrayed federal imprisonment as a system that is broken and incarceration as an ineffective response to criminal behaviour. The implications of these findings – including the need for a “radical rethink” of federal imprisonment – and suggestions for future research are discussed.

## INTRODUCTION

In mid-March 2020, COVID-19 was declared a global health pandemic: as of September 20, 2022, 609 million cases have been detected and 6 million people have died worldwide (World Health Organization (WHO), 2020a). As these numbers indicate, COVID-19 represents a serious threat to the health and safety of the public; however, according to the WHO (n.d.), the most at-risk group for contracting COVID-19 is prisoners. Prisons house many health-vulnerable individuals, many of whom suffer from compromised health profiles that put them at risk of getting seriously ill from the virus; for example, the elderly and those who suffer from human immunodeficiency virus (Sapers, 2020). Further, prisoners' living conditions are often substandard and by their nature preclude social distancing, as prisons are often overcrowded and unsanitary (Burki, 2020; Sapers, 2020). Prisons have been identified as “hotspots for COVID-19” (Burki, 2020, p. 1411).

Previous research explains the critical role media play in shaping the public's knowledge and understanding of the criminal justice system (CJS) and its key players (Marsh, 2009). During the pandemic, 75% of Canadians reported using the Internet more frequently, allocating most of their time to following the news (Statistics Canada, 2020). Given the media's presence in Canadians' lives, it is important to understand how the media communicates information about COVID-19, including how the virus affects vulnerable populations such as residents in long-term care facilities, homeless individuals, and prisoners.

Previous studies have found that the media have portrayed crime and offenders in a distorted manner, as the media tend to report only the most heinous crimes (Jewkes, 2006). By depicting the most gruesome crimes, the media present offenders as a homogenized group: as extremely “dangerous” and “violent” beings (Boyle & Stanley, 2019, p. 80). According to Garland (2012), this “dangerous other” narrative distorts the audience's perception of offenders by evoking negative feelings among viewers, playing on their fear of crime and resentment towards the criminal “other” (p. 158). Thus, the media can sway the public's opinion, creating opportunities for penal reform, especially in response to high-profile cases. To illustrate, Garland (2012) argued the media's depiction of high-profile crimes (e.g., sexual assault and murder), contributes to the public's fear of crime. Politicians then play on the public's fear by using the media as a political platform to advocate for tough on crime policies to win votes (Garland, 2012).

Scholars have also found the media negatively portray certain subgroups of offenders. For example, research examining media portrayals of Black male offenders has found the media are more likely to portray them negatively, as criminal “thugs” (Hall, 1993, p. 245), with media images typically showing them dressed in jail or street clothes (Entman, 1990). In contrast, other research suggests that White male offenders are rarely shown looking disheveled and are usually presented as sophisticated, white-collar criminals (Colburn & Melander, 2018; Entman, 1990). Further discrepancies exist regarding the portrayal of female offenders with some research demonstrating the media attribute a more positive outlook to female offenders. For example,

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Landor and Eisenclas (2012) found that female sex offenders were portrayed as “lovers” whereas male sex offenders were portrayed as “pedophiles,” casting women as less dangerous (p. 499). However, other scholars have not reached similar conclusions, finding instead that the media portray female offenders as “cold” (Christensen, 2018, p. 182; Collins, 2016, p. 305) and violent people (Cecil, 2007; Clowers, 2001).

While much of the existing literature examining the media’s portrayal of prisons is outdated, what is known about these media portrayals is that they too are distorted, rarely discussing the typically routine and boring nature of prison (Chen et al., 2016; Welch et al., 2000). For example, Marsh (2009) and Mason (2006) found the media present two extreme depictions of prison life. One portrayal includes prisons being luxurious spaces where prisoners receive amenities, whereas the second portrayal includes prisons being dangerous and violent spaces. The media have also been found to depict prison as a necessary component of the CJS: as a “what works” solution to crime (Mason, 2006, p. 253).

Chartrand (2021) notes that abolition groups (e.g., Abolition Coalition) have utilized the media as a political platform to raise awareness about various issues prisoners are experiencing amidst the pandemic and to pressure the Canadian government to release prisoners. However, very little is known about how the media have portrayed prisoners and incarceration throughout this time. Liebrez et al. (2020) suggest there may be a “blind spot in the media regarding the spread of COVID-19 among prison inmates” (p. 2). As such, the current study contributes to the gap in the literature by exploring how the Canadian news media portrayed the Correctional Service of Canada (CSC), the agency responsible for people sentenced to a term of imprisonment of two years or more, and prisoners detained in CSC penitentiaries during the first 11-months of the pandemic.

## METHODS

The Canadian Newsstream database was used to identify newspaper articles for inclusion in the analysis because it only includes Canadian newspapers, provides full-text access, and offers a breadth of coverage from multiple news sources. Boolean search terms were used to minimize the risk that relevant articles would be excluded and to help generate accurate and relevant results. Different combinations of keywords were used to capture the different ways newspaper articles presented COVID-19 in Canadian federal custody and/or among federal prisoners. The search terms used were: (“Correctional Service of Canada” OR “Correctional Service Canada” OR “CSC” OR “Corrections Canada” OR “federal prison” OR “federal prisoner” OR “federal prisoners” OR “federal prisons” OR “federal corrections” OR “federal institutions” OR “federal custody” OR “federal penitentiaries” OR “federal penitentiary” OR “federal inmates” OR “federal inmate”) AND (coronavirus OR covid-19 OR pandemic OR virus OR COVID). Articles were selected from between March 11, 2020, when the WHO (2020b) declared COVID-19 a pandemic, and January 31 2021, to meet the requirements of the Honours program the author was participating in.

The use of these search parameters generated a total of 860 articles. A random number generator was then used to narrow the purposive sample down with a goal of retrieving 10 articles for each of the months, as there was “no obvious reason to choose one case over another” (Sandelowski, 2000, p. 249). Fewer than 10 articles were published for some months, so all articles were included for analysis (i.e., June (5), July (4), September (4), and October (6)). This process resulted in a purposeful random sample of 84 online newspaper articles.

Articles were uploaded to NVivo 12, a qualitative data software analysis program, for analysis purposes. Given the open-ended, exploratory nature of the research question, inductive coding was

used to identify emergent themes (Saldaña, 2013). The first stage of the coding process involved reading the articles to understand the subject matter. The second stage included assigning codes and placing the references in the appropriate nodes folders. The third review included reviewing each of the references in the folders to ensure they accurately reflected each theme. During the final review, codes were condensed into major themes and sub-themes.

## RESULTS AND DISCUSSION—MEDIA PORTRAYALS OF PRISONERS AND CSC

Four key themes emerged from the data regarding how the media portrayed prisoners and CSC institutions during the first 11-months of the COVID-19 pandemic. First, prisoners were portrayed as “human beings” entitled to exercising their rights. Second, prisoners were portrayed as an undeserving “dangerous” population, though this narrative only emerged during the second wave of the pandemic. The media portrayed CSC institutions as “failing” to address and accommodate prisoners’ needs and uphold their rights during the pandemic. The final theme which emerged was that CSC institutions do not work in response to criminal behaviour.

### Prisoners are Human Beings

Chaimowitz et al. (2020) predicted that the Canadian media would portray prisoners negatively during the pandemic. However, the media portrayed prisoners positively in that they were typically presented as human beings. This theme emerged when journalists referred to prisoners as people or noted their occupational role in the family unit, such as being a “grandmother” (Baranyai, 2021, para. 7). Incorporating these humanistic identifiers is a unique finding in this study, as existent literature has typically found that these identifiers were only shared when talking about female offenders (Brennan et al., 2015; Carlyle et al., 2014; Cecil, 2007; Landor & Eisenclas, 2012). In addition, these identifiers move away from the “dangerous other” narrative. For example, referring to a prisoner as a “grandmother” may imply that she is a person incapable of committing harm as she may pose a lower risk and does not need to remain incarcerated during the pandemic. This humanistic and non-dangerous narrative runs contrary to the existing literature of offenders being presented in the media as the dangerous ‘other’ (Boyle & Stanley, 2019; Christensen, 2018; Entman, 1990; 1992; Garland, 2012; Oliver, 2003; Welch et al., 2000).

### Prisoners’ Rights are Human Rights

Earlier studies found the media tend to be unsupportive of human rights for prisoners, claiming that because they are “dangerous” people, their rights should be forfeited (Boyle & Stanley, 2019, p. 80). This theme did not emerge in this study: the media portrayed prisoners’ lives as valuable and prisoners as people entitled to exercising their section 7 Canadian Charter of Rights and Freedoms right (the right to life, liberty, and security). Journalists presented advocates’ arguments that exercising this right could be achieved by providing prisoners with access to medical treatment and facilitating their early release to protect them from the virus. To illustrate, Jeaurond, the wife of a prisoner, explained:

“These people are serving time for a crime, but they don’t deserve a death sentence because of a virus that could potentially have been contained if efforts had been made to protect the inmates [by releasing them], who are still Canadian citizens with rights...” [emphasis added] (as cited in Macalpine, 2020, para. 22).

### Prisoners are the Undeserving “Dangerous” Population

There was a major shift in the narrative starting in December 2020

when the media started to talk about vaccinations and people started to debate who should be prioritized to receive the vaccine. At this time the media's narrative shifted to the portrayal of prisoners as not deserving of vaccinations because they are 'dangerous criminals.' This theme emerged when journalists highlighted politicians' and the public's pushback to prisoners being prioritized for the vaccine. The adjectives used to describe prisoners were no longer humanistic. Journalists applied the criminal 'other' label as justification for why prisoners should not be prioritized. For example, Mandel (2021) wrote that it is outrageous that an "axe murderer" is going to receive the vaccine first and incorporates Freeman's (the victim and a victims' advocate) Facebook post to highlight the graveness of the situation: "Not one inmate should receive the vaccine before the vulnerable residents ...[and] all healthcare and front-line workers who ... put themselves at risk every single day" (p. A8). This phrase is in-line with previous research that the media portray offenders as the "undeserving underclass" (Jewkes, 2006, p. 138) who should not be afforded any protection.

### CSC Failing to Meet and Uphold Prisoners' Needs and Rights during the Pandemic

Examining how the media portrayed CSC during the pandemic provides insight about key issues that plague Canada's federal correctional system. One theme that emerged was that CSC "failed" (Palmer, 2020, p. A13) to protect its residents because they did not take adequate steps to manage COVID-19. One article cited Dr. Ivan Zinger, Canada's Correctional Investigator responsible for investigating prisoners' complaints, who summarized CSC's COVID-19 response protocols as "slow, contradictory, confused, and deficient" ("Inmates Were Not Released Early," 2020, p. A4). For example, many journalists noted that CSC did not offer prisoners basic necessities, such as adequate food, hot water, and personal protective equipment. The media also reported that the cleaning services CSC offered were generally inadequate. Quan (2020) noted that a prisoner contracted a respiratory infection from being exposed to the cleaning chemicals.

Journalists also documented how CSC failed to offer prisoners adequate medical services. To illustrate, one article shared Boutilier's, a prisoner at Mission Institution, experience of contracting COVID-19 and how CSC dealt with the situation: "Chunks of blood [came] up from my lungs and they...finally came and...tested me...they came back and said, 'Yeah, you do have it.'" He was given Tylenol and toughed it out inside his cell (as cited in Bolan, 2020, paras. 5-7).

A handful of news articles argued that depriving prisoners' access to health care constitutes a rights violation. The United Nation's (2005) manual, which sets out international guidelines for supervising incarcerated individuals, explains that prisoners have the right to attain the "highest standard of physical health:" a standard the media portrayed CSC as having failed to uphold for Boutilier (alongside other prisoners) (p. 61).

The media argued that rights violations have been a pertinent issue during the pandemic. To illustrate, the media described CSC's isolation practices to curb the spread of the virus as "very backward" (Macalpine, 2021, para. 28). They reported that CSC was not isolating infected prisoners in a separate quarantine range but keeping them in close contact with non-infected prisoners. Mussell and Rampersaud (2020) reported that CSC kept prisoners in their cells for 23 hours a day as a tactic to minimize their movements to manage the "security and order" of the prison, (para. 6). Journalists contended that these "solitary-like" (Penner, 2020, para. 3) conditions continued to exist even after there were no more positive cases inside CSC's institutions, thus depriving prisoners of their liberty.

### CSC Institutions Do Not Work

Mason (2006) found that the media typically portray prisons as "what works" as a response to people who engage in crime and the only practical solution to crime (p. 253). Given the media's portrayal of CSC failing to protect prisoners during the pandemic, it is not surprising that this "what works" narrative did not emerge in this study. Instead, the final theme identified the need to move away from incarceration, with the media calling to "defund" prisons (Mussell & Rampersaud, 2020, para. 24). Many journalists questioned Canada's over-reliance on incarceration as the primary mode of punishment, especially for non-violent offenders ("The Pandemic Forces Us to Rethink Prison," 2020).

While CSC's (2018) mandate is to help prisoners become law-abiding citizens, the media portrayed CSC as doing anything but: many journalists discussed the flaws surrounding incarceration, positing that it holds little rehabilitative potential. For example, many journalists identified barriers prisoners experience upon release, such as finding employment and affording basic necessities. Because of these issues, many journalists argued that now "is [the] time for a radical rethink of a prison system" ("The Pandemic Forces Us to Rethink Prison," 2020, p. A10). As one article argued:

The goal [of incarceration] is not to coddle criminals or ignore crime. It's to find better ways to help offenders - many of whom come out of difficult circumstances - become law-abiding citizens, find employment, and live as good neighbours... What about sentences whose "punishment" includes the obligation to graduate from high school, get a postsecondary degree or apprentice in a trade? ("The Pandemic Forces Us to Rethink Prison," 2020, p. A10).

Indeed, studies have shown that educative and community-based alternatives are more effective in rehabilitating offenders and decreasing recidivism than incarceration (see e.g., DeMatteo et al., 2013; Marion, 2002; Zhang et al., 2006).

### LIMITATIONS

This study is the first to examine Canadian news media portrayals of prisoners and federal penitentiaries during the COVID-19 pandemic. The results reveal that COVID-19 has made it difficult to protect some of our most vulnerable citizens: incarcerated individuals. Exploring the media's portrayal of key issues plaguing Canada's federal correctional service may help to mobilize public support, contributing to the creation and implementation of solutions that lead to systemic changes. For instance, advocacy groups can use the narrative that prisoners are human beings to push for a radical rethink of incarceration.

However, the study is not without limitations. This research lacks generalizability. Analysis was limited to online news articles and federal incarceration. Future research should examine how other forms of media portray Canadian prisoners and correctional institutions. Further, future research should examine media portrayals specific to the provincial/territorial system of corrections responsible for people sentenced to less than two years of imprisonment in Canada, and correctional services and prisoners internationally. Although importantly, the goal of any qualitative study is not to generalize, but to explore and to deeply understand the subject matter, which this study has achieved through the analysis of rich data.

### CONCLUSION

The current study makes a critical contribution to the existing literature as it explores Canadian news media portrayals of prisoners and federal penitentiaries during the first 11-months of the COVID-19 pandemic. Contrary to the existing literature,

prisoners were portrayed as human beings that are entitled to exercise their rights. However, once vaccination rollouts ensued, prisoners were portrayed as the “dangerous other” (Garland, 2012). The media also portrayed CSC institutions as failing to meet and uphold prisoners’ needs and rights, which is contrary to Mason’s (2009) findings, as the media did not portray prisons as “what works.”

As Dr. Justin Piché explained, “Canada can do better” (as cited in Powell, 2020, p. A24). The results indicate that CSC can improve their practices to meet prisoners’ needs and uphold their rights. As the data suggest, many journalists questioned Canada’s reliance on incarceration, contending that it does little to help prisoners. Therefore, the findings of this study shed light on the need for a “radical rethink” of federal imprisonment.

The media have the potential to play on the public’s perception and “act as a catalyst for penal reform” (Jewkes, 2006, p. 142) as the media offer politicians a platform to promote their punitive agenda. As such, the theme found in this study that prisoners are “human beings” may serve to dispel the criminal label as it reminds the public that not all prisoners are dangerous, and further, that they are people worthy of protection. This humanistic narrative may allow the public to view prisoners differently, potentially allowing viewers to feel sympathy towards prisoners. The public must however act on these sentiments to push for change. Advocacy groups, non-governmental organizations, and the Canadian government could try to mobilize and use the narrative that CSC is not sufficiently caring for prisoners to introduce and implement evidence-based reforms to federal correctional policies and practices.

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### Conflict of Interest

The author declares no conflict of interest.

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