Body Weight Misperception among Chinese International Students in Canada during the COVID-19 Pandemic

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Abstract

The phenomenon of BWM (body weight misperceptions) has been linked to a range of health risks. Unfortunately, the COVID-19 outbreak may have exacerbated this issue, leading to detrimental weight fluctuations and an increased susceptibility to BWM. This study investigates BWM and its association with sociodemographic and lifestyle behaviors factors and self-perceived mental, physical, and overall health among Chinese international students in Canada during the second wave of the COVID-19 pandemic in early 2021. Data were collected from 296 eligible study participants through targeted sampling. Bivariate descriptive analyses and multivariate binary logistic regression analyses (BLR) were used.

The study found that (29.1%) had overweight and (7.9%) had underweight misperceptions among Chinese international students in Canada. The study found that females had a higher likelihood of reporting overweight misperceptions (OR=3.18, CI=1.39-7.24), while financial dissatisfaction and lifestyle behaviors such as watching television were associated with a higher risk of overweight misperception (OR = 2.84, 95% CI = 1.39-5.82 and OR = 1.92, 95% CI = 1.09–3.34, respectively). On the other hand, exercise was associated with a lower risk of overweight misperception (OR = 0.56, 95% CI = 0.32-0.98). This study also found that overweight misperception have a lower likelihood of having poor overall health (OR = 0.61, 95% CI = 0.39-0.95), but no significant association with mental health (OR = 1.35, 95% CI = 0.86-2.11), or physical health (OR = 1.15, 95% CI = 0.75-1.77). However, underweight misperception was associated with a higher likelihood of poor overall health (OR = 1.54, 95% CI = 1.03-2.38), but no significant association was found with self-reported physical health (OR = 1.17, 95% CI = 0.78-1.76) and mental health (OR = 1.03, 95% CI = 0.67-1.56).

In conclusion, the study highlights that overweight misperceptions are prevalent among Chinese international students in Canada, particularly among female and those who are financially dissatisfied and watch television. Exercise was found to lower the risk of overweight misperception. Underweight misperception was associated with poor overall health. The study highlights the need for targeted interventions to promote healthy lifestyles and well-being, and further research is required to identify additional factors and develop effective interventions.

Keywords: COVID-19, BWM (body weight misperception), self-perceived overall health, self-perceived mental health, self-perceived physical health, sociodemographic factors, lifestyles behaviors and Chinese international students.

General Summary

Body weight misperception refers to a discrepancy between an individual's perceived weight and their actual weight, resulting in either overestimation or underestimation of their body weight. It can contribute to body dissatisfaction and potentially unhealthy behaviors. The evidence suggests that BWM is becoming a growing concern as it is associated with various health problems, such as eating disorders, depression, and social isolation. The COVID-19 pandemic has exacerbated this issue as changes in lifestyle and stressors associated with the pandemic have increased the risk of misperceptions and unhealthy weight changes. A study on 296 Chinese international students during the pandemic found that Overweight misperceptions were more common among females, while overweight misperception was associated with financial dissatisfaction and watching television. The study revealed a significant association between underweight misperception and poor self-perceived overall health during the pandemic.

The study emphasizes the need for further investigation and interventions to address BWM and promote healthy lifestyle behaviors among Chinese international students in Canada. This intervention could include education and awareness-raising programs and the development of healthy habits. The study's results provide valuable insights and reinforce the importance of future research with larger sample sizes and more diverse populations to confirm and expand upon these findings. Overall, the study's results provide valuable insights into the prevalence and predictors of BWM among Chinese international students and reinforce the need for further research and interventional study to explore weight misperception health risks.

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List of Abbreviations

BWM: Body Weight Misperception iii

CI: Confidence Interval(S) iii

COVID-19: Coronavirus Disease 2019 iii

OR: Odd Ratio iii

(BLR): Multivariate (Binary Logistic Regression) iii

(BMI): Body Mass Index iii

(CBIE): Canadian Bureau for International Education 6

(CDC): Centers for Disease Control and Prevention……...……...7

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Chapter 1: Introduction

1.1 Background

The COVID-19 pandemic significantly impacted global health, affecting individuals from all walks of life.[1] While some populations, such as the elderly, low-income households, and individuals with chronic illnesses, were identified as particularly at risk, international students were also significantly affected due to their immigration status.[2] The government implemented public policies such as medical interventions, lockdowns, and border closures to curb the spread of the COVID-19 virus.[1] Canadian universities closed their campuses, causing adverse effects on the physical, mental, and financial well-being of international students.[2] One affected segment of society has been international students in Canada.[3] These disruptions also affected Chinese international students studying in Canada.[4]

The closure of Canadian universities due to the pandemic has resulted in significant disruptions in the academic year, and the shift to online learning has caused difficulties for many students. With the second wave of the Covid-19 pandemic taking hold, the lives, education, and schooling of students in Canada have been profoundly disrupted,[3] leading to changes in lifestyle such as excessive dieting or over exercising, as individuals strive to match their perceived weight with their desired body image. Furthermore, it can impact physical activity patterns, leading some individuals to engage in more intense exercise routines in pursuit of their perceived ideal weight, and it can also influence snacking behavior, causing individuals to restrict or indulge in food based on their distorted perception. These factors may ultimately contribute to weight gain and further

perpetuate the misperception of body weight.[5, 6] These changes have resulted in weight gain for many people, especially adolescents and adults and may influence their body weight perception.[6, 7]

The previous research found an incongruence between people's perception of their body weight and the reported changes in body weight during the COVID-19 pandemic, potentially leading to an increased risk of disordered eating in some individuals.[8] Psychological stress due to the pandemic may also contribute to changes in eating behaviors and body weight.[9, 10]. Studies show that Chinese students are more likely to be dissatisfied with their body weight than their Canadian counterparts,[11] likely due to cultural differences in how they perceive their body weight.[12]

BWM (body weight misperception) refers to a situation where an individual's perception of their weight does not match their actual weight, as determined by their body mass index (BMI).[13] As previous studies indicate, the phenomenon is prevalent among university students.[14-17] Many factors can affect how people perceive their own body weight. These include their age, gender, education level, and financial situation.[18-21] lifestyle behaviours factors such as smoking, alcohol consumption[20] and physical inactivity, such as not engaging in exercise[22] or spending excessive time watching television, were also associated with BWM.[23]

The COVID-19 pandemic has significantly impacted the mental and physical health of Chinese international students in Canada.[4] Studies have found that misperceiving their body weight can lead to several health problems. Weight misperception is a significant risk factor for cardiovascular disease (CVD) in both genders, and has a moderating effect on the relationship between obesity indices and CVD risk specifically in women.[24] Females with inaccurate

perception of their body weight are more prone to engage in unhealthy weight management behaviors and experience depressive symptoms.[25] When overweight and obese adults have a misperception about their weight, they are less likely to demonstrate an interest in weight loss and engage in physical activity. These associations exhibit variations based on gender and race/ethnicity.[26] BWM can result in negative self-perception and body image, leading to conditions such as bulimia nervosa.[27] Additionally, perceiving one's body as overweight is associated with an increased risk of suicidality in US adolescents, with a greater risk observed in recent years.[28]

The research suggests that misunderstanding one's body weight can lead to adverse psychological outcomes, such as low self-esteem[28] and poor mental health.[29] It's well-known that self-perceived health status is a robust predictor of actual health status.[30] A prior study has examined the correlation between BWM and self-perceived health status and found that BWM was negatively related to self-perceived health status among Korean adults and adolescents.[31] However, research is lacking on the relationship between BWM and self-perceived overall health, self-perceived mental change and physical health change.

Overall, the literature also shows that a sedentary lifestyle, unhealthy eating habits, and a lack of physical activity can contribute to BWM.[6] With the growing prevalence of BWM among the general population,[15, 26, 32-36] it is essential to identify risk factors such as age, gender, education level, smoking, alcohol consumption and watching. Despite the existing literature on the topic, the prevalence of overweight and underweight body misperception among Chinese international students in Canada remains unclear, particularly during the COVID-19 pandemic.

Given the multitude of stressors that Chinese international students in Canada are already facing, it is crucial to investigate the association between sociodemographic factors, lifestyle behaviors, and the misperception of body weight. Moreover, it is important to understand how BWM among Chinese international students is associated with their overall self-perception of health, mental health, and physical health during the COVID-19 pandemic. Thus, this study aims to bridge this research gap by exploring the relationship between BWM, sociodemographic factors, lifestyle behaviors, and self-perceived health status among Chinese international students in Canada. The results of this study will provide valuable insights into the prevalence of BWM and facilitate identifying strategies for healthcare professionals and researchers to develop effective interventions that can prevent and address adverse outcomes associated with BWM. Additionally, the findings will promote healthy body weight management. Further, this research will aid in determining the support and resource needs of Chinese international students during the pandemic to promote their health and well-being.

1.2 Study Purpose and Hypotheses

Purpose

Using data from a cross-sectional survey among Chinese international students, the study presented in this dissertation aims to:

(1) Estimate the prevalence of BWM among Chinese international students during the second wave of the COVID-19 pandemic.

(2) Assess sociodemographic factors and lifestyle behavior in relation to BWM among Chinese international students during the second wave of the COVID-19 pandemic.

(3) Explore the associations between BWM and self-perceived health status (overall health, mental health and physical health) of Chinese international students during the second wave of the COVID-19 pandemic.

Hypotheses

To test the following hypotheses.

(1) Individuals such as being younger adult, being female, being at a university level, having lower financial status, smoking, and drinking alcohol, watching television may increase the likelihood of misperceiving one's body weight. Conversely, those exercising are more likely to have an accurate body weight perception.

(2) Individuals who misperceive their body weight are more likely to experience poor physical, mental, and overall health.

1.3 Organization of Thesis

This thesis comprises six chapters that discuss the research conducted in this study. Chapter 1 provides an overview of the study. Chapter 2 examines the epidemiological literature to provide context for the COVID-19 pandemic and investigates the link between BWM and health status, including the risk factors for such misperceptions. Chapters 3 and 4 present two different but

related projects in manuscript format, each containing sections for abstract, introduction, conceptual framework, methods, results, discussion, and conclusion. Chapter 5 summarizes the previous chapters' findings, discussing their strengths, limitations, and implications for future research, policy, and practice.

Chapter 2: Literature Review

2.1 Chinese International Students in Canada

A Canadian Bureau for International Education (CBIE) report states that in 2017, Canadian institutions had more than 490,000 international students. About one-third of these students came from China.[37] However, due to the COVID-19 pandemic, the number of Chinese students enrolled in Canadian universities has decreased by 44%. Firstly, the COVID-19 lockdowns have made it difficult for students to travel and study abroad. Secondly, there are diplomatic tensions and border restrictions between countries, making it harder for Chinese students to go overseas. Thirdly, many universities have switched to online teaching, which may not be as appealing to Chinese students. Lastly, due to the pandemic, there have been significant job losses in industries that often employ foreign students, which has likely affected the decision of Chinese students to study abroad.[38] Most Chinese international students in Canada are younger, with over half of them aged 25 or under,[39] with more than half (74% to 80%) aged 25 or under.[37] There is also a significant gender imbalance among international students, with an almost two-thirds female.[40] Approximately 12% of the international student population in Canada comprises students from China.[41] Most Chinese international students in Canada are self-funded and pay for their education.[42, 43]

Previous studies have shown that the COVID-19 pandemic has negatively affected students in Canada,[3, 4] particularly those from low-income families and those with special needs, making them susceptible during the phase of the second wave of the COVID-19 pandemic.[2-4] Therefore,

it is essential to understand how the pandemic is affecting international students in Canada, especially Chinese international students. Therefore, it is vital to understand how the pandemic is affecting international students in Canada, especially Chinese international students. By analyzing their gender, age, education, financial status, and length of study, we can determine their unique needs and develop policies to meet them. It is crucial to ensure that these students can continue to benefit from their education.

2.2 Prevalence of Overweight and Underweight and Related Health Issues

The Body Mass Index (BMI) is an indicator of body fat calculated by dividing a person's weight (in kilograms) by the square of their height (in meters).[44] The BMI classifies individuals as underweight, healthy, overweight, or obese. In the Chinese population, a BMI below 18.5 kg/m^2 is considered underweight, a BMI between 18.5-24.9 kg/m^2 is considered normal, and a BMI above 25-29.9 kg/m^2 or > 30 kg/m^2 is considered overweight or obese.[44] The use of body mass index (BMI) as a measure of body fat is widespread; however, it has some limitations that need to be considered. Firstly, BMI does not consider body fat distribution or distinguish between muscle and fat mass, leading to inaccuracies in some cases.[45] For instance, individuals with a high waist-to-hip ratio may be at risk of health problems even if their BMI is within the healthy range, while athletes or older adults may have inaccurate BMI readings due to their higher muscle mass. Additionally, BMI may not be reliable for certain populations, such as children or pregnant women.[45] But as per CDC, BMI does not measure body fat directly, but BMI is moderately correlated with more direct measures of body fat. Nevertheless, the CDC has reported that while BMI does not measure body fat directly, it is moderately correlated with more direct measures of

body fat. Moreover, research has shown that BMI is strongly associated with various metabolic and disease outcomes, similar to these more direct measures of body fatness.[45]

The BMI is essential to monitor health among Chinese students, as being underweight or overweight can cause various health problems.[44, 46-49] Being underweight can result in serious health problems.[50] It weakens the immune system, makes individuals more susceptible to infections and illnesses, and causes nutritional deficiencies due to a lack of essential vitamins and minerals.[50] It can also lead to decreased bone density, increased risk of osteoporosis, and reproductive issues such as infertility and irregular periods.[50] Being underweight can increase the risk of heart problems and sudden death. Anemia, often caused by iron deficiency, is common among underweight individuals.[50] On the other hand, Being overweight can increase the risk of metabolic diseases such as heart disease, stroke, and diabetes.[51]

The prevalence of being underweight and overweight among students in Canada changes as they get age.[52] Available research and reports primarily focus on overweight and obesity among Canadian students, with prevalence rates ranging from 12% to 21% for overweight and 4% to 9% for obesity. Where boys tend to have higher proportions of excess weight compared to girls. A 2010 survey revealed that 16% to 24% of boys and 9% to 14% of girls believed their bodies were too thin. Limited specific and recent statistics make it challenging to determine the prevalence of underweight among Canadian students.[53] The COVID-19 pandemic has significantly impacted many aspects of daily life, including diet and nutrition.[54] The pandemic may have disrupted these factors despite Chinese society's resilient cultural emphasis on maintaining a healthy weight and access to healthy food.[54] The disruptions to food systems and availability caused by the pandemic have made it difficult for individuals to maintain a balanced and nutritious diet.[54, 55] Further

research is needed to understand the impact of the pandemic on the weight status of Chinese students in Canada, including specific data on weight status perception among Chinese international students during the COVID-19 pandemic and the factors influencing it. This information is crucial for healthcare providers to create a healthy eating plan and address the underweight and overweight risk factors. Further research and data collection are necessary to gain a comprehensive understanding. Monitoring and addressing all aspects of student health, including underweight, overweight, and obesity, is crucial. Implementing comprehensive strategies promoting healthy habits and positive body image is essential for educators, healthcare professionals, and policymakers to enhance the well-being of Canadian students.

2.3 Self-Perceived Body Weight and the COVID-19 Pandemic

Self-perceived body weight refers to an individual's subjective evaluation of their body size, shape, and weight, regardless of their actual body weight or BMI.[56] Before the COVID-19 pandemic, the research found that overweight female students were more likely to take weight-loss measures than those who saw themselves as having a normal weight.[57] Meanwhile, male students saw themselves as too thin.[57] The pandemic has significantly impacted the body weight of the Chinese population in Canada, causing weight gain due to lifestyle changes and reduced physical activity.[58]

Studies have shown that self-perceived body weight is a strong indicator of BWM[59] and is influenced by various factors such as age, gender, education, income, smoking, alcohol consumption, and physical activity.[29, 36, 60, 61] BMI can also influence body weight perception to measure body fatness.[62] Young adults, females, and those with higher education levels are more

likely to be overweight or obese,[36, 60, 61] while sedentary lifestyles can contribute to weight gain.[63] Conversely, exercise can help combat weight gain by increasing energy expenditure and decreasing appetite, while financial stress can lead to increased weight and appetite.[64]

Further research is needed on how Chinese international students perceive their weight during the COVID-19 pandemic, given the impact of various factors on body weight perception. This knowledge is crucial, particularly during times of stress, such as the pandemic, to help healthcare professionals assist individuals in making informed decisions about their health and potentially reduce the risk of obesity. By learning how lifestyle changes, like increasing physical activity, can positively impact body weight perception, individuals may be more likely to make healthier choices.

2.4 BWM (Body Weight Misperceptions)

BWM has become a significant concern for public health.[65] Misperceiving their body weight can lead to unhealthy eating habits and obesity, associated with various chronic diseases and health risks.[66] Overeating and undereating can result in harmful dieting practices and negatively impact one's physical and mental well-being.[67]

Distorted body image and a false perception of one's weight can drive individuals to engage in restrictive or extreme dieting, resulting in malnutrition, eating disorders, and other health problems.[68] It is crucial to have a balanced and nutritious diet, engage in physical activity regularly, and have a healthy relationship with food and one's body to maintain a healthy weight.[69, 70]

Accurately measuring body weight and size is essential for understanding the health risks of obesity and developing effective interventions.[71] Studies have explored the combination of BMI and self-perceived weight to measure BWM.[72, 73] In one study, BMI and self-perceived weight were positively correlated, with self-perceived weight being a better indicator of BWM than BMI alone.[73] In another study, BMI and self-perceived weight were significant predictors of BWM.[31] However, self-perceived weight was more strongly associated with BWM than BMI.[31, 72]

It is important to note that while BMI is an objective measure of weight status based on height and weight, self-perception is a subjective measure of a person's perceived body weight. On the other hand, self-perception is a subjective measure of a person's perceived body weight. It is essential to understand that they are different measures, and a person's self-perception can differ from their actual weight and BMI, leading to weight misperception.[31] Health professionals may consider a combination of objective measures, such as BMI, and subjective measures, such as self-reported weight and body image when evaluating a person's overall health status and risk for disordered eating behaviours.[31, 59, 74]

2.5 Sociodemographic Predictors of BWM (Body Weight Misperception)

Research indicates that different factors such as age, financial situation, and gender can affect how people perceive their own body weight.[19, 21] For instance, studies have found that younger people and those with lower socioeconomic status are more likely to have a distorted body image and overestimate their weight than older individuals.[65] Women are also more likely to overestimate their body weight due to the greater emphasis on thinness in Chinese culture.[12, 36]

Studies found that younger age, lower education level, lower financial status, male gender, and shorter study length were all associated with a higher risk of BWM.[16, 19, 21]

University students experience a substantial increase in body weight and body fat from their freshman to senior year of university,[75] affecting their eating habits and lifestyle.[76] A more prolonged study duration may increase stress levels,[77] leading to changes in dietary intake and physical activity,[76] which can impact weight, body perception and body image.[78] International students may also face cultural and environmental differences that affect their eating patterns and body weight,[12] contributing to BWM.[79]

Literature highlights the need for support and resources to promote healthy weight and body image in students. Addressing this research gap by exploring the impact of these factors on BWM amongst Chinese international students will enable informed interventions to reduce the risk of BWM effectively.

2.6 Lifestyle Behaviors is a Predictor of BWM (Body Weight Misperception)

The COVID-19 pandemic has had far-reaching impacts on public health, including a rise in BWM.[66] A correlation exists between pandemic-related worry or anxiety and increased substance use; individuals with substance use disorders face a higher risk of severe COVID-19 illness.[80] The second wave of the pandemic has caused significant disruptions to daily routines, leading to increased stress and anxiety levels, which may lead to unhealthy coping strategies such as overeating, snacking,[9, 10] and decreased physical activity.[81] The pandemic has resulted in adopting unhealthy lifestyles.[5, 6] Lifestyle behaviours, including smoking, alcohol consumption,

exercise, and television watching, have been linked to BWM.[23, 80-84] Smokers overestimate their body size and have a more positive body image than non-smokers.[85] At the same time, alcohol consumption is associated with perceiving oneself as thinner [86], and exercise protects against misperception.[21, 31] Conversely, watching more television has been linked to perceiving oneself as heavier than one's weight.[82]

The impact of the second wave of the COVID-19 pandemic has been even more severe on people's lives.[87-89] Due to the pandemic, unhealthy lifestyle habits have become more common, causing an increase in the misperception of body weight. However, there is a lack of research on the impact of these lifestyle habits on BWM among Chinese international students during the pandemic. Hence, it is crucial to research how these lifestyle habits affect Chinese international students' BWM and body weight perception.

2.7 Body Weight Misperception and Health Risk (Self-Perceived Overall Health, Mental Health, and Physical Health)

BWM is an issue that is increasingly gaining attention in the medical and public health fields due to its association with a range of adverse health outcomes.[17, 31, 33, 90] Research has shown that individuals' body weight perception is associated with their overall health, including physical and mental health.[17, 31, 33, 90, 91] Specifically, body misperception is associated with an increased risk of or overweight or obese,[92] coronary heart disease,[24, 86] Type 2 diabetes,[93] lower self-esteem,[94] self-harm and suicide,[25, 95] and higher levels of depression, anxiety, and stress.[25, 33]

Moreover, evidence suggests that BWM is associated with an increased risk of being

underweight[31] and developing eating disorders.[91] BWM was found to be pervasive among the general population. It contributes to various severe mental illnesses, such as body dysmorphic disorder, anorexia nervosa, and bulimia nervosa.[27, 33, 50, 96, 97] The consequences of having a distorted body image can be severe and even life-threatening in some cases.[97]

The COVID-19 pandemic has resulted in decreased physical activity due to isolation and quarantine[87, 88] and increased levels of anxiety, depression, and stress,[4] which have all been linked to unhealthy eating habits.[54, 58] Physical activity is essential to healthy weight management.[98, 99] The lack of access to physical activities due to the pandemic impacted individuals' ability to maintain a healthy weight.[100] Limited access to healthcare, social and educational activities have led to [3] increased stress levels,[9] anxiety, depression, and other mental health problems,[33, 95] These problems can cause changes in eating habits, physical activity, and appetite, resulting in unhealthy weight gain or loss.[9, 10]

These lifestyle changes can lead to misperceptions about body weight and an increased risk for health complications. [13, 17, 26, 31, 33, 50, 86, 90, 92] Poor body image can affect an individual's physical and psychological well-being, influencing self-esteem, mood, sense of competence, social integration, and occupational performance.[28, 61] The strong predictive power of self-perceived health status on actual health status is widely recognized.[30] A previous study explored the link between BWM and self-perceived health status, revealing a negative association between BWM and self-perceived health status.[31]

However, research on the association between BWM and self-perceived mental and physical health remains scarce. Despite the importance of the issue, there is a lack of research on the impact of BWM on the health of Chinese international students, particularly during the

COVID-19 pandemic. Further research is needed to examine the association between BWM and self-perceived health status (overall health, mental health, and physical health) among Chinese international students in Canada during the COVID-19 pandemic

2.8 Literature Summary

The COVID-19 pandemic significantly impacted BWM. Several studies have found that among Chinese international students, sociodemographic factors such as female gender, younger age, lower socioeconomic status, and lifestyle behaviours factors are associated with BWM. In addition, Social distancing and quarantine protocols have further exacerbated the issue, leading to restricted physical activity, unhealthy eating habits, and increased levels of anxiety, depression, and stress. BWM has been linked to a variety of physical and psychological health problems, including obesity, coronary heart disease, and Type 2 diabetes, lower self-esteem, self-harm, suicide, depression, anxiety, stress, impaired social functioning, social isolation, reduced socialization, and poorer quality of relationships. Therefore, there is a need for further research into the impact of sociodemographic factors and lifestyle Behaviours risk on BWM among Chinese international students during the pandemic. The pandemic has made BWM more prevalent, potentially leading to various adverse health outcomes. Hence, exploring the association between BWM and self-perceived physical, health, mental health, and overall health among Chinese international students during the COVID-19 pandemic is essential.

2.9 Conclusion

The COVID-19 pandemic has emphasized the need to examine BWM, its associated sociodemographic factors and lifestyle behaviours, and its impact on self-perceived overall health, mental health, and physical health. The COVID-19 pandemic second wave has had a particularly significant impact on students in Canada, making it even more crucial to identify potential health risks associated with weight misperception in this context. The findings from this review demonstrate the importance of considering sociodemographic and lifestyle factors and health status when studying weight misperception. This research can inform the development of effective prevention programs for unhealthy weight and BWM in similar contexts, particularly in the event of future outbreaks of the COVID-19 pandemic. Further research is necessary to understand the consequences of weight misperception better and identify associations for promoting overall health and well-being in the face of pandemics like COVID-19.

Chapter 3: Manuscript 1

Assessing Body Weight Misperceptions and Associated Factors among Chinese International Students in Canada during the COVID-19 Pandemic: Results from an Online Cross-Sectional Study

Authorship Statement

Author contributions

The manuscript resulted from a collaborative effort by a team of authors who each contributed unique skills and expertise. Kashish Jafri, the first author, oversaw the manuscript's intellectual content, including its conception, design, drafting, and critical revision. Jafri also played a crucial role in survey design, statistical analysis, and result interpretation.

Dr. Peizhong Peter Wang, the second author of this research, played a vital role as the principal investigator responsible for the study's design and data collection. His active involvement ensured the quality of the study's methodology and data collection.

Dr. Shree Mulay and Dr. Delphine Grynszpan provided valuable feedback, which improved the manuscript's overall quality. By clearly defining each author's role and responsibilities, the team ensured that the manuscript was thorough and accurate.

3.1 Abstract

The COVID-19 pandemic and preventive measures have significantly impacted global health, leading to lifestyle changes and increasing concern about BWM (body weight misperception). This study aimed to examine the relationship between BWM (a phenomenon in which individuals have an inaccurate perception of their body weight) and sociodemographic factors and lifestyle behaviors among Chinese international students in Canada during the second wave of the COVID-19 pandemic.

An online cross-sectional study was conducted using targeted sampling from (February 7th and May 31st, 2021). Data were collected from 296 eligible study participants through targeted sampling. Univariate, bivariate descriptive analyses and multivariate binary logistic regression analyses were used. The study found that 29.1% of the participants misperceived their weight as overweight and 7.5% as underweight. Females had higher odds of reporting underweight misperception with an odds ratio of 1.96 (95% CI=1.13-3.40). Those with unsatisfactory financial status and who watched more television had higher odds of overweight misperception with corresponding odds ratios of 2.84 (95% CI= 1.39-5.82) and 1.92 (95% CI= 1.09-3.34), respectively. However, who exercised during the COVID-19 pandemic were found to have a lower likelihood of overweight misperception (OR=0.56, 95% CI= 0.32-0.98).

The study highlights the prevalence of overweight misperception, particularly among those with unsatisfactory financial status and increased television watching, and suggests the need for targeted interventions to improve weight perception and prevent the development of unhealthy weight-related behaviors. The finding that females were more likely to have an underweight

misperception emphasizes the need for gender-specific approaches to promote accurate weight perception and prevent the development of eating disorders.

Keywords: BMI (body mass index), BWM (body weight misperception), sociodemographic factors, lifestyle behaviors, Chinese international students, COVID-19 pandemic.

3.2 Introduction

The Covid-19 pandemic has significantly impacted the lifestyles of many people worldwide [3, 87-89], including Chinese international students in Canada.[2, 4] The second wave of COVID-19 in Canada was harsher than the first,[3, 88, 101] such as, public health control measures with the closure of gyms and schools and the restrictions on social gatherings, As a result, people have been spending more time at home, which has resulted in increased snacking and sedentary behaviors.[6, 102] These changes in lifestyle have led to weight gain for many people, which may affect their body weight perception.[8] Due to the pandemic, people may experience psychological stress, leading to changes in eating behaviors and body weight.[9] This is especially concerning because an increased body weight can lead to health issues, such as obesity and related chronic diseases[103].

Studies have shown that Chinese students are more likely to be dissatisfied with their weight and body shape than their Canadian counterparts.[11, 12] This discrepancy may be due to cultural differences in how Chinese students perceive their weight.[11] In China, being overweight is often seen as a sign of good health and prosperity, whereas in Canada, being overweight is often seen as unhealthy and undesirable.[104] This discrepancy in cultural norms can lead to BWM and feelings of self-consciousness among Chinese students trying to adjust to life in a new country.[105]

Body weight misperceptions (BWM) refer to the discrepancy between an individual's perceived and actual body weight.[13, 29, 57] Individuals who are overweight or obese often underestimate their body weight, while those who are underweight often overestimate their body weight.[15] Studies also indicate that BWM is common among university students.[15-17]

In Canada, Chinese students represent a significant percentage (34.1%) of international students attending universities.[106] Research on BWM s has traditionally focused on Western populations, but there is a growing body of literature on this topic in other countries and cultures.[12, 105] In China, for example, a recent study found that nearly 44.50 % of Chinese children and adolescents were misperceiving their body weight, with 26.10% perceiving themselves as overweight when they were actually underweight (BMI) and 28.32% perceiving themselves to be underweight when they were actually overweight (BMI).[107] However, there is a research gap on the prevalence of BWM among Chinese international students in Canada, particularly during the COVID-19 pandemic.

Background

BWM (body weight misperceptions) about own body weight are common and include underestimating and overestimating.[13, 19, 105] Previous studies have reported BWM in males and females from various racial/ethnic backgrounds, education levels, financial statuses, lengths of study, and age groups.[16, 19, 21, 60, 108]

Literature has shown that several sociodemographic factors and lifestyle behaviours are associated with BWM. In general, women are more likely to misperceive their body weight than men, especially women who are underweight.[19] Girls tended to overestimate their weight (26.10%), while boys tended to underestimate their weight (28.32%).[36] Boys, especially those in higher grades and wealthier districts, were more likely to misperceive body weight.[36] In addition, younger adults are more likely to misperceive their body weight than older adults, [109] particularly

those who are overweight or obese.[109] Other sociodemographic factors associated with BWM include education and income.[21, 109]

Regarding lifestyle behaviors, BWM are more common among less physically active people with poorer dietary habits.[66, 84, 91, 107, 108] In addition, those who watch more television[23, 82] and are exposed to more Western media images are more likely to misperceive their body weight.[23, 82, 110] Smoking and drinking alcohol are the most common risk factors for developing BWM.[20, 80, 83, 85, 86, 108] Research has shown that people who smoke are more likely to underestimate their body weight and that people who drink alcohol they were overestimating their body weight.[109] Also, the high prevalence of weight misperception was closely related to unhealthy weight patterns[36] and unhealthy lifestyles[111] or exercise patterns.[107] Exercise has a significant impact on body weight perception. Individuals who exercise regularly are more likely to have a positive body image and be satisfied with their weight.[81]

According to previous research, health risks associated with BWM include eating disorders,[72] body dysmorphic disorder,[112] and general poor body image.[65] Individuals who are misperceived as overweight and underweight are more likely to suffer from adverse health consequences,[21] including high blood pressure, diabetes, heart disease,[24] unhealthy weight loss and malnutrition.[27, 50, 96] Recognition of the BWM as a public health concern could decrease misperception,[113] while exposure to negative weight-related images and weight stigmatization could further exacerbate body weight inaccuracies.[114] However, no research has been done on BWM and associated factors among the Chinese international student population during Canada's the context of the COVID-19 pandemic.

The COVID-19 pandemic has highlighted the need for this research on the prevalence of BWM among Chinese international students. This issue has been brought to the forefront by the COVID-19 pandemic. Research into the contributing factors for these misperceptions is needed to develop evidence-based health policies and targeted interventions to help Chinese international students maintain a healthy weight during future pandemics. Such interventions could mitigate the devastating risk to their health caused by unhealthy weight gain or loss.

Therefore, based on a literature review, I hypothesized that individuals are more likely to misperceive themselves as overweight. Factors such as being younger, being female, being at a university level, having lower financial status, smoking, and drinking alcohol, watching television may increase the likelihood of misperceiving one's body weight as overweight compared to underweight. Conversely, those exercising are more likely to have an accurate perception than overweight and underweight misperceptions

This study aimed to describe the prevalence of BWM among Chinese international students in Canada during the COVID-19 pandemic and measure BWM associated factors.

3.3 Methods

3.3.1 Procedure and Participants

This cross-sectional study was conducted as part of the "COVID-19 Impact on Students" project during the second wave of the pandemic between February 7th and May 31st, 2021. The Health Research Ethics Authority reviewed and approved the study protocol at Memorial University of Newfoundland (20201772-ME). The study population was Chinese international

students enrolled in Canadian institutions and was selected using a targeted sampling approach. A pilot study was done among 27 people before the participants were recruited through online survey distribution on social media platforms like WeChat and Facebook, as well as official institutes and organizations such as the Consulate General of China in Toronto, the International Student Office at Memorial University, and several Chinese Student Associations at different universities in Canada. The sample selection process involved three stages: participants had to be 16 years or older, currently enrolled in a formal education institute or recently graduated in 2021, and international students at the time of the study. Individuals who did not provide their age and gender information were under 16 years old and declined to participate in the survey were excluded from the study.

3.3.2 Data Collection

During the second wave of the COVID-19 pandemic, an online survey questionnaire was used to collect data from February 7th to May 31st, 2021. The survey was built in Qualtrics TM and was available in simplified Chinese, traditional Chinese, and English. A total of 492 respondents participated in the survey, and 296 of these respondents were eligible Chinese international students included in the study. Participation in the survey was voluntary, have a right to skip survey questions if they didn't want to answer to secure their privacy and each respondent obtained informed consent electronically. Only consenting individuals proceeded, and participation in the survey was anonymous.

The survey questionnaire consisted of three parts. The first part aimed to gather general sociodemographic information about Chinese international students in Canada, such as age,

gender, education level, and financial status. The second part focused on measuring the students' lifestyle behaviors, specifically their smoking, alcohol consumption, and exercise habits. Finally, the third part gathered self-reported data on the students' body height and weight, which were then used to calculate their BMI and respondents were asked to estimate their self-perception of their body during the COVID-19 pandemic. After completing the survey, participants could enter their email addresses for a prize draw with a CAD 25 electronic gift card (40 prizes). The email address was not linked to survey data and was used exclusively for the prize draw. Finally, identifiers, such as WeChat IDs and email IP addresses, were removed from the final analysis.

3.3.3 Measures

Outcome Variables

The study evaluated BWM by comparing the self-perception of participants' body weight with their actual weight status (BMI). It was determined by calculating their body mass index (BMI) by dividing their weight in kilograms by their height in meters squared. As per the world health organization (WHO), BMI categories were defined as underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), and obesity (30 or greater). Participants were asked to rate their current weight on a 5-point Likert scale, and their responses were grouped into three categories: "underweight" (including "underweight" and "slightly underweight"), "just right" (normal), and "overweight" (including "slightly overweight" and "overweight"). Misperceptions were identified when participants' self-perceived weight did not align with their actual BMI status, resulting in either overweight or underweight misperceptions.

BWM (Body Weight Misperception)

Overweight misperceptions were identified when participants perceived themselves as slightly overweight or overweight despite having normal BMIs. Accurate perceptions were identified when participants perceived their weight as "just right" when their BMI was normal.

Underweight misperceptions occurred when participants perceived themselves as slightly underweight or underweight despite having normal BMIs. Accurate perceptions were identified when participants perceived their weight as "just right" when their BMI was normal.

Explanatory Variables

The study analyzed sociodemographic factors, including age, gender, education, study duration, financial status, and lifestyle behavior factors, such as smoking, drinking alcohol, and exercising, as explanatory variables, in response to the COVID-19 pandemic. Based on the literature review, the independent variables chosen for the multivariate binary logistic regression model were age, gender, education, length of study, financial status, smoking, drinking, alcohol, and exercising. All variables were categorical and recoded into smaller categories using visual binning and theoretical considerations for a more straightforward solution. The variables were recoded as 2-level or 3-level to improve clarity and reduce distribution skewness.

Sociodemographic factors

This study measured several demographic variables, including age, gender, educational levels, study duration, and financial status. Age was categorized as follows: 1 = "less than 20 years

old", 2 = "20-24 years old", and 3 = "25 years old or above". Gender was coded as 1 = "male" and 0 = "female". Educational levels were classified as 1 = "less than undergraduate" and 2 = "undergraduate and above" (including Master, Ph.D., and postdoctoral fellowship). Study duration was assessed by asking, "What is the total number of years you have studied abroad?" Responses were measured as 1 = "less than one year," 2 = "2-4 years," and 3 = "more than five years." The financial status referred to the participants' subjective economic status, with responses measured on a five-point Likert scale: 1 = "Very dissatisfied," 2 = "Not satisfied," 3 = "Neutral," 4 = "Satisfied," and 5 = "Very satisfied."

Lifestyle behavioral factors

The study evaluated lifestyle factors such as smoking and alcohol consumption by asking participants to rate their behaviour on a 6-point Likert scale. The question asked was, "Do you have the following behaviours?" Participants were assured that their answers would remain anonymous. If they found it inconvenient to answer, they could choose not to respond (option 6), but these participants were excluded from the analysis. Responses of "1=Yes, more frequent compared to prior to the pandemic," "2=Yes, same frequency compared to prior to the pandemic," and "3=Yes, less frequent compared to prior to the pandemic" were combined and indicated as "1=Yes." On the other hand, responses of "4=I used to do it before the pandemic, but not now, or I have quit" and "5=Never" were combined and indicated as "0=No."

The study assessed the participants' engagement in physical exercise and watching television during the pandemic as stress-relieving and emotion-regulating activities. The participants were asked the question, "During the pandemic, what activities did you use to help

you relieve stress and regulate emotions?" responses were measured on a binary scale, with "1=Yes" indicating engagement in the activity and "0=No" indicating non-engagement.?"

The study included BMI as a covariate because it can influence the outcome variable of BWM. By controlling for BMI in the statistical analysis, the researchers obtained a more accurate estimate of the relationship between sociodemographic and lifestyle factors and BWM. This increases the validity and reliability of the findings, making BMI an essential measure in the study. The study used BMI calculated by dividing weight in kilograms by the square of height in meters. The categories were defined as underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), and obesity (30 or greater). These categories were then collapsed into underweight, normal, and overweight/obesity. The participants' current weight was assessed using this scale and categorized accordingly.

3.3.4 Statistical Analysis

The statistical analysis was conducted in four stages. Firstly, univariate analysis was performed to present participant characteristics as percentages. Next, cross-tabulation was used to compare self-perceived weight status with objective weight status based on BMI. Kappa statistics were then used to measure the agreement between self-perceived weight status and accurate weight status based on BMI and to calculate the BWM. Secondly, bivariate analysis was conducted using Pearson's Chi-square to assess the association between BWM and socioeconomic and lifestyle behavior factors. Thirdly, multivariate binary logistic regression (BLR) was used to determine the influence of socioeconomic and lifestyle behavior factors on BWM (overweight misperception and underweight misperception). The multivariate binary logistic regression aimed to explore the

strength of association with each predictor and was estimated using odds ratios with a 95% confidence interval. The data analysis was conducted using the IBM Statistical Package for Social Sciences (version 16.0) and SAS (version 9.4) for Windows software.

3.4 Results

3.4.1 Baseline Characteristics and Descriptive Statistics of Participants across BMI, Self-Perceived Weight, Sociodemographic and Lifestyle Behaviors Variables Characteristics

The baseline sociodemographic and lifestyle characteristics of the study sample (N=296) are presented in (Table 3.1). The majority of the participants were either below 20 years old (N=124, 41.9%) or between 20-24 years old (N=105, 35.5%). In terms of gender, (N=177, 59.8%) of participants were female, and a substantial proportion of them had attained a high level of education, with (N=123, 41.5%) having an undergraduate degree and (N=77, 26.1%) having a graduate degree or higher. A large number of participants (N=156, 64.5%) had studied for 2-4 years. With regard to financial status, (N=128, 43.2%) reported being neutral, (N=87, 29.4%) reported being satisfied, and (N=81, 27.4%) reported being dissatisfied.

Smoking was reported by only a small proportion of participants (N=21, 8.6%), while (N=69, 28.4%) reported drinking alcohol. However, the majority of participants reported engaging in regular exercise (N=190, 64.2%) and watching television (N=189, 63.9%). The study also measured body mass index (BMI) and self-perceived body weight. The majority of participants had a normal BMI (N=140, 61.7%), but a significant proportion of participants (N=123, 50.0%)

perceived themselves as overweight. This finding suggests a possible misperception of body weight, which may have implications for their health and well-being.

Table 3.1: Baseline Characteristics and Descriptive Statistics of Participants across BMI, Self-Perceived Weight, Sociodemographic and Lifestyle Behavior Factors Variables.

Variables	Categories	N (%) = 296(100)
Age	Less than 20 years old	124(41.9)
	20 – 24 years old	105(35.5)
	25-year-old and above	67 (22.6)
Gender	Female	177 (59.8)
	Male	119(40.2)
Education Level	Less than undergraduate	96 (32.4)
	Undergraduate	123(41.5)
	Graduate and above	77(26.1)
Study length^	Less than 1 year	29 (11.0)
	2-4 years	156(64.5)
	5 years and more	57(23.5)
Financial Status	Dissatisfied	81(27.4)
	Neutral	128(43.2)
	Satisfied	87(29.4)
Smoking ^	Yes	21(8.6)
	No	224(91.4)
Alcohol consumption ^	Yes	69(28.4)
	No	174(71.6)
Exercising	Yes	190(64.2)
	No	106(35.8)
Watching Television	Yes	189(63.9)
	No	107(36.1)
BMI (body mass index) ^	Underweight	42(18.5)
	Normal	140(61.7)
	Overweight/Obese	42(19.5)
Self-perceived body weight ^	Underweight	48(19.5)
	Just right	75(30.5)
	Overweight	123(50.0)

^ indicate responses with missing values; missing values were not included in the analysis

3.4.2 Bivariate Analysis Association between Self-Perceived Weight and Sociodemographic and Unhealthy Lifestyle Factors.

The present study investigated the relationship between self-perceived body weight and various predictor variables among Chinese international students during the COVID-19 pandemic. The results of the bivariate associations, presented in (Table 3.2), highlight that individuals who were dissatisfied with their financial situation ($\chi2=10.08$, $P=0.039$) and did not engage in regular exercise ($\chi2=7.789$, $P=0.020$) were more likely to perceive themselves as overweight.

Furthermore, BMI ($\chi2=93.308$, $P<0.001$) was found to be significantly associated with self-perceived body weight, with a substantial number of individuals perceiving themselves as overweight or obese despite having a normal BMI. Notably, (N= 66, 47.1%) of individuals with a normal BMI perceived themselves as overweight or obese. Conversely, only (N=18, 12.9%) of individuals with a healthy BMI perceived themselves as underweight, indicating a significant gap between perceived and actual body weight. In contrast, the lack of significant associations between self-perceived body weight and age, gender, education level, study length, smoking, alcohol consumption, or television-watching habits may be attributed to the complexity of body weight perception. Other factors, such as individual body image ideals, cultural influences, or psychological factors, could play a stronger role in shaping how individuals perceive their body weight. These findings suggest a crucial need to address the gap between individuals' perceived and actual weight to promote healthy lifestyle and improve overall well-being.

Table 3.2: Bivariate Association between Self-Perceived Weight and Sociodemographic and Unhealthy Lifestyle Factors.

Variables	Categories	Body weight Perception			*(Chi x2 ,P value)*
		Underweight (N %)	Just right (N %)	Overweight (N %)	
Age	Under 20 years old	23(21.7)	32(30.2)	51(48.1)	(1.947,0.745)
	20 - 24 years old	16(18.6)	29(33.7)	41(47.7)	
	25-year-old and above	9(16.7)	14(25.9)	31(57.4)	
Gender	Male	27(26.5)	28(27.5)	47(46.0)	(5.387,0.067)
	Female	21(14.6)	47(32.6)	76(52.8)	
	Less than undergraduate	17(19.5)	28(32.2)	42(48.3)	(0.249,0.992)
Education level	Undergraduate	18(19.4)	27(29.0)	48(51.6)	
	Graduate and above	13(19.7)	20(30.3)	33(50.0)	
Study length	Less than 1 year	4(17.4)	6(26.1)	13(56.5)	(3.423,0.489)
	2-4 years	31(22.0)	39(28.9)	65(48.1)	
	5 years and more	5(11.4)	16(35.4)	23(52.3)	
Financial Status	Dissatisfied	8(12.5)	16(25.0)	40(62.5)	(10.081,0.039)
	Neutral	26(23.8)	29(26.6)	54(49.6)	
	Satisfied	14(19.2)	30(41.1)	29(39.7)	
[b]Smoking	Yes	3(15.0)	7(35.0)	10(50.0)	(0.297,0.861)
	No	43(19.4)	68(30.6)	111(50.0)	
[b]Alcohol	Yes	16(23.5)	16(23.5)	36(15.0)	(2.748,0.253)
consumption	No	30(17.4)	58(30.8)	99(52.7)	
Exercising	Yes	16(15.1)	42(39.6)	48(45.3)	(7.789,0.020) *
	No	32(22.8)	33(23.6)	75(53.6)	
Watching	Yes	31(16.5)	58(30.8)	99(52.7)	(4.896,0.086)
Television	NO	17(29.3)	17(29.3)	24(41.4)	
BMI	Underweight	26(61.9)	12(28.6)	4(9.5)	(93.308,<0.001)*
	Normal	18(12.9)	56(40.0)	66(47.1)	
	Overweight/Obese	1(2.2)	2(4.5)	42(93.3)	

a. a Difference of self-perception body weight was evaluated using Pearson chi-square tests
b. b when those who refused to disclose were excluded from the analysis
*c. -*Asterisks indicate significance; the p-value was < 0.05.*
d. ^ indicate responses with missing values; missing values were not included in the analysis.

3.4.3 Kappa Agreement between Body Weight Perception and BMI (Body Mass Index/ Weight Status)

In Table 3.3 presents the outcomes of a study that explored the relationship between actual weight status and body weight perception among Chinese international students using BMI as a measure. The results of the study revealed that 18.5% of the total participants were underweight, while 61.7% had a normal body weight and 19.5% were overweight. However, 19.8% perceived themselves as underweight, 30.8% as having a "just right" weight, and 49.3% as overweight or obese.

These findings underscore the significance of accurate body weight perception and its impact on overall health outcomes. The agreement between actual weight status and body weight perception was found to be moderate, with a squared kappa coefficient of 0.41 (95% CI: 0.32-0.49, $p < 0.001$). The prevalence of underweight and overweight misperceptions was also noted in Table 3.3. Specifically, among "normal weight" participants, 7.9% misperceived themselves as "underweight," while only 0.4% misperceived themselves as "underweight" when they were actually "overweight." Furthermore, 29.1% misperceived themselves as having an "overweight" weight, while 1.8% misperceived themselves as "overweight" when they were actually underweight. Overall, (Table 3.3) results showed that there was a (41%) moderate level of agreement between body weight perception and actual weight status among Chinese international students, with the highest agreement observed for those who perceived themselves as having an "Overweight/obese" weight with normal BMI.

Table 3.3: Kappa Agreement between Body Weight Perception and BMI (Body Mass Index/ Weight Status)

		BMI (Actual weight status)			Squared Kappa	CI Lower	CI upper
		Underweight N (%) 42(18.5)	Normal N (%) 140(61.7)	Overweight N (%) 45(19.5)			
Chinese international Students *(Body weight perception)*	Underweight *45(19.8)*	26(11.5)	18(7.9) †	1(0.4) †	0.41	0.32	0.49***
	Just right *70(30.8)*	12(5.3) †	56(24.7)	2(0.9) ††			
	Overweight/obese *112(49.3)*	4(1.8) ††	66(29.1) † †	42(18.5)			

a. Abbreviation: BMI - body mass index measured by (HC)-Canadian Guideline for body weight classification in Adults; C (95% confidence interval; Cohen's kappa Statistic for Measuring Agreement.
b. "Asterisks indicate significance, the p-value was » ‹ 0.05, w < 0.01.
c. †Underweight misperception: † † overweight misperception.
d. Actual body weight status: underweight (BMI < 18.5 kg/m2), Healthy (18.5 ≤ BMI < 23 kg/m2), overweight (23 ≤ BMI < 25 kg/ m2) /obesity (BMI 2 25 kg/ m2)

3.4.4 Multivariate Binary Logistic Regression [BLR] For Associations between Body Weight Misperception and Sociodemographic Factors among Chinese International Students during COVID-19 Pandemic Wave 2

The results from the multivariate binary logistic regression analysis (presented in Table 3.4) demonstrate a link between sociodemographic factors and BWM. Specifically, the analysis revealed that females (OR=3.18, CI=1.39-7.24) were more likely to have a misperception of being overweight compared to males. Moreover, individuals who were dissatisfied with their financial status (OR=2.84, CI=1.39-5.82) were also more prone to having an overweight misperception.

However, the study found no significant association between BWM and age, educational level, or study length after adjusting for BMI.

Table 3.4: Results of Multivariate Logistic Regression [BLR] For Associations between Body Weight Misperceptions and Sociodemographic Factors among Chinese International Students during the Covid-19 Pandemic Wave 2.

SOCIODEMOGRAPHIC FACTORS		Overweight Misperception		Underweight Misperception	
Variable	**Categories**	**OR**	**95% CI**	**OR**	**95% CI**
Gender	Male	Ref	---	Ref	---
	Female	3.18	(1.39-7.24)**	0.04	(0.36-0.64)
Age	Under 20 years old	Ref	---	Ref	---
	20-24 years old	0.99	(0.31-2.73)	0.51	(0.16-1.55)
	25 years and above	1.06	(0.29-4.57)	0.51	(0.12-2.09)
Education level	Less than undergraduate	Ref	---	Ref	---
	Undergraduate	0.87	(0.32-2.38)	1.55	(0.53-4.48)
	Post-graduate and above	0.56	(0.14-2.31)	1.05	(0.25-4.32)
Study length	Less than one year	Ref	---	Ref	---
	2-4 years	0.84	(0.34-2.06)	0.83	(0.32-2.17)
	5 years and more	0.56	(0.19-1.63)	0.89	(0.35-2.64)
Financial status	Neutral	Ref	---	Ref	---
	Satisfied	0.74	(0.39-1.41)	0.78	(0.43-1.44)
	Dissatisfied	2.84	(1.39-5.82**)	1.97	(0.99-3.89)

a. *Abbreviations: BMI body mass index, OR, odds ratio, Ref, Reference. Values are represented as odds ratios (95% confidence intervals) derived from binary logistic regression analyses.*
b. *Asterisks indicate significance; the p-value was * < 0.05. ** < 0.01.*
c. *Because of > 10% missing data for Body weight misperceptions (overweight and underweight), multiple imputations by chained equations were used on all variables.*
d. *Analyses controlled for body mass index (BMI).*
e. *Odds ratio refers to the odds of incorrect perception of weight status (overweight or underweight misperception) versus accurately perceived as a reference.*

3.4.5 Multivariate Binary Logistic Regression [BLR] for Associations between Body Weight Misperceptions and Lifestyle Behavior Factors among Chinese International Students during the COVID-19 Pandemic Wave 2

The multivariate binary logistic regression analysis results in (Table 3.5) indicate the association between lifestyle behavior factors and BWM among Chinese international students during the COVID-19 pandemic. The study result revealed that among the investigated lifestyle factors, watching television was associated with a higher likelihood of overweight misperception (OR = 1.92, 95% CI = 1.09–3.34). Notably, individuals who exercised during the COVID-19 pandemic had a lower likelihood of overweight misperception (OR=0.56, 95% CI= 0.32-0.98). Smoking and drinking alcohol had no significant association with BWM after controlling for BMI.

Table 3.5: Results of Multivariate Logistic Regression [BLR] for Associations between Body Weight Misperception and Unhealthy Lifestyle Behavior Factors among Chinese International Students during the COVID-19 Pandemic Wave 2

Lifestyle Behavioral factors		***Overweight Misperception***		***Underweight Misperception***	
Variables	**Categories**	***OR***	***95%CI***	***OR***	***95%CI***
Smoking	*No*	*Ref*	---	*Ref*	---
	Yes	*1.83*	*(0.62-5.42)*	*0.80*	*(0.30-2.66)*
Drinking alcohol	*No*	*Ref*	---	*Ref*	---
	Yes	*0.64*	*(0.31-1.07)*	*0.82*	*(0.45-1.51)*
Exercising	*No*	*Ref*	---	*Ref*	---
	Yes	*0.56*	*(0.32-0.98*)*	*0.62*	*(0.35-1.08)*
Watching television	*No*	*Ref*	---	*Ref*	---
	Yes	*1.92*	*(1.09-3.34**)*	*0.82*	*(0.46-1.47)*

a. Abbreviation: BMI, body mass index, OR odd ratio. Values are represented as odd ratios (95% confidence intervals) derived from Binary logistic regression analysis.

*b. * Asterisk indicates significance, the P values was * <0.05, **<0.01.*

c. Because of >10% missing data for body weight misperceptions (Overweight and underweight), multiple Imputation by chained equation was used on all values.

d. Analyses adjusted (controlled) by BMI (Body Mass Index).

e. Odds ratio refers to the odds of the incorrect perception of weight status (overweight or underweight misperception) versus accurately perceived as reference.

3.5 Discussion

This online cross-sectional study among 296 Chinese international students found that most participants had a normal weight based on their body mass index (BMI) presented in (Table 3.1), in contrast to previous research reporting a high prevalence of overweight or obesity globally.[115] Furthermore, the study found a significant association between financial status, exercise, and BMI with self-perceived body weight during the pandemic (Table 3.2), which aligns with previous research indicating that financial stress is associated with increased weight gain.[116] Financial stress can increase weight gain through the production of cortisol, leading to increased appetite and cravings for unhealthy foods.[117] Similarly, anxiety and depression caused by financial stress can also contribute to weight gain.[118, 119] Exercise, on the other hand, can reduce weight gain by increasing energy expenditure, reducing appetite,[120] and lowering cortisol levels.[117, 120] The study also revealed a discrepancy between participants' actual and self-perceived body weight (Table 3.2). In this study, most individuals with a normal weight tend to perceive themselves as overweight, which contradicts previous studies suggesting that BMI is linked to self-perceived body weight because it measures body fat. However, individuals may still perceive themselves as underweight even when they are not.[121]

Overweight and underweight misperceptions are prevalent in contemporary society.[13, 15, 72, 92] This study explored the prevalence and determinants factors associated BWM among Chinese international students and found that overweight misperception is more prevalent among this group. Previous research has consistently identified sociodemographic and lifestyle behavior factors associated with BWM,[13, 15, 20, 21, 29, 66, 91, 92] and this study found that gender and financial status were significant factors associated with weight misperception. At the same time, age and

educational level were not significant factors.

In (Table 3.4) it was found that females had a greater tendency to have an inaccurate perception of themselves as overweight. At the same time, financial dissatisfaction was associated with a higher probability of perceiving themselves as overweight or obese. This research aligns with other studies examining the factors influencing weight perception.[18, 21] For example, a study found that women were more likely than men to misperceive their weight, especially when they were underweight.[18] In particular, among girls, their socioeconomic status predicted individuals' misperceptions of their body weight as healthy despite being overweight.[19, 116] The observation that females are more prone to perceive themselves as underweight during the COVID-19 pandemic, in conjunction with the influence of financial status, implies that gender and socio-economic background are significant determinants of weight perception. Consequently, these results highlight the need to consider gender and financial status when developing interventions to address the issue of weight misperception, particularly during the COVID-19 pandemic.

The results of this study suggest that sedentary lifestyle behaviors, such as watching TV, may increase the likelihood of misperceiving one's weight as overweight. In contrast, physical activity, such as exercise, may reduce the likelihood of misperception (Table 3.5). This study contributes to the existing body of literature on BWM, and the findings are consistent with previous research that has linked lifestyle factors to BWM.[20, 23, 66, 81, 82] For instance, it was noted that overestimating one's body weight status was more common among females, younger individuals, parents with lower education levels, and those who watched more hours of TV daily. On the other hand, underestimating one's body weight status was more common among males and older individuals. Furthermore, examining each gender, it was found that overestimating body weight

status was associated with more TV viewing hours among men while underestimating was positively related to depressive symptoms among women.[122]

There are several possible explanations for the findings of this study. Students who watch more television may be more likely to be exposed to images of thin, idealized bodies, which can lead to a misperception of their body weight.[82, 123] Students who exercise more may be more likely to have a more realistic view of their body weight, as they are more likely to be aware of the changes in their body composition that occur with weight loss or gain.[22, 81, 84] It is consistent with other research that has found that sedentary lifestyle behaviors are associated with overweight and obesity, while physical activity is protective against overweight and obesity.[99, 100, 120] Nonetheless, smoking and drinking alcohol was not significantly associated with BWM.

3.6 Conclusion

This cross-sectional study highlights a significant discrepancy between the actual and self-perceived body weight of Chinese international students in Canada, with overweight misperception being more prevalent. The study's findings emphasize the crucial role of accurate weight perception, especially among females who tend to misperceive themselves as Overweight, leading to unhealthy weight management behaviors. Education and awareness-raising campaigns are needed to address this issue to promote healthy weight management and accurate weight perception among college students. The study also stresses the need for gender and financial status-specific interventions, considering the COVID-19 pandemic's ongoing impact. Promoting physical activity, such as exercising and reducing sedentary lifestyle behavior, as part of weight management interventions is crucial. However, the study's limitations should be acknowledged,

including using self-reported data and excluding other factors influencing BWM, such as cultural and environmental factors, social media use, or exposure to weight-related stigma. Further research is necessary to confirm this study's findings, explore underlying mechanisms behind weight misperception, and assess the effectiveness of targeted interventions to reduce misperception and improve health outcomes. Further research addressing weight misperception can significantly contribute to reducing the burden of being overweight and obese and improving overall health and well-being.

Chapter 4: Manuscript 2

Body Weight Misperception and Health Status of Chinese International Students in Canada during the Second Wave of the Covid-19 Pandemic: Results from an Online Cross-Sectional Study

Authorship statement

Author contributions

The contributions of the authors to this manuscript are as follows:

Kashish Jafri, the first author, led the conception, design, drafting, and critical revision of the manuscript's important intellectual content. Additionally, the first author contributed to the survey design, statistical analysis, and result interpretation.

Dr. Peizhong Peter Wang, the second author, served as the principal investigator for this project and was responsible for study design and data collection. Furthermore, the second author reviewed and provided feedback to improve the manuscript.

Dr. Shree Mulay and Dr. Delphine Grynszpan contributed to this study by providing thoughtful, detailed, and constructive feedback during the review process, which helped in enhancing the study's quality.

4.1 Abstract

The COVID-19 pandemic has adversely affected individuals' health, leading to unhealthy eating habits and changes in body weight, resulting in the misperception of one's weight and increased health risks. This study explored the association between BWM and self-perceived overall health, mental and physical health of Chinese international students in Canada during the second wave of the COVID-19 pandemic.

An online cross-sectional study was conducted using targeted sampling in early 2021. The data were analyzed using bivariate, and multivariate binary logistic regression analysis to assess the strength of the association with OR and 95% CI. The study revealed that females had a higher frequency of being overweight (29.2%) than males (12.5%), while (25.7%) of those under age 20 were underweight. This study also found that individuals with an underweight misperception had higher odds of poor overall health (OR = 1.54, 95% CI: 1.03-2.38) while, there were no significant associations with mental health (OR = 1.03, 95% CI: 0.67-1.56) or physical health (OR = 1.17, 95% CI: 0.78-1.76). However, individuals with an overweight misperception had was no significant association with overall health (OR = 0.65, 95% CI: 0.39-0.95), mental health (OR = 1.35, 95% CI: 0.86-2.11) and physical health (OR = 1.15, 95% CI: 0.75-1.77).

In conclusion, the study's findings indicate that women have a higher BMI than men, and higher education is associated with better health outcomes. Accurate body weight perceptions are crucial for maintaining good health, particularly in the context of underweight misperceptions. However, the study's limited sample size and lack of diversity highlight the need for further research among more extensive and more varied populations to confirm the relationship between

body weight perceptions and health outcomes. Additionally, more research is needed to evaluate lifestyle behaviors modifications aimed at improving healthy weight.

Keywords: COVID-19 pandemic, BWM (body weight misperception), overall health, mental health, physical health, wellbeing, Chinese international students.

4.2 Introduction

BWM (body weight misperception) has been identified as a public health issue with the potential to negatively impact overall health outcomes, including mental and physical health.[13, 15, 66, 72, 91, 122, 124-126] BWM refers to the inaccurate perception of one's body weight, often leading to underestimating or overestimating weight status.[127] BWM can have severe consequences for health behaviours and health, including an increased risk of obesity, eating disorders, and mental health problems.[17, 31, 91]

Researches indicates that people who are dissatisfied with their body size or shape may be more likely to engage in unhealthy behaviors such as dieting, purging, and excessive exercise.[84, 97, 122] Additionally, those with BWM may be more likely to experience anxiety, depression,[35] and low self-esteem and also linked to numerous adverse health outcomes, including obesity,[95, 126, 128] cardiovascular disease,[24, 86] metabolic diseases like diabetes,[93] depression, anxiety,[35] and increased risk of suicide.[33] Chinese international students studying in Canada were also vulnerable during the COVID-19 pandemic and showed health risks concerns.[54, 58] Studies have indicated that BWM is connected to acculturation and the unique stresses of transition in Chinese culture, where thinness and beauty are highly valued.[11, 129] Therefore, the COVID-19 pandemic preventive measure has further exacerbated the health risks among Chinese international students.[58, 130] Students were already experiencing stressors related to academics, adaptation, and language barriers during the COVID-19 pandemic,[2, 4, 58] affecting their health.[130]

While the effects of BWM on the general population's health have been widely researched,[66, 86, 91, 122, 124, 125] research on its impact on Chinese international students' health has been limited. Identifying the association between BWM and overall health, physical health, and

mental health among this population is crucial to develop effective interventions to address this issue. Such research will provide insights into BWM associated with health risks among Chinese international students and inform policies and interventions to promote their health and well-being.

Background

Previous research has established a clear association between BWM and physical health outcomes.[17, 71] Numerous studies have demonstrated that individuals with BWM are at an elevated risk of developing obesity,[44, 61, 126] as well as other chronic health conditions such as cardiovascular disease[24, 86] and type 2 diabetes[93] and hypertension and dyslipidemia.[103] Furthermore, research has also identified a link between BWM and poorer mental health outcomes,[33] such as depression, anxiety,[35, 91] eating disorders,[79] and other mental health issues.[33, 91] Additionally, it has been linked to poorer overall health outcomes,[57, 91] including higher levels of physical illness, lower levels of physical activity,[31] and poorer dietary practices.[91]

In addition, it has been found that BWM is associated with an increased risk of developing metabolic syndrome.[93] Metabolic syndrome is a cluster of conditions that can increase the risk of developing heart disease, stroke, and diabetes.[93, 131] One study found that those with BWM were more likely to have higher fasting glucose levels, triglycerides, and waist circumference,[103] all risk factors for metabolic syndrome.[131]

The COVID-19 pandemic has further highlighted the importance of this issue, as individuals may be more likely to engage in unhealthy eating behaviours,[132] such as overeating

or skipping meals, which can contribute to increased BWM.[72] The association between BWM and the health of Chinese international students in Canada during the COVID-19 pandemic is significant because studies have shown that increased stress and anxiety levels pose health risks for Chinese international students in Canada during the pandemic.[4, 58] These elevated stress and anxiety levels may lead to unhealthy behaviors such as poor eating habits, lack of physical activity, and excessive alcohol consumption.[133] This can lead to an increase in BWM,[79, 95, 105] which can have a negative impact on mental and physical health.[33, 78]

Research has also shown that Chinese people are more likely to experience BWM due to cultural and family influences, gender stereotypes, and body image concerns.[11, 36, 105, 134] Furthermore, the lack of access to health care services and resources due to the pandemic[135] might make it difficult for Chinese international students to access the help they need to address BWM. It is essential to understand how BWM is associated with overall health, mental health, and physical health among Chinese international students in Canada during the COVID-19 pandemic to develop targeted interventions to ensure the health and well-being of this population.

As per the literature review, BWM is an important issue to consider when examining the impact of the COVID-19 pandemic on Chinese international students in Canada. Previous research has demonstrated a link between BWM and physical and mental health worse outcomes.[24, 26, 31, 33, 72, 79, 91, 126] The COVID-19 pandemic has increased stress and anxiety levels,[4, 58] making Chinese international students more vulnerable to developing BWM.

Overall, existing studies have shown a strong association between BWM and negative physical and mental health outcomes,[91] such as obesity,[72] unhealthy behaviors`, low self-esteem,[79, 95] and serious health problems such as depression, anxiety, stress,[91] eating disorders,

diabetes,[93] and heart disease.[86] The COVID-19 pandemic has further emphasized the significance of this issue, as unhealthy eating habits and increased stress and anxiety levels may exacerbate the problem among Chinese international students in Canada. The unique cultural and societal influences on the Chinese population's body image and weight perception also contribute to health issues. However, there is no research has been done on BWM and its association with overall health, mental health and physical health among Chinese international students in Canada, and there is a pressing need for targeted interventions to promote the health and well-being of Chinese international students in Canada.

This study highlights the importance of further exploring the association between BWM and overall health, physical health, and mental health outcomes in this population and developing effective interventions to address this critical public health issue. Therefore, based on the literature review, I hypothesized that those who misperceive their weight are more likely to experience poor self-perceived physical health, self-perceived mental health, and self-perceived overall health. This study aimed to explore the BWM (overweight and underweight) on the health status (self-perceived overall health, mental and physical health) of Chinese international students in context to COVID-19 pandemic.

4.3 Methods

4.3.1 Procedure and Participants

This cross-sectional study is part of the "COVID-19 Impact on Students" project (see Appendix 1). The study protocol was reviewed and approved by Health Research Ethics Authority

at Memorial University of Newfoundland (20201772-ME), carried out during the second wave of the COVID-19 pandemic from February 7th to May 31st, 2021. The study population consisted of Chinese international students studying in Canadian institutions. A targeted sampling approach was used to recruit participants by distributing an online survey through social media platforms, such as WeChat (i.e., the most popular social media platform among Chinese across the globe) and Facebook, or official institutes/organizations such as the Consulate General of China in Toronto, International Student Office at Memorial University, and several Chinese Student Associations at different universities (primarily in Chinese communities) in Canada. The sample selection process was determined in three stages: first, participants must be aged 16 years or older. Secondly, participants currently enrolled in a formal education institute or recently graduated in the year 2021, and lastly, were international students at the time of the study. Moreover, students who didn't respond to their age and gender, who were less than 16 years old and who did not consent to participate in the survey were excluded from the study.

4.3.2 Data Collection

Data collection was carried out from February 7th to May 31st, 2021, with an online survey questionnaire built in Qualtrics TM and delivered in simplified Chinese, traditional Chinese, and English during the second wave of the COVID-19 pandemic. A total of 492 respondents' data were collected, and only 296 Chinese International students were included in this study. This study was carried out with the students who voluntarily wished to participate in the study, and consent was obtained electronically from each respondent before participation. Only consenting individuals were able to proceed. Participation in the study was anonymous.

This study encompasses a four-part questionnaire. The first part collected general sociodemographic information about Chinese international students in Canada, including age, gender, education level, study length and financial status. The second part measures lifestyle behaviors such as smoking, alcohol consumption, watching television and exercising. The third part collects self-reported body height and weight used for BMI calculation. The fourth part collected self-perceived overall health, self-perceived mental health change, and self-perceived physical health change information. After completing the survey, participants had a chance to enter their email addresses to participate in a prize draw to win an electronic gift card of $25 in Canadian dollars (40 prizes in total). The email address was not linked to the survey data and was used exclusively for the prize draw. The final analysis removed Identifiers (WeChat IDs and email IP addresses).

4.3.3 Measures

Outcome Variables

Self-Perceived Overall Health

The question to measure self-perceived overall health was, "In general, how would you rate your overall health?". The self-perception of overall health was evaluated using a 5-point Likert scale (1=excellent, 2=very good, 3=good, 4=Fair, 5=poor) with responses collapsed into binary responses for logistic regression purposes, with the categories Good (1, 2 & 3) and Poor (4 & 5).

Self- Perceived Physical Health Change Status

Participants were also asked to rate their physical health. "Compared prior to the pandemic, how would you rate your physical health?" The self-perception of physical health was evaluated using a 5-point Likert scale (1= much worse, 2= worse, 3=no change, 4=better, 5=extremely better) with responses collapsed into binary responses for the logistic regression analysis purposes, with the categories worse (1, 2) and Not worse (3, 4& 5).

Self-Perceived Mental Health Change Status

Participants were also asked to rate their mental health. "Compared prior to the pandemic, how would you rate your mental health?" The self-perception of mental health was evaluated using a 5-point Likert scale (1= much worse, 2= worse, 3=no change, 4=better, 5=extremely better) with responses collapsed into binary responses for the logistic regression analysis purposes, with the categories “worse” (1, 2 & 3) and “Not worse” (3, 4 & 5).

Explanatory variables

In this study, Body Mass Index (BMI) and self-perceived weight were used to measure explanatory variables (body weight misperception). BMI is calculated based on an individual's self-reported height and weight, which allows for categorization into one of four WHO-defined categories: underweight (BMI < 18.5 kg/m^2), Normal weight (BMI 18.5 to <25 kg/m^2), overweight (BMI 25 to <30 kg/m2), or obese (BMI ≥ 30 kg/m2). Participants were then asked to self-report

their weight perception as either underweight, just right, overweight, or obese. Self-Perceived Weight was used as a measure of an individual's subjective weight perception. BWM was defined as the incorrect perception of one's body weight compared to their actual BMI. The study investigated two types of BWM: underweight misperception (when individuals perceived themselves as underweight despite having a BMI within the normal weight range or overweight range) and overweight misperception (when individuals perceived themselves as overweight despite having a BMI within the normal weight range or underweight range).

Overweight Body Misperception

The variables for measuring overweight body misperception are determined by considering the individual's BMI (Body Mass Index) and self-perceived weight. Overweight body misperception occurs when an individual's subjective perception of their weight does not align with their actual weight status (as determined by BMI). To identify overweight misperception, individuals who perceived themselves as slightly overweight or overweight/obese when their BMIs were normal weight were categorized as having overweight misperception. Additionally, individuals who accurately perceived their weight as "just right" when their BMIs were "normal" were also included in the analysis.

Underweight Body Misperception

The individual's BMI (Body Mass Index) and self-perceived weight were considered to measure underweight body misperception. Underweight misperception is when an individual's weight perception does not match their actual weight status (as determined by BMI). To identify

underweight misperception, individuals who perceived themselves as slightly or underweight when their BMIs were normal weight were categorized as having underweight misperception. Additionally, individuals who accurately perceived their weight as "just right" when their BMIs were "normal" were also included in the analysis.

Participants provided information about a range of characteristics, which could be expected to have an influence on BWM and self-perceived overall health, self-perceived mental and self-perceived physical health. In particular, BMI is an important indicator of health since changeability in body weight increases an individual's risk for numerous diseases. In addition to BMI, it can also influence self-perceived overall health, self-perceived physical health and self-perceived mental health.

4.3.5 Statistical Analysis

This study conducted a bivariate analysis of categorical variables expressed as percentages (%) and classified by body mass index (BMI) to evaluate the prevalence of overweight and underweight across different characteristics. To identify significant associations between explanatory and outcome variables, this study also utilized the robust multivariate binary logistic regression analysis (BLR) to explore the association between BWM (overweight and underweight) and self-perceived mental health change, physical health change and overall health while controlling for the influence of BMI. By employing the odds ratio and 95% confidence interval, this study determined the precise magnitude and significance of the association between the independent and dependent variables. This study used the highly advanced IBM Statistical Package for Social Sciences (version 16.0) and SAS (version 9.4) for Windows software to analyze

all the data meticulously. This study employed a robust statistical analysis and logical thinking approach to uncover the underlying patterns and relationships between various factors.

4.4 Results

4.4.1 Bivariate Descriptive Characteristics of Individuals Based on their BMI (Body Mass Index)

The descriptive characteristics of the total 296 participants by BMI are presented in (Table 4.1). According to the bivariate frequency table, (N=63, 65.4%) of the participants have a healthy BMI. Among those who are 25 years and above, the percentage of overweight participants is higher, at (N=19, 38.8%). Males have a higher percentage of overweight participants (N=28, 29.2%) compared to Females (N=17, 12.8%). Participants with less than undergraduate education have a higher percentage of underweight participants, with (N=24, 28.6%). Interestingly, most participants who studied for 2-4 years have a healthy BMI (N=79, 62.7%). Participants who are satisfied with their financial status have a lower percentage of overweight participants (N=12, 17.6%). Conversely, participants who do not exercise have a higher percentage of overweight participants, at (N=27, 20.6%). Those who watch television have a higher percentage of healthy participants (N=118, 66.7%). Participants who report worse physical health have a higher percentage of overweight participants (N=21, 17.8%). Finally, participants who report worse mental health have a similar percentage of overweight and healthy participants, with both at (N=24, 20.0%). These findings suggest that various factors, including age, gender, education, exercise, and overall health, self-perceived mental health, self-perceived physical health, can influence BMI categories.

Table 4.1: Bivariate Descriptive Characteristics of Individuals Based on their BMI

Variables	Categories	(N=296) BMI (Body Mass Index)		
		Underweight n (%)	Healthy n (%)	Overweight n (%)
Age^	Less than 20 years	*26(25.7)*	*63(65.4)*	*12(11.9)*
	20-24 years	*13(16.5)*	*52(65.8)*	*14(17.7)*
	25-years and above	*4(8.1)*	*26(53.1)*	*19(38.8)*
Gender^	Male	*12(12.5)*	*56(58.3)*	*28(29.2)*
	Female	*31(23.3)*	*85(63.9)*	*17(12.8)*
Education level^	Less than undergraduate	*24(28.6)*	*51(60.7)*	*9(10.7)*
	Undergraduate	*11(12.8)*	*55(60.9)*	*20(23.3)*
	Graduate and above	*8(13.6)*	*35(59.3)*	*16(27.1)*
Study length^	Less than 1 year	*6(26.1)*	*12(52)*	*5(21.7)*
	2-4 years	*26(20.6)*	*79(62.7)*	*21(16.7)*
	5 years and above	*5(12.2)*	*27(65.8)*	*9(21.0)*
Financial status^	Dissatisfied	*6(9.8)*	*42(68.8)*	*13(21.3)*
	Neutral	*23(23.2)*	*56(56.6)*	*20(20.2)*
	Satisfied	*14(20.3)*	*43(62.3)*	*12(17.6)*
aSmoking^	Yes	*2(11.1)*	*9(50.0)*	*7(38.9)*
	No	*38(18.4)*	*132(63.7)*	*37(17.9)*
aDrinking alcohol^	Yes	*9(14.7)*	*33(54.1)*	*19(31.2)*
	No	*30(18.5)*	*108(66.7)*	*24(14.8)*
Exercise	Yes	*12(12.2)*	*68(69.4)*	*18(18.4)*
	NO	*31(23.6)*	*73(55.7)*	*27(20.6)*
Watching television^	Yes	*26(14.7)*	*118(66.7)*	*33(18.6)*
	NO	*17(29.3)*	*17(29.3)*	*24(41.4)*
Overall Health^	Good	*31(19.2)*	*102(63.3)*	*28(17.4)*
	Poor	*12(17.6)*	*39(57.3)*	*17(25.0)*
Physical Health^	Not worse	*27(21.1)*	*80(62.5)*	*21(16.4)*
	Worse	*16(15.8)*	*61(60.4)*	*24(23.8)*
Mental Health^	Not worse	*24(20.3)*	*73(61.9)*	*21(17.8)*
	Worse	*19(17.1)*	*68(61.3)*	*24(21.6)*

a. a when those who refused to respond were excluded from the analysis.
b. ^ indicated responses with missing values; missing values were not included in the analysis.
c. Abbreviations: BMI, body mass index

4.4.2 Body Weight Misperception Association with Self-Perceived Overall Health

The results of the binary logistic regression analysis conducted in this study are presented in Table 4.3. The analysis aimed to examine the association between body weight perceptions and self-perceived overall health. The findings indicate that individuals with an underweight misperception had 1.54 times higher odds of reporting poor self-perceived overall health (OR: 1.54, 95% CI: 1.03-2.38), compared to those with an accurate perception of their body weight. However, individuals with an overweight misperception have a lower likelihood of reporting poor self- perceived overall health (OR: 0.61, 95% CI: 0.39-0.95).

4.4.3 Body Weight Misperception Association with Self-Perceived Mental Health Change

The binary logistic regression analysis conducted in this study aimed to examine the association between body weight perceptions and self-perceived mental health change, and the results are presented in Table 4.3. The odds ratios (OR) and 95% confidence intervals (CI) are reported. The analysis revealed that individuals with overweight misperception had an odds ratio of 1.35 (95% CI: 0.86-2.11), and those with underweight misperception had an odds ratio of 1.03 (95% CI: 0.67-1.56), showing no significant association with self-perceived mental health change.

4.4.4 Body Weight Misperception Association with Self-Perceived Physical Health Change

This study's binary logistic regression analysis aimed to examine the association between body weight perceptions and physical health. The odds ratios (OR) and 95% confidence intervals (CI) for the association are presented in (Table 4.3). The analysis revealed that individuals with

overweight misperception had an odds ratio of 1.15 (95% CI: 0.75-1.77), and those with underweight misperception had an odds ratio of 1.17 (95% CI: 0.78-1.76), showing no significant association with self-perceived poor physical health compared.

Table 4.2: Body Weight Misperception Association with Self-Perceived Overall Health, Self-Perceived Mental Health Change, Self-Perceived Physical Health Changes.

Body weight perceptions		**Overall health**		**Mental health**		**Physical health**	
		OR	***(95% CI)***	***OR***	***(95%CI)***	***OR***	***(95%CI)***
Overweight	No	*Ref*	---	*Ref*	---	*Ref*	---
misperception	Yes	*0.61*	*(0.39-0.95)*	*1.35*	*(0.86-2.11)*	*1.15*	*(0.75-1.77)*
Underweight	No	*Ref*	---	*Ref*	---	*Ref*	---
misperception	Yes	*1.54*	*(1.03-2.38)***	*1.03*	*(0.67-1.56)*	*1.17*	*(0.78-1.76)*

a. *Abbreviation: BMI, body mass index, OR odd ratio. Values are represented as odd ratios (95% confidence intervals) derived from Binary logistic regression analysis.*
b. ** Asterisk indicates significance, the P values was * <0.05, **<0.01.*
c. *Analyses adjusted (controlled) by BMI (Body Mass Index).*
d. *Odds ratio refers to the odds of the overall health (Poor) versus Good as reference, mental health change (worse) versus not worse as reference, and physical health (worse) versus not worse as a reference.*

4.5 Discussion

Obesity is a growing problem worldwide, considered a determinant of BWM, and its association with various health outcomes has been well documented in the literature [7, 126, 136]. Body mass index (BMI) is a commonly used indicator of obesity and underweight. It is often used

in research to examine the relationships between body weight and various health outcomes.[59, 137, 138]

This online cross-sectional study explored the association between BWM and self-perceived overall health, mental health and physical health. Initially, this study's descriptive analysis of the participants by BMI revealed that most participants had a healthy BMI. However, the percentage of overweight participants was higher among those who were 25 years and above. Interestingly, females had a higher percentage of overweight participants than males, and participants with less than undergraduate education had a higher percentage of underweight participants. The study also found several lifestyle behavior factors associated with BMI, including exercise and television-watching habits. Participants who did not exercise had a higher percentage of overweight participants, while those who watched television had a higher percentage of healthy participants, as presented in (Table 4.1).

These findings align with the literature, which has established that BMI is a complex measure influenced by various factors such as age, gender,[136] education,[138] financial status,[139] alcohol consumption, television watching, and physical and mental health.[140, 141] The COVID-19 pandemic has created unprecedented challenges for people worldwide, affecting their physical and psychological well-being, including students [3] and Chinese immigrants [4]. Despite widespread BWM in the general population.[15, 16, 29, 31, 36, 105, 113, 124, 125]

As presented in (Table 4.3), this study found that individuals who misperceived themselves as underweight may be at a greater risk of poor overall health. This study result consisted of the previous research; for example, underweight misperception can lead to an eating disorder, obesity[128] and chronic diseases[103]. However, this study also found an unexpected result that

overweight misperception is less likely associated with poor overall health and the absence of significant associations between BWM and self-perceived mental health and physical health as presented in (Table 4.3). This finding is not consistent with previous studies, which have shown that BWM is associated with poor health outcomes such as obesity [44, 126] cardiovascular disease,[24, 86] type 2 diabetes,[93] eating disorders, and mental health issues[91]. The consequences of a distorted body image can be catastrophic. They can detrimentally influence physical and mental well-being, self-assurance, disposition, capacity, social communication, and job execution [65, 96, 97].

4.6 Conclusion

In summary, this study provides valuable insights into the prevalence of overweight and underweight individuals, with a focus on Chinese international students in Canada. Our findings indicate that older and female participants have a higher risk of being overweight, while those with less than undergraduate education are more likely to be underweight. We also established a significant association between BMI and lifestyle behavior factors, such as exercise and television-watching habits. These results underscore the importance of targeted interventions to promote healthy body weight and lifestyle modifications, especially among high-risk groups.

Furthermore, our study identified an unexpected result that individuals who misperceive themselves as underweight may be at a greater risk of poor overall health and less likely to have a poor overall health. However, we did not find a significant association between BWM and mental health and physical health, which challenges previous research in this area and warrants further investigation among diverse populations.

Despite limitations such as self-reported measures, geographic specificity, limited assessment of lifestyle factors and confounding variables, and the cross-sectional design, our study contributes valuable insights to promote healthy body weight and lifestyle modifications. Our findings might be relevant to other populations, particularly those impacted by the COVID-19 pandemic, suggesting that weight gain and body weight perception may be common concerns among international students and other groups.

In conclusion, this study highlights the need for continued research and intervention efforts to promote healthy body weight and address the complex relationship between body weight perception and health outcomes.

Chapter 5: General Summary of Findings

5.1 Introduction

The COVID-19 pandemic has significantly influenced the lives and health of individuals worldwide, including students studying in Canada. Studies suggest that the pandemic has resulted in a rise in sedentary habits and snacking, contributing to weight gain in many individuals. Furthermore, psychological distress brought on by the pandemic may intensify these lifestyle changes. It has been found that Chinese students are more prone to be dissatisfied with their body weight and shape compared to Canadian students, likely due to cultural disparities in weight perception. While being overweight may be viewed as a sign of good health and prosperity in China, it is usually seen as unhealthy and undesirable in Canada.

This discrepancy in cultural norms may contribute to BWM, which has been associated with various health risks such as obesity, cardiovascular disease, diabetes, depression, anxiety, and suicide. Chinese international students may be particularly prone to these risks during the pandemic due to additional stressors like academics, integration, and language barriers. Although there is research on BWM in western countries, there is a lack of information about the prevalence of BWM among Chinese international students in Canada during the pandemic. Therefore, further investigation is required to gain insight into the relationship between BWM and overall health, physical health, and mental health to develop effective interventions to address this issue among this population.

The research project conducted in this thesis consists of two parts. The first part is an online cross-sectional study on the Factors related to BWM during the second wave of the COVID-19

pandemic among Chinese International students in Canada. The second part is an online cross-sectional study on the BWM association with health status (overall health status, mental and physical health) among Chinese international students in Canada during the second wave of the COVID-19 pandemic. Both parts are presented in Chapters 3 and 4.

This study's objectives were as follows:

1) Estimate the prevalence of BWM among Chinese international students during the second wave of the COVID-19 pandemic.

2) Assess sociodemographic factors and lifestyle behavior factors in relation to BWM among Chinese international students during the second wave of the COVID-19 pandemic.

3) Explore the associations between BWM and self-perceived health status (overall health, mental health and physical health) of Chinese international students during the second wave of the COVID-19 pandemic.

An online cross-sectional study data were collected through targeted sampling and analyzed by bivariate descriptive analyses, Multivariate (BLR) were applied by using IBM Statistical Package for Social Sciences (version 16.0) and SAS (version 9.4) for Windows software. Data from 296 respondents in the second wave of the COVID-19 pandemic that lasted from February 7th to May 31st, 2021, were included in the study.

The results of a study on 296 Chinese international students during the pandemic showed that overweight misperception was more prevalent (29.1%). The study found that there was a significant association between Overweight misperception and female gender (OR=3.18, CI=1.39-

7.24). Additionally, the findings indicated that dissatisfied financial status (OR = 2.84, CI = 1.39-5.82) and watching television (OR = 1.92, 95% CI = 1.09–3.34) were significantly associated with overweight misperception. Additionally, 38.8% of those aged 25 and above were overweight, and 25.7% of those under 20 were underweight, with females having a higher rate of being overweight than males (29.2% vs 12.5%). This study also found that overweight misperception have a lower likelihood of reporting poor self-reported overall health (OR = 0.61, 95% CI = 0.39-0.95), mental health (OR = 1.35, 95% CI = 0.86-2.11), or physical health (OR = 1.15, 95% CI = 0.75-1.77). However, underweight misperception was associated with a higher likelihood of poor overall health (OR = 1.54, 95% CI = 1.03-2.38), but no significant association was found with self-reported physical health (OR = 1.17, 95% CI = 0.78-1.76) and mental health (OR = 1.03, 95% CI = 0.67-1.56).

5.2 Discussion

This study explored the BWM of Chinese international students during the COVID-19 pandemic and found that many participants with a healthy weight misperceived themselves as overweight or obese. Factors such as; gender, financial status, exercise, and watching television were significantly associated with BWM. This finding suggests that individuals of specific demographics are more prone to developing a distorted view of their body image. For example, women in higher education may not accurately perceive their body size due to the pressures to be thin that come with a college lifestyle. Similarly, those with financial insecurity may be more likely to misperceive themselves as overweight due to dissatisfaction with their financial situation. Those who exercised more were more likely to have a realistic view of their body weight. These findings

highlight the need for increased awareness of the sociodemographic and unhealthy lifestyle factors contributing to BWM.

The findings of this study also suggest that underweight BWM significantly associated with poor overall health outcomes, particularly for those who perceive themselves as underweight despite of having overweight and normal body weight. Surprisingly, the study did not find a significant association between BWM and physical and mental health, suggesting that this issue is complex and requires further investigation. These findings emphasize the importance of further researching how misjudging one's body weight can affect overall health. It's also essential to recognize this issue as a mental health risk factor that has been neglected, especially during the COVID-19 pandemic. Therefore, this study emphasizes the requirement for more research to validate the outcomes and evaluate how well-focused interventions can work.

5.3 Conclusion

This cross-sectional study highlights a significant gap between the actual and self-perceived body weight of Chinese international students in Canada, with overweight misperception being more prevalent. The study identifies specific sociodemographic and lifestyle factors, including sex, financial status, exercise habit, and watching television, that significantly contribute to BWM. The potential impact of BWM on overall health outcomes is emphasized, especially for those who misperceive themselves as underweight. While the study did not find a significant association between BWM and physical and mental health, further investigation is required due to the complexity of the issue. The findings underscore the need for increased awareness and targeted interventions, such as education and awareness-raising campaigns, to

promote healthy body image and accurate weight perception among college students. Gender and financial status-specific interventions should also be considered due to the impact of the COVID-19 pandemic. Promoting physical activity, such as exercise and reducing sedentary behavior, is crucial. Although caution should be exercised in generalizing the findings since this was a cross-sectional study, it provides timely information on an understudied population. To reduce the risk of BWM among Chinese international students, lifestyle behavior interventions, financial stability, and tailored health services should be developed. Future longitudinal research would help determine how the associations observed in this study may change over time.

5.4 Strengths

This study has several strengths. Firstly, it is the first to assess BWM and explore the influence of sociodemographic and lifestyle factors on BWM and their effects on overall health, mental health and physical health among Chinese international students in Canada during the COVID-19 pandemic. Secondly, the study was conducted using a cross-sectional design with many participants. Thirdly, the study was conducted online, making it more accessible to a broader audience. Fourthly, because the survey was conducted mid-pandemic, the findings from this study make a unique contribution to existing literature. Finally, as all data were collected online anonymously, study participants could answer questions about sensitive topics without concerns. Thus the results are less likely to be affected by social desirability bias and are likely to reflect the actual underlying facts in this population.

5.5 Limitations

The study had several limitations that must be considered when interpreting the results. Firstly, the use of an online survey during the COVID-19 pandemic may not have provided a representative sample of Chinese international students in Canada, and volunteers may have had a bias towards the epidemic, potentially influencing the results. Moreover, the study was conducted during the peak of the second wave of the COVID-19 epidemic in Canada, so it is uncertain if the findings would differ during different time periods.

Secondly, the study's age range was narrow, which prevented exploration of age-related associations. Additionally, the study focused on a young population with a low prevalence of chronic health conditions, which may limit the generalizability of the results to other populations. Self-reported changes in health status were used, which may have introduced reporting bias and inaccuracies. Also this study used convenience sample, which may introduce selection bias. The study's reliance on volunteers or easily accessible participants could lead to a non-representative sample that may not accurately reflect the broader population. Additionally, the response rate for data collection is not reported, making it difficult to assess potential non-response bias

Thirdly, the study's results were limited to a specific group of Chinese international students in Canada, and the study was cross-sectional, so causality could not be established. Uncontrolled factors such as clothing, hydration levels, pre/postprandial state, and defecation may have impacted measurement accuracy. The study did not measure body fat percentage, which could have provided a more precise measure of body weight.

Fourthly, the findings were limited to participants at least 16 years old to ensure independent consent, which may not reflect the weight misperceptions of younger students. The

study's results were also limited to a specific pandemic period, and other factors may explain the results.

Lastly, this research was not able to fully capture the diverse and complex influences of factors such as media influence, cultural norms, and personal experiences on the prevalence of underweight, overweight, and obesity among students. These factors can vary significantly across different regions, communities, and individual experiences, making it challenging to generalize findings. Furthermore, relying on self-reported data to assess body weight and perception may introduce biases and potential inaccuracies due to social desirability and subjective interpretations. Future research should aim to incorporate qualitative methods and consider a more comprehensive examination of the contextual and individual factors contributing to weight-related issues among students in Canada.

To address these limitations, future studies with larger sample sizes and different measures could consider using multiple logistic regression to provide a more in-depth understanding of these relationships. Moreover, future research with a longitudinal approach could better understand body weight misperceptions and associated health risks among students during different stages of the pandemic. Overall, while the study provides valuable insights, its limitations must be taken into account when interpreting the results.

5.6 Implications

This study suggested that public health interventions should be developed to address the high prevalence of BWM among Chinese international students in Canada during the COVID-19

pandemic. Targeted interventions are needed to address socio-demographic and unhealthy lifestyle factors associated with BWM, prioritizing financial status and excessive television watching as potential risk factors for overweight misperception. Additionally, the study highlights the importance of promoting healthy body weight and dispelling misconceptions about body weight being overweight. Health education programs should address Chinese international students' unique challenges during the pandemic, such as social isolation and reduced access to health services.

Although this study did not find a significant association between BWM and mental, physical, and overall health, the findings underscore the need for future longitudinal research to understand how the associations observed in this study may change over time. Overall, comprehensive public health interventions are needed that address the complex socio-demographic and lifestyle factors contributing to BWM during the pandemic. These interventions should prioritize health education, social support, and access to physical health services.

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Appendices

Appendix 1

Survey Questionnaire Description

(Only Relevant Information was taken from the "Covid-19 Impact on Students Survey" to Conduct this Study)

A0_Screening

Are you currently enrolled in a formal education institution (including those who are newly graduated after March 1, 2020)?

o Yes (1)

o No (0)

A1_StudentType

Are you or were you an international student during the pandemic?

o Yes (My educational institution is different from the country of my nationality/permanent residence) (1)

o No (my educational institution is the same country as my nationality/permanent residence) (0)

A2_Age

Please select your age:

o Under 16 years old (1)

o 16-19 years old (2)

o 20-24 years old (3)

o 25 years old or above (4)

A3_Gender

Please choose your gender:

o Male (1)

o Female (2)

o Other (3) _____

o Choose not to answer (4)

A4_Education

Please select the education you are currently receiving (if you are newly graduated, please choose the most recent education that you have completed):

o Junior high school and below (1)

o High school (2)

o Undergraduate/college (3)

o Post-graduate programs (e.g. master's, PhD's, postdoc fellowship) (4)

o Other (please enter) (5) _____

A5_Legnth

What is the total number of years you have studied abroad? (Including the total years of studying in different foreign countries)

o Less than 1 year (1)

o 2-4 years (2)

o 5 years or more (3)

A7_FinanceStatus

Are you satisfied with your current financial situation?

o Very dissatisfied (1)

o Not satisfied (2)

o Neutral (3)

o Satisfied (4)

o Very satisfied (5)S

B2_SmokeDrinkingMari

Do you have the following behaviours? All your answers are completely anonymous. If you still find it inconvenient to answer, please check "choose not to answer".

	Yes, more frequent compared prior to the pandemic (1)	Yes, the same frequency compared prior to pandemic (2)	Yes, less frequent compared prior to the pandemic (3)	I used to do it before the pandemic, but not now or I have quit (4)	Never (5)	Choose not to answer (6)
Smoking/Vaping (1)	○	○	○	○	○	○
Drinking alcohol products (2)	○	○	○	○	○	○

C1_Health

In general, would you say your health is:

o Excellent (1)

o Very good (2)

o Good (3)

o Fair (4)

o Poor (5)

C11_ComparingBefore

Compared prior to the pandemic, your physical health is:

o Much worse (1)

o Worse (2)

o No change/almost no change (3)

o Better (4)

o Much better (5)

D2_WeightThought

How do you think of your current weight?

o Underweight (1)

o Slightly underweight (2)

o Just right (3)

o Slightly overweight (4)

o Overweight (5)

D3_WeightNumber

What is your current weight? (Please use kg [kilogram] as the unit, if your weight is 60kg, please fill in 60 below)

D4_Height

What is your height now? (Please use cm [centimetre] as the unit, if your height is 170cm, please fill in 170 below)

E2_Methods

During the pandemic, which of the following activities did you use to help you relieve stress and regulate emotions?

o Watching TV, movies

o Exercising

E3_PsychStatus

Compared prior to the pandemic, your mental health is:

o Much worse (1)

o Worse (2)

o No change (3)

o Better (4)

o Much better (5)

F21_AgreetoSubmit

I agree to submit my response.

o Yes (1)

o No (0)

Appendix 2

Strobe Checklist for Observational Cross-Sectional Studies

STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies	**Item No**	**Recommendation**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract. Yes. See abstract (page 1). Also, see pages II, 16, and 38.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found. Yes. See Pages II, 16, and 38.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the Investigation being reported Yes. See pages 1,3 and 4.
Objectives	3	State-specific objectives, including any pre-specified Hypotheses. Yes. See pages 3 and 4.
Methods		
Study design	4	Present key elements of study design early in the paper. Yes. See Title page. Also, see pages 27 and 44.
Setting	5	Describe the setting, locations, and relevant dates, including Periods of recruitment, exposure, follow-up, and data collection. Yes. See pages II, III, 23 and 44.
Participants	6	(a) Give the eligibility criteria and the sources and methods of selection of participants. Yes. See pages 23 and 44
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Yes. See pages 24 and 49.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe the comparability of assessment methods if there is more than one group. Yes. See pages 27 and 48.
Bias	9	Describe any efforts to address potential sources of bias. Yes. See pages II, III, and 65.
Study size	10	Explain how the study size arrived at Yes. See pages 23 and 44.

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why. Yes. See pages 23 and 44.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding. Yes. See pages 31 and 52. (b) Describe any methods used to examine subgroups and interactions. Yes. See pages 31 and 52 (c) Explain how missing data were addressed. Yes. See pages 97 and 107. (d) If applicable, describe analytical methods taking account of the sampling strategy. Yes. See pages 23 and 44.
Result		
Participants	13*	(a) Report numbers of individuals at each stage of study—e.g., potentially eligible, examined for eligibility, confirmed eligibility, included in the study, completing follow-up, and analyzed Yes. See pages 23 and 44. (b) Give reasons for non-participation at each stage Yes. See page 23 and 44 (c) Consider use of a flow diagram. Yes. This information was derived during analyses. It is available upon request.
Descriptive data	14*	(a) Give characteristics of study participants (e.g. demographic, clinical, and social) and information on exposures and potential confounders. Yes. See pages 23 and 44. (b) Indicate number of participants with missing data for each Variable of interest. Yes. See page 96 to 107
Outcome data	15*	Report numbers of outcome events or summary measures Yes. See pages 32-35 and 53-56.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included. Yes. See pages 32-35 and 43-56. (b) Report category boundaries when continuous variables were categorized. Yes. See pages 23 and 44 (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.-No
Other analyses	17	Report other analyses done- Multiple imputations.
Discussion		

Key results	18	Summaries key results with reference to study objectives. Yes. See page 39 and 56.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias. Yes. See pages 61.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence. Yes. See pages 3, 23, 44, 57-62.
Generalizability	21	Discuss the generalizability (external validity) of the study results Yes. See pages 31 and 52
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based. Yes. See page V.
**Give information separately for exposed and unexposed groups.*		

Note: It is recommended to use the STROBE checklist in combination with the Explanation and Elaboration article, which can be found for free on the websites of PLoS Medicine (http://www.plosmedicine.org/), Annals of Internal Medicine (http://www.annals.org/), and Epidemiology (http://www.epidem.com/). This article provides methodological background and examples of transparent reporting for each checklist item. For more information on the STROBE Initiative, visit www.strobe-statement.or

Appendix 3

Ethics Approval Letter 1

MEMORIAL UNIVERSITY

Interdisciplinary Committee on
Ethics in Human Research (ICEHR)

St. John's, NL Canada A1C 5S7
Tel: 709 864-2561 icehr@mun.ca
www.mun.ca/research/ethics/humans/icehr

ICEHR Number:	20201772-ME
Approval Period:	March 17, 2020 – March 31, 2021
Funding Source:	CIHR [RGCS # 20201727]
Responsible Faculty:	Dr. Peter Wang, Faculty of Medicine
Title of Project:	*Implementing and Assessing a COVID-19 Outbreak Response Plan in the GTA Chinese Community*
Amendment #:	*03*

January 20, 2021

Dr. Peizhong Peter Wang
Division of Community Health and Humanities, Faculty of Medicine
Memorial University of Newfoundland

Dear Dr. Wang:

The Interdisciplinary Committee on Ethics in Human Research (ICEHR) has reviewed the proposed revisions for the above referenced project, as outlined in your amendment request dated December 18, 2020, and is pleased to give approval to conduct an online survey with students, as described in your request, provided all other previously approved protocols are followed.

If you need to make any other changes during the conduct of the research that may affect ethical relations with human participants, please submit an amendment request, with a description of these changes, via your Researcher Portal account for the Committee's consideration.

Your ethics clearance for this project expires March 31, 2021, before which time you must submit an annual update to ICEHR. If you plan to continue the project, you need to request renewal of your ethics clearance, and include a brief summary on the progress of your research. When the project no longer requires contact with human participants, is completed and/or terminated, you need to provide an annual update with a brief final summary, and your file will be closed.

Annual updates and amendment requests can be submitted from your Researcher Portal account by clicking the *Applications: Post-Review* link on your Portal homepage.

The Committee would like to thank you for the update on your proposal and we wish you well with your research.

Yours sincerely,

[redacted]

Kelly Blidook, Ph.D.
Vice-Chair, Interdisciplinary Committee on
Ethics in Human Research

KB/bc

Ethics Approval Letter 2

MEMORIAL UNIVERSITY

Interdisciplinary Committee on
Ethics in Human Research (ICEHR)

St. John's, NL Canada A1C 5S7
Tel: 709 864-2561 icehr@mun.ca
www.mun.ca/research/ethics/humans/icehr

ICEHR Number:	20201772-ME
Approval Period:	March 17, 2020 – March 31, 2021 ** For "AIM 1" Only
Funding Source:	CIHR [RGCS # 20201727] **Rapid Response
Responsible Faculty:	Dr. Peter Wang, Faculty of Medicine
Title of Project:	*Implementing and Assessing a COVID-19 Outbreak Response Plan in the GTA Chinese Community*

March 17, 2020

Dr. Peizhong Peter Wang
Division of Community Health and Humanities, Faculty of Medicine
Memorial University of Newfoundland

Dear Dr. Wang:

Thank you for your correspondence of March 12, 2020 addressing the issues raised by the Interdisciplinary Committee on Ethics in Human Research (ICEHR) for your research project. ICEHR has re-examined the proposal with the clarifications and revisions submitted. In accordance with the *Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans (TCPS2)*, "AIM 1" [survey assessing GTA Chinese immigrants' knowledge, attitudes / beliefs, and adherence to the protection practices toward COVID-19] of the project has been granted *ethics clearance* for one year. However, you must submit ethical protocols for AIM 2 [evaluating a mutual support self-quarantine network model] and AIM 3 [assessing the psychological impacts of the COVID-19 outbreak and identifying the associated predictors] to ICEHR for review before you can proceed with those. ICEHR approval applies to the ethical acceptability of the research, as per Article 6.3 of the *TCPS2*. Researchers are responsible for adherence to any other relevant University policies and/or funded or non-funded agreements that may be associated with the project.

The *TCPS2* **requires** that you submit an Annual Update to ICEHR before March 31, 2021. If you plan to continue the project, you need to request renewal of your ethics clearance and include a brief summary on the progress of your research. When the project no longer involves contact with human participants, is completed and/or terminated, you are required to provide an annual update with a brief final summary and your file will be closed. If you need to make changes during the project which may raise ethical concerns, you must submit an Amendment Request with a description of these changes for the Committee's consideration prior to implementation. If funding is obtained subsequent to ethics approval, you must submit a Funding and/or Partner Change Request to ICEHR so that this ethics clearance can be linked to your award. All post-approval event forms noted above must be submitted from your Researcher Portal account by selecting the relevant event form from the *Applications: Post-Review* link on your Portal homepage. We wish you success with your research.

Yours sincerely,

[redacted]

Russell J. Adams, Ph.D.
Chair, Interdisciplinary Committee on
Ethics in Human Research
Professor of Psychology and Pediatrics
Faculties of Science and Medicine

RA/th

cc: Supervisor – Director, Research Grant and Contract Services