Relationship Between Health Literacy (HL), eHealth Literacy (eHL), Subjective Well-being (SWB) and COVID-19 Related Health Behaviours Among Canadian University Students: A Cross-Sectional Study

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Abstract

Background: One significant predictor of health practices and outcomes is health literacy. Health literacy is an individual's ability to search, understand, appraise, and apply health information. Much research has occurred on health literacy (HL), ehealth literacy (eHL), subjective well-being (SWB), and COVID-19 health-related behaviours; however, few studies have explored the association between these variables, particularly within Canada. Understanding university students' HL and eHL levels would yield beneficial information on a group that impacts their community, particularly in a pandemic setting where students gather in large groups.

Methods: An online survey was administered to 336 university students via Google Forms from April 2022 - December 2022. The survey used the Computer Adaptation of Newest Vital Sign to measure HL, eHEALS to measure eHL, a modified COVID-19–Related Health Behaviors questionnaire, and the Satisfaction with Life Scale to measure SWB. Data analysis was analyzed using Pearson correlation and hierarchical regression analysis on SPSS.

Results: Most participants were, on average, 26.1 years and 76.7% identified as female. The statistical analysis revealed that eHL significantly predicted COVID-19-related health behaviours, whereas SWB and HL were not statistically significant predictors of COVID-19-related health behaviours. Overall, the results suggest that individuals with higher eHL levels may engage in less healthy behaviours related to COVID-19.

Conclusion: Although this study found that eHL predicted COVID-19 related health behaviours, HL and SWB did not seem to have a significant relationship with COVID-19 related health behaviours. This suggests that other interdisciplinary factors are involved in understanding the

relationship between HL, eHL, SWB, and COVID-19 health-related behaviours among Canadian university students. Cultural beliefs and values, political alignment, fear and anxiety, misinformation, and disinformation are reasons HL may not be a strong predictor of COVID-19 related health behaviours. Future research should continue to explore a more interdisciplinary approach to public health practice geared towards researching the factors that affect health behaviours on college campuses will improve future health and well-being outcomes among this population.

Résumé

Contexte : L'un des principaux facteurs prédictifs des pratiques et des résultats en matière de santé est la littératie en matière de santé. La littératie en santé est la capacité d'un individu à rechercher, comprendre, évaluer et appliquer des informations sur la santé. De nombreuses recherches ont été menées sur la littératie en santé (LS), la littératie en santé électronique (LSE), le bien-être subjectif et les comportements liés à la santé (COVID-19) ; toutefois, peu d'études ont exploré l'association entre ces variables, en particulier au Canada. Comprendre les niveaux de LS et de LSE des étudiants universitaires permettrait d'obtenir des informations utiles sur un groupe qui a un impact sur sa communauté, en particulier dans un contexte de pandémie où les étudiants se rassemblent en grands groupes. La présente étude évalue donc la relation entre les niveaux de LS, LSE, la BES et les comportements liés à la santé du COVID-19 chez les étudiants universitaires du Canada.

Méthodes : Une enquête en ligne a été menée auprès de 336 étudiants universitaires via Google Forms d'avril 2022 à décembre 2022. L'enquête a utilisé la Computer Adaptation of Newest Vital Sign pour mesurer LS, eHEALS pour mesurer LSE, un questionnaire COVID-19 adapté sur les comportements liés à la santé et l'échelle de satisfaction à l'égard de la vie pour mesurer la BSV.

Les données ont été analysées à l'aide de la corrélation de Pearson et de l'analyse de régression hiérarchique sur SPSS.

Résultats : Les résultats ont montré que la plupart des participants avaient en moyenne 26,1 ans et que 76,7 % d'entre eux étaient des femmes. La plupart des participants avaient reçu au moins deux doses du vaccin COVID-19 (92,3). 52,7 % des participants avaient au moins obtenu une licence. L'analyse statistique a révélé que LSE permettait de prédire de manière significative les comportements de santé liés au COVID-19, tandis que le BES et LS n'étaient pas des prédicteurs statistiquement significatifs des comportements de santé liés au COVID-19. Dans l'ensemble, les résultats suggèrent que les personnes ayant des niveaux LSE plus élevés peuvent adopter des comportements moins sains liés à COVID-19.

Conclusion : Bien que cette étude ait révélé que LSE prédisait les comportements de santé liés à la COVID-19, LS et BES ne semblaient pas avoir de relation significative avec les comportements de santé liés à la COVID-19. Cela suggère que d'autres facteurs interdisciplinaires sont impliqués dans la compréhension de la relation entre LS, LSE, BES et les comportements liés à la santé COVID-19 chez les étudiants universitaires canadiens. Les croyances et valeurs culturelles, l'alignement politique, la peur et l'anxiété, la mésinformation et la désinformation sont des facteurs qui expliquent pourquoi le HL n'est peut-être pas un prédicteur solide des comportements liés à la santé dans le cadre du COVID-19. Les recherches futures devraient continuer à explorer une approche plus interdisciplinaire de la pratique de la santé publique axée sur la recherche des facteurs qui affectent les comportements de santé sur les campus universitaires afin d'améliorer les résultats futurs en matière de santé et de bien-être au sein de cette population.

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Table of Contents

List of tables

Introduction:

According to some historians, history is the interpretation of knowledge, statements, facts and events that occurred in the past (Macfie, 2013). Macfie (2013) defines history as the study of human matters and events situated in time and space. Other historians claim that history is considered history when it transpires in the past to distinguish it from current events (Macfie, 2013). Yet is it possible for momentous events happening in the present not also be considered history? September 11, 2001, the rise of social media, and the COVID-19 pandemic were all events that could simultaneously be regarded as historical yet current news. These seismic occurrences drastically impacted how humans lived and interacted with the world. Studying historical human events as they are ongoing allows for the opportunity to seize and understand the moment's significance. The caveat is that complete comprehension will not be possible until time passes, long-term effects can be ascertained, and reflection upon those moments can be had.

Modern civilization has entered a period where humanity lives longer than ever, and various technologies have improved our well-being (Tasnim et al., 2018). The advanced development in medicine, technology, and particularly information sharing is continuously pushing the world to evolve rapidly (Tasnim et al., 2018). Yet, with the arrival of these developments, new problems have emerged amid the accelerated pace of progression. For example, throughout the COVID-19 pandemic, copious amounts of misinformation have been spread (Patil et al., 2021). This has largely resulted in adverse health outcomes (Patil et al., 2021). Research has found that the pandemic worsened young adults' health behaviours and generalized anxiety (Czenczek- Lewandowska et al., 2021). Research has begun to identify Health Literacy (HL) as an underlying cause and predictor of this issue (Johnson et al., 2010;

Patil et al., 2021). To combat this, it has become apparent that assessing and improving HL can provide a solution to mitigate the effects of the pandemic. With the advent of the internet and, more recently, social media, new subcategories like eHealth literacy (eHL) have materialized. High levels of self-reported HL and eHL have been associated with better health outcomes and behaviours involving decreased medical costs, increased medication adherence, and increased well-being (Patil et al., 2021). This, in turn, affects subjective well-being (SWB) (Kimhi et al., 2020).

University students' HL, eHL, and COVID-19 related behaviours have become a subject of increased relevance during the COVID-19 pandemic (Patil et al., 2021). University students are an interesting population to investigate as they are considered a suitable, homogenous representative sample of the general population (Hanel & Vion, 2016). University students are at a stage of life where they start developing higher-level thinking, particularly regarding their well-being, which will have a lasting impact on the rest of their lives (Broder et al., 2017). University students often travel long distances to and from campus, where they live and interact in proximity with many people (Patil et al., 2021). These behaviours unique to university students may impact COVID-19 infection rates, health outcomes, and the economic welfare of campuses and surrounding communities (Patil et al., 2021). Thus, exploring the relationship between HL, eHL, and SWB on COVID-19 related health behaviours among university students may prove significant, especially in developing programs, policies, and health information across universities, health systems, and public health departments.

Research Objectives

The objective of this thesis is to delve into the interconnection between Health Literacy (HL), eHealth Literacy (eHL), Subjective Well-being (SWB), and COVID-19 related health behaviors. In order to accomplish this, a number of specific goals have been put in place:

1. To gauge the levels of HL and eHL among university students.
2. To evaluate the SWB of Canadian university students.
3. To evaluate COVID-19 related health behaviors.
4. To undertake a thorough analysis of the data in order to investigate the relationship between HL, eHL, SWB, and COVID-19 related health behaviors among Canadian university students.

Hypothesis: Individuals with high health literacy (HL) and electronic health literacy (eHL) are more likely to exhibit positive health behaviors related to COVID-19.

Literature Review:

Background

Although health treatment, medication, and information have evolved to manage most diseases, new challenges have emerged to mitigate this evolution. HL is starting to surface as a concept that can help expound on how a population deals with health. HL is the ability of an individual to consume and interpret health-related information and make informed decisions regarding their health behaviours (Patil et al., 2021). It is the gateway to grasping issues such as health (in)equity, socioeconomic determinants of health, compliance with public health measures, and science communication.

COVID-19 is an overwhelming example of this. COVID-19 is an upper respiratory tract disease caused by the new coronavirus: SARS-COV-2. it is known to have emerged in Wuhan, China in December 2019 (Platto et al., 2020). SARS-CoV-2 transmission in humans occurs mainly through air droplets, close contact with infected persons, and through contaminated

surfaces (Platto et al., 2020). The contingent discovery of this virus urged scientists, public health experts, governments, and various institutions to develop various methods to alleviate the rapid spread of this disease. These methods involved implementing the following restrictions: social distancing; mask wearing; mandatory lockdowns and isolations; increased hand washing (Li et al., 2021). Nonetheless, the best tool to combat the COVID-19 pandemic is the uptake of a preventive vaccination. Vaccines reduce the risks of getting a disease by working with the body's immune system to build protection and aid in preventing symptomatic disease (Lopez Bernal et al., 2021).

COVID-19 has caused a global pandemic that has claimed millions of lives and has drastically affected healthcare, socioeconomic, and political systems worldwide (Li et al., 2021). As the world navigates how to handle the pandemic, it has become apparent that HL is an essential topic of contention. An individual's capacity to appraise and act on information relating to their health impacts not only themselves but their communities. HL is primarily a public health concern but can also be considered a political, socioeconomic, and policy issue as academic institutions, governments, workplaces, and many more establishments attempt to communicate COVID-19 information effectively. HL goes beyond COVID-19 : a better understanding of the HL skills and needs of the population would help in assorted settings such as medication adherence, weight management, drug abuse, mental health, and much more (Haun et al., 2014; Squiers et al., 2012). As more novel diseases become apparent, healthcare treatment is changing dynamically. With increased HL, individuals will become more active in their own personal and community health and well-being.

Health Literacy in Canada

Approximately 55% of Canadians aged 16-65 years have limited HL (Rootman & Gordon, 2008). This data was collected from the International Adult Literacy and Skills Survey (IALSS) conducted in 2003. The purpose of the survey was to collect information to estimate various literacies, including HL among different countries. Saskatchewan residents were found to have the highest levels of HL in Canada on average whereas Nunavut was found to have the lowest (Rootman & Gordon, 2008). There was no significant difference in HL between men and women (Rootman & Gordon, 2008). There are more adults with low HL (55%) than there are with low levels of prose literacy (48%) (Rootman & Gordon, 2008). Low HL is even more apparent in Canadians 65 and older where it was found that over 80% of them had low HL (Visscher & Hutnik, 2015). This essentially means that an overwhelming portion of the population fails to search, comprehend, and use information to maintain good health. This is aggravated in the elderly population as low HL drastically increases all causes of mortality (Visscher & Hutnik, 2015). This is a significant issue as older adults are more likely to have chronic health problems and thus have a higher need for health information demands.

The immigrant population was also found to be another demographic with increased levels of limited HL (Ng & Omariba, 2014). Immigrants make up 21.9% of the population, and they are a demographic that consistently scores below the national average in HL (Ng & Omariba, 2014). Ng & Omariba (2014) conducted a study comparing the HL levels of immigrants & non-immigrants and suggested that immigrants have lower HL levels due to language barriers, literacy-related factors, education levels, cultural barriers, and income levels.

HL seems to be directly correlated to the level of education, as the International Adult Literacy and Skills Survey found that HL scores tend to rise alongside the level of education

attained. HL, prose, and numeric literacy are not the same but are directly related. Low prose and numeric literacy have consistently been associated with low HL as the skills required to decipher, search and make use of health-related information require adequate prose and numeric literacy (Ng & Omariba, 2014; Rootman & Gordon, 2008).

Unfortunately, the literature does not seem to have appropriate data on HL and persons with disabilities. Generally, HL studies do not ask participants to report disabilities nor are there many studies specifically done on HL and the persons with disabilities. As one in five Canadians have a disability, there needs to be more HL research on this population (Morris et Al., 2018).

The pandemic has emboldened researchers to churn out more studies on HL to develop the appropriate HL measuring instruments, develop more interventions to promote health equity, and investigate the results of said interventions on health outcomes for individuals and populations (Mansfield et al., 2018). Haun et al., (2014) conducted a descriptive review on HL measuring tools and found that the gold standard among HL measuring tools were the Rapid Estimate of Adult Literacy in Medicine (REALM) and the Test of Functional Health Literacy in Adults (TOFHLA). These measuring instruments do come with some faults, however: they are subjective due to their self-rating aspects; they do not consider different cultural and linguistic profiles, and they fail to take into consideration if there is a clinically meaningful difference as opposed to a statistically significant difference which indicates the lack of clinical physicians actively participating in formulating HL measuring instruments (Beauchamps et al., 2015; Haun et al., 2014). Moreover, these measuring tools generally represent a narrow set of conceptual dimensions that do not encapsulate health in a holistic and, more noticeably, interdisciplinary manner (Haun et al., 2014). Thus, more research needs to be done to create revised HL measuring instruments as no all-encompassing HL measuring tool is available (Haun et al.,

2014). Fortunately, a plethora of HL measuring tools are conceived every year to study and measure HL efficiently. Research depicts that HL assessment tools need to be tailored to the population of interest (Rosenbaum et al., 2018). For example, the 2003 International Adult Literacy and Skills Survey reported that adults aged 65 and older, immigrant groups, and unemployed persons had the lowest HL in Canada. Albeit, there needs to be more research done on HL in a Canadian context.

eHealth Literacy

eHealth literacy (eHL) is the propensity of an individual to search, acquire, appraise, and apply health-related information in an online environment (Holt et al., 2020). eHL is an interchangeable term used with Digital Health literacy. For the purposes of this paper, eHL will be the term employed. It is essential to understand that studying HL alone is inadequate to comprehensibly gauge the HL levels of individuals or groups as the modern world digitizes everything. The healthcare landscape is no exception. Now, more than ever, particularly with the pandemic, medical appointments, health records, and, most importantly, health-related information is all online (Monkman et al., 2017; Norman & Skinner, 2006). Furthermore, the widespread use of social media makes eHL much more critical as it makes the appraisal element of eHL much more necessary (Monkman et al., 2017). Internet users do not have to seek health-related information out anymore as they are plastered with health-related (mis)information daily on their social media. Possessing the ability to procure, evaluate, and apply digital health information to health problems is what the most ubiquitous eHL measuring tool (eHEALS) assesses (Norman & Skinner, 2006). eHEALS measures six constituents of literacy: computer literacy, information literacy, media literacy, traditional literacy and numeracy, scientific literacy, and health literacy (Norman & Skinner, 2006). The eHEALS is the most cited eHL

measuring instrument in the literature (Del Giudice et al., 2018; Monkman et al., 2017). eHEALS does come with a caveat: it is a self-reported measure and thus comes with perceived implications rather than empirical, observable skills (Norman & Skinner, 2006). It is to be noted that recent studies have discovered evidence that participants' scores on the eHEALS assessment do not always lead to positive results on digital health tasks (Neter & Brainin, 2017; van der Vaart, 2011). These studies revealed a low to moderate correlation between perceived eHL and performed eHL (Neter & Brainin, 2017; van der Vaart, 2011). Thus, researchers are currently attempting to create a more objective measure of eHL (Del Giudice et al., 2018; Monkman et al., 2017). Yet, eHEALS is still considered the best and most cited eHL measuring tool available currently (Del Giudice et al., 2018; Monkman et al., 2017).

Relationship Between HL and eHL

It is intuitive to assume that HL and eHL converge as their definitions overlap. However, there has been some research on that relationship that seems to indicate otherwise. Monkman et al., (2017) found no relationship ($r=-.041$, $p=.81$) between HL and eHL. This occurs because the process in eHL that involves searching and appraising health-related information requires different skills (Monkman et al., 2017). There is more emphasis on searching and appraising health-related information online due to the vast amounts of information and resources available (Monkman et al., 2017). Proficiency in using digital devices and accessing online health information is necessary for eHL, along with the capacity to critically evaluate and interpret this information. This encompasses skills such as navigating health-related websites, conducting online searches for health information, and identifying credible sources of information. On the other hand, HL is a more comprehensive measure of an individual's capacity to access, comprehend, and apply health information, regardless of its format or medium. Computer

literacy is also a major factor that limits older adults (Bonderski et al., 2019). It is important to note this disparity as HL and eHL need to be treated as two different literacies to employ the appropriate interventions. Albeit, Del Giudice et al. (2018) found a relationship between HL and eHL but only in participants who worked in the medical field and were predisposed to have high HL levels. Thus, there is still value in assessing eHL, distinctly those with limited HL and eHL, as those are the populations where interventions should be targeted.

HL, eHL, and COVID-19

More than ever, the need to understand, assess, and improve HL and eHL has never been higher. COVID-19 has necessitated the need for everyone to rapidly absorb, search, appraise, and apply accurate health information. Unfortunately, COVID-19 has caused problems that are constantly evolving, misunderstood, and context-dependent (Sentell et al., 2020). As more people turn to the internet to search and make use of health-related information, misinformation has emerged as a concern (An et al., 2021). This has led to innumerable studies addressing the effects of HL and eHL and everything COVID-19 related (Sentell et al., 2020). COVID-19 has been met with an explosion of information, most notably health-related information. Unsolicited health-related information can spring up from anywhere: a loved one saying hot water kills COVID-19 ; videos of a self-proclaimed doctor calling COVID-19 a sham; and the vaccine coming with a microchip placed by the government (Sentell et al., 2020). eHL has never been more relevant than now. The lines between the COVID-19 pandemic and an infodemic are blurred. This indicates the interdisciplinarity of the topic. Appraising and applying the wrong health-related information leads to adverse outcomes (An et al., 2021; Sentell et al., 2020). This is an exciting phenomenon as low HL, and eHL may lead to appraising and applying the wrong

health-related information and lull one to a false sense of improved health and subjective well-being, resulting in adverse health outcomes.

Subjective Well-Being

Subjective well-being (SWB) is defined as self-reported feelings of life satisfaction (Costanza et al., 2007). This is essentially an evaluation of one's well-being from their perspective, typically consisting of mental health matters including anxiety, fulfillment, happiness, self-esteem, loneliness, and social capital (Johnston et al., 2013; Seo et al., 2016). The relationship between SWB and HL and eHL, particularly in the pandemic, is not prevalent in the literature. This relationship needs to be investigated as there seems to be a direct association between HL and eHL and SWB. Specifically, regarding the use of eHEALS, a subjective self-report of one's ability to procure, evaluate, and apply digital health information to health problems (Monkman et al., 2017).

COVID-19 Related Health Behaviours

Health-related behaviours involve any activity that improves, maintains, or diminishes an individual's health and well-being as a bio-psycho-social entity (Czenczek- Lewandowska et al., 2021). The lockdowns and restrictions implemented during the pandemic compelled how people interacted with their physical and mental health. Between sports institutions being closed, fitness equipment being sold out, and limited access to various health services, the physical health of people dwindled. In terms of mental health, the isolation protocols and lack of physical encounters in social settings led to increased stress, depression, and anxiety (Czenczek-Lewandowska et al., 2021; Usher et al., 2020). A study on young adults found that lockdowns caused an increase in generalized anxiety and had the most significant negative impact on health-related behaviours (Czenczek- Lewandowska et al., 2021). This is important to note because

decreased health and well-being adversely affect the immune system, which is already at risk of getting infected by the SARS-CoV-2 virus (Czenczek- Lewandowska et al., 2021). In particular, physical activity is critical in combatting viral infection and even enhances the efficacy of vaccines (Czenczek- Lewandowska et al., 2021).

HL has a role in this, as high HL is associated with better COVID-19 related health behaviours (An et al., 2021; Li et al., 2021). Studies have found that those who practice more social distancing, increased handwashing, and willingness to be vaccinated may have adequate HL.

The Interdisciplinarity

The topic of COVID-19, health literacy (HL), and electronic health literacy (eHL) is intricate and encompasses various disciplines, such as economics, government, personal and public health, politics, and education. It has been observed that people's political beliefs, socioeconomic status, education level, and trust in government can affect their evaluation of health-related information (Sentell et al., 2020). Cultural factors also play a significant role in how people interpret and respond to health information, making it crucial to consider diverse cultural perspectives when creating information dissemination strategies. In addition, communication technology is essential in providing user-friendly platforms for accessing and interpreting health information. The reliance on digital platforms during the pandemic has accentuated the role of eHL in accessing and interpreting health information. Collaborating with IT specialists can aid in developing more user-friendly platforms for diverse populations, making essential health information more accessible and understandable.

Subjective well-being is another crucial aspect that cannot be ignored as it influences how individuals respond to the pandemic (Monkman et al., 2017). Therefore, it is necessary to

collaborate between health educators and psychologists to develop strategies that consider emotional well-being as a component of HL initiatives. Governments play a significant role in disseminating health information and implementing policies. It is imperative to integrate research findings into public policies to enhance the effectiveness of health interventions. This necessitates dialogue and cooperation between healthcare professionals, researchers, and policymakers.

To combat misinformation, it is essential to increase HL levels and develop interventions that are accessible and easy to understand. Two of the most common solutions to addressing low levels of HL and eHL are to either make all health-related information easily accessible to everyone no matter the level of HL and eHL (Bonderski et al., 2019; Sentell et al., 2020) or to create and provide simple interventions at the point of healthcare between patient and healthcare provider (Robinson & Graham, 2010; Johnson et al., 2010). By bridging the gap between economics, government, public health, education, culture, communication technology, psychology, and policy-making, it is possible to craft more holistic and effective strategies for tackling the challenges posed by the pandemic and improving health literacy and outcomes. This requires collaboration between researchers across disciplines to address the issue adequately.

Gaps in Research

The current pandemic is a case study that intersects many disciplines. As mentioned previously, there needs to be more research on HL and eHL and how it pertains to COVID-19 health-related behaviours and information as that is highly relevant. Some papers discuss COVID-19 and COVID-19 related health behaviours but do not have an explicit link to HL or eHL: Pongou et al., (2021) found that individuals with higher levels of education get tested more frequently for COVID-19 compared to individuals with lower levels of education. This is

indirectly tied to HL and eHL as level of education is correlated to levels of prose and numeric literacy, which is indicative of HL and eHL levels. This thesis will be able to fill in those gaps and make the connections in the literature. There is also a gap in the literature on HL and eHL and their association with SWB (Nguyen et al., 2021).

Furthermore, Canadian-focused COVID-19 research is sparse. As Canada has a high vaccination rate per capita (*COVID-19 Vaccine Doses Administered per 100 People*), the literature surrounding COVID-19 related health behaviours, HL, and SWB focus mainly on countries with increased infection and death rates, such as the United States and the UK and China (Pongou et al., 2022). In addition, the last comprehensive, nationwide HL study on Canadians was conducted in 2006 (Rootman & Gordon, 2008). Furthermore, research on Canadian university students' HL and eHL is lacking— most research on HL and eHL among university students is based in the United States. The findings indicated that approximately 50% of students had adequate HL and eHL (Patil et al., 2021). However, a recent review found that many young adults have low eHL levels, particularly in accessing and appraising online information (Patil et al., 2021). Understanding this group's HL and eHL levels would yield beneficial information on a population that impacts their community, particularly in a pandemic setting where students gather in large groups. Furthermore, most HL and eHL research on university students focus on its measurement and assessment; rather than the effect of HL and eHL on behaviours.

Lastly, research on interventions to improve HL and eHL needs to be assessed. Understanding HL and eHL will provide more insight beyond COVID-19 and health-related behaviours and information, but also on mediating factors such as politics, socioeconomic background, education levels, and government policies.

The Framework

This study will use the integrated conceptual model of the HL framework by Sorensen et al., (2012). It is the most cited HL framework on the PubMed database and has been empirically tested numerous times. Contrary to other HL frameworks, this model bridges the gap between "medical" and "public health" HL. Moreover, this integrated framework recognizes that HL is not static; but rather a dynamic process that involves the consecutive steps of accessing, understanding, processing and communicating information, which also is relevant in eHL. As Table 1 details, there are four competencies in HL: access to health-related information, understanding of health-related information, the appraisal of health-related information, and the application of health-related information (Sorensen et al., 2012). These competencies exemplify an element of HL: accessing health-related information depends on understanding, timing and trustworthiness; understanding health-related information requires grasping the perceived value of said information, outcome individualization, and interpretation of causality; appraisal of health-related information depends on processing the complexity and jargon of the information; and lastly, practical application of health-related information depends on comprehension of the information (Sorensen et al., 2012).

In turn, these competencies are used in the following three contexts: health care, disease prevention, and health promotion. These competencies in HL allow for navigation within these three contexts as portrayed in Table 1. Sorensen et al., (2012) describe the four competencies in the healthcare context as the ability to access health-related information on medical or clinical issues, understand medical information, appraise medical information, make informed decisions on medical matters and comply with medical advice. Examples of this involve communication with health care providers, medication adherence, and the use of medical services. Sorensen et al.

(2012) denote the four competencies in relation to disease prevention in the ability to access information on risk factors for health, understand information on risk factors, appraise information on risk factors, and make informed decisions on risk factors for health. Examples of this involve searching and evaluating the information on preventing chronic and infectious diseases and understanding why health screenings and vaccinations are important. Sorensen et al., (2012) assert that the four competencies related to health promotion are: the ability to habitually inform oneself on determinants of health in the social and physical environment, to understand information on determinants of health in the social and physical environment, to appraise information on determinants of health in the social and physical environment, and the ability to make informed decisions on health determinants in the social and physical environment. This context is particularly relevant in the COVID-19 pandemic and, thus, this study. An example would be an individual's ability to participate in good health behaviours. This culminates in a matrix with four HL competencies applied to three health contexts, as shown in Table 1.

This framework also addresses distal and proximal factors. Distal factors affecting HL are societal and environmental determinants: societal systems and culture (Sorensen et al., 2012). Proximal factors are personal determinants: age, gender, race, socioeconomic status, education, occupation, and literacy (Sorensen et al., 2012). Both proximal and distal factors intertwine and influence each other as they impact an individual's HL level. For example, distal factors such as socioeconomic status and education can influence an individual's access to health-related information and their ability to understand and appraise it. Proximal factors such as age and literacy can also affect an individual's ability to access, understand, and apply health-related information. This is why both proximal and distal factors are identified in this model. Increasing

HL in both the individual and community allows for more autonomy and better health outcomes, which leads to an increase in SWB (Sorensen et al., 2012).

In addition to these factors, the HL framework by Sorensen et al. (2012) also recognizes the role of communication in HL. Effective communication is crucial in all aspects of HL, including accessing, understanding, appraising, and applying health-related information. Communication also plays a crucial role in promoting HL and reducing health disparities. This includes the ability to communicate health-related information clearly and effectively, as well as the ability to receive and interpret health-related information in a meaningful and actionable way.

One limitation of this framework in the pretext of the current study is that it does not explicitly discuss eHL; however, it still encompasses the components of eHL in its personal HL framework component; particularly through the matrix with four dimensions of HL applied to three health domains. This is because the four competencies of HL identified in this framework - accessing, understanding, appraising, and applying health-related information - can all be applied to electronic sources of health information. For example, in the healthcare context, individuals may need to access and understand information on medical issues from online sources. In the context of disease prevention, individuals may need to appraise and make informed decisions about information on risk factors for health found online. In the context of health promotion, individuals may need to habitually inform themselves on determinants of health in the social and physical environment, which may include accessing and interpreting information from electronic sources. Moreover, the matrix with four dimensions of HL applied to three health domains in the Sorensen et al. (2012) framework also indirectly addresses eHL. By considering the competencies of HL in different health contexts, the framework implicitly acknowledges the role of electronic sources of health information in the modern healthcare landscape. Therefore, while

eHL is not explicitly discussed in the Sorensen et al. (2012) framework, the model still encompasses the components of eHL through its personal HL framework component and matrix of health literacy competencies applied to different health contexts.

Overall, the integrated conceptual model of the HL framework by Sorensen et al. (2012) provides a comprehensive approach to understanding and promoting HL. By considering the four competencies in three different health contexts and the role of proximal and distal factors and communication, this framework can be a valuable tool for researchers, practitioners, and policymakers working to improve health outcomes and reduce health disparities.

Table 1

The matrix with four dimensions of health literacy applied to three health domains

	Access/obtain information relevant to health	**Understand information relevant to health**	**Process/appraise information relevant to health**	**Apply/use information relevant to health**
Health care	Ability to access information on medical or clinical issues	Ability to understand medical information and derive meaning	Ability to interpret and evaluate medical information	Ability to make informed decisions on medical issues
Disease prevention	Ability to access information on risk factors for health	Ability to understand information on risk factors and derive meaning	Ability to interpret and evaluate information on risk factors for health	Ability to make informed decisions on risk factors for health
Health promotion	Ability to update oneself on determinants of health in the social and physical environment	Ability to understand information on determinants of health in the social and physical environment and derive meaning	Ability to interpret and evaluate information on health determinants in the social and physical environment	Ability to make informed decisions on health determinants in the social and physical environment

Methods

This research employed an online convenience sampling method using a survey. This allowed for efficient gathering of information from a diverse group of participants while adhering to safety guidelines set by Ottawa Public Health and the University of Ottawa. Although convenience sampling was chosen for its practicality, it is important to acknowledge that this method may introduce selection bias and limit the generalizability of the findings. The survey was conducted entirely virtually using Google Forms to host the questionnaire and collect data. To ensure accurate data collection, participants were only able to answer the questions once using Google Forms. The website scanned the browser's cookies to prevent duplicate responses, and no identifying information was collected. Finally, participants were encouraged to share the flyers and link with other university students, although the decision to participate was left up to individuals.

Before beginning the online questionnaire, participants were informed of their right to remain anonymous by not providing any identifying information. The questionnaire also included a section that outlined the participant's right to skip questions or stop the questionnaire at any point, which had to be acknowledged before proceeding to the actual questions. Participants could complete the questionnaire from any location since it was an online survey, and it took approximately 15-20 minutes to complete. This study was cross-sectional, which was a quick and cost-effective way to analyze the associations between variables in this study.

Participants in this study were university students attending a Canadian university or recent graduates who were at least 18 years old and proficient in English or French. Since participants did not receive treatment, ethical issues were minimized, and no exclusion criteria were applied.

Sample size

Sample size calculation was done by using Cochran's formula:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Z is the Z score

e is the margin of error

p is the (estimated) proportion of the population

q is 1 – p.

thus, ((1.96)2 x .5(.5)) / (.05)2

(3.8416 x .25) / .0025

.9604 / .0025

384.16. Hence, approximately 384 participants are needed to have an adequate sample size.

Measuring instruments

To measure HL: Computer Adaptation of Newest Vital Sign (C-NVS) adapted by Mansfield et al., (2018). This assessment tool was chosen as it encapsulates more than prose literacy and numeracy but also measures health-specific literacy like nutrition label interpretation. The C-NVS has been adapted and validated for online use across different populations and demographics (Mansfield et al., 2018). Specifically, the C-NVS tests the participant's capacity to assess and interpret the numerical and text information found on a nutrition label in 6 multiple-choice questions. The participant's scores reflect the number of correct answers, and HL is categorized into three levels accordingly: likely limited literacy (0-1 correct answers), possibility of limited literacy (2-3 correct answers), and adequate literacy (4-6 correct answers). This is because understanding a nutrition label requires the same analytical and

conceptual skills needed to understand health-related information (Mansfield et al., 2018). Research has shown that poor comprehension of nutrition labels correlated highly with low-level HL (Mansfield et al., 2018). Participants need to use numbers and make mathematical calculations; they need to identify and be mindful of different ingredients that could be potentially harmful to them and consequently make decisions about their actions based on the given information. This is relevant to the HL framework outlined previously and thus, this instrument is well equipped to measure HL in this study. Online administration of the C-NVS permits the C-NVS to be easily and quickly administered, especially amid COVID-19 regulations. Moreover, the online administration's privacy aspect could help reduce the stigmatization of some participants in previous studies to interviewer-administered health literacy assessments (Mansfield et al., 2018).

Measuring eHL: eHEALS is an 8-item self-report scale assessing participants' perception of their ability to search, evaluate, and apply health-related information gleaned online. The eHEALS uses a 5-point Likert scale to judge how they search for health-related information, how they use health-related information, how to evaluate health-related information, how to differentiate between high- and low-quality health-related information, and how to use this information to inform their health-related decision-making (Norman & Skinner, 2006). The eHEALS is the most cited eHL measuring instrument (Del Giudice et al., 2018; Monkman et al., 2017) and thus is well suited to measure eHL in this study. The eHEALS can be easily and quickly administered, especially amid COVID-19 regulations. Moreover, the online administration's privacy aspect could help reduce the stigmatization that some participants have expressed in previous studies to interviewer-administered health literacy assessments (Mansfield et al., 2018). It is important to consider the limitations associated with using self-reported data.

Participants might provide responses that they believe are socially desirable or expected rather than what truly reflects their behavior or opinions. Furthermore, recall bias might also affect the accuracy of the responses, especially in relation to past behaviors or experiences.

Measuring COVID-19 related health behaviours: The COVID-19 –Related Health Behaviours instrument used in this study is a modified version of the validated questionnaire created by Li et al., (2021). It was designed to reflect two main categories: government-recommended preventive behaviours and self-adaptive conventional health behaviours. It is a 10-item self report measure that assesses COVID-19 related health behaviours. Each item uses a 5-level scoring method: 1 (none of the time), 2 (a small amount of the time), 3 (sometimes), 4 (most of the time), and 5 (almost all the time). Therefore, the higher the score, the healthier and more positive a COVID–19–related health behaviour was considered. In addition, it is short and easily administered online. The privacy aspect of online administration could help reduce the stigmatization that some participants have expressed in previous studies of interviewer-administered health literacy assessments (Mansfield et al., 2018). Similar to eHEALS, it is important to consider the limitations associated with using self-reported data. Participants might provide responses that they believe are socially desirable or expected rather than what truly reflects their behavior or opinions. Furthermore, recall bias might also affect the accuracy of the responses, especially in relation to past behaviors or experiences.

In addition to the main independent variables, the study includes SWB as an auxiliary variable to explore its potential impact on the results. The SWLS (Satisfaction with Life Scale) is used as a measuring tool to assess SWB. This is a short 5-item instrument that assesses overall cognitive judgments of satisfaction with one's life using a 7-point Likert scale. The questions on the SWLS are open to interpretation, making it suitable for use with adults from various

backgrounds. Although SWB is not the primary focus of the study, the SWLS has been validated as having a single factor with high internal consistency, making it appropriate for use with a wide range of groups. It is also a reliable tool that can be administered easily online (Kobau et al., 2010). The demographic section will ask the participant to submit voluntary information on their age (in continuous form), sex at birth, gender, race, the highest level of education, vaccination status, and household income.

Data Analysis

Dependent variable: COVID-19 related health behaviours

Independent variables: HL and eHL levels; SWB; sociodemographic data

Regarding the first objective, which was to gauge the levels of Health Literacy (HL) and eHealth Literacy (eHL) among university students, HL was measured using the Computer Adaptation of Newest Vital Sign (C-NVS). This scale categorized HL into three ordinal levels. The analysis for HL included calculating the frequencies and percentages for each category. eHL was measured using the eHEALS scale, which utilized an 8-item self-report measure with a 5-point Likert scale, thus rendering eHL an interval level variable. The analysis for eHL comprised calculating descriptive statistics such as mean and standard deviation.

For the second objective of evaluating the Subjective Well-being (SWB) of Canadian university students, SWB was measured using the Satisfaction with Life Scale (SWLS), which was an interval scale based on a 7-point Likert scale. Descriptive statistics, including the mean and standard deviation, were calculated for SWB scores.

In terms of the third objective, which was to evaluate COVID-19 related health behaviours, these behaviours were measured using a modified version of the questionnaire created by Li et al. (2021), utilizing a 5-level scoring method, thus making it an ordinal scale.

The analysis involved calculating descriptive statistics, such as mean and standard deviation for the scores, as well as frequencies and percentages for each level.

The fourth objective involved undertaking a thorough analysis of the data to investigate the relationship between HL, eHL, SWB, and COVID-19 related health behaviours among Canadian university students. Pearson correlations were used to quantify the bivariate associations between eHL, SWB, and COVID-19 related health behaviors. However, since HL was an ordinal scale, Spearman's rank-order correlations were used for its relationships with other variables. Hierarchical linear regression was employed to analyze the relationship between the independent and dependent variables of COVID-19 related health behaviors. This regression analysis aimed to understand how different sets of independent variables contributed to predicting the dependent variable when they were entered into the regression model in separate steps. In hierarchical regression, unstandardized coefficients (B) and standardized regression coefficients (β) were reported to show the direction and strength of the relationships between the independent and dependent variables. T-values were calculated to assess the statistical significance of each coefficient, and p-values were used to determine whether the coefficients were significantly different from zero. The 95% confidence intervals for B were computed to provide a range within which the true population parameter was likely to fall.

Lastly, sociodemographic data were analyzed using descriptive statistics to assess the frequency and percentages of participants belonging to particular categories. Given that the sample size was small, a significance level of 0.01 was chosen to provide a higher degree of confidence in the results. It was essential to ensure that assumptions for the hierarchical linear regression were met and to address any deviations accordingly. Raw data was exported into SPSS-26 to conduct analysis.

Research Ethics

Before commencing the research for this thesis, ethical clearance was obtained from the University of Ottawa Research Ethics Board (REB). Participants enrolled in the study on the basis of free and informed consent. This will imply providing each participant with the language and the format of her choice, a detailed form explaining critical features of the study, including the purpose, duration, procedures, their right to decline or withdraw at any time, eventual consequences of participating, prospective research benefits, incentives and whom to contact for questions. Participants who indicated an interest in the study enrolled without considering religion, culture, or language. This study affirms that their privacy and confidentiality were ensured. Incidental findings during the research were dealt with according to the appropriate University of Ottawa research ethics board (REB). Participants were made aware of that principle when soliciting their consent and before the study.

Significance of Results

These results matter because they provide more depth to the evolving concept of HL and eHL, especially amid the COVID-19 crisis and context. Understanding the mechanisms will impact multiple disciplines and practices and ultimately help the world. High levels of self-reported HL and eHL have been associated with better health outcomes and behaviours, including decreased medical and hospital costs, increased medication adherence, and improved well-being (Patil et al., 2021). COVID-19 has also brought about changes in SWB (Kimhi et al., 2020). University students are an interesting population to investigate as they are considered a convenient, homogenous representative sample of the larger population (Hanel & Vion, 2016).

Results

Sociodemographic statistics

Overall, 336 students completed the questionnaires with a mean age of 26.1 years (SD = 6.6). Most participants identified as female (76.7%) and were between the ages of 18-24 (54.5%). The racial breakdown of the sample was predominantly white (60.8%), with smaller proportions of Black/African (15.3%), Middle Eastern (6.3%), and East Asian (4.2%) participants. Most participants had at least obtained a degree (52.1%), with 28% having a master's and 6.3% having a PhD. Regarding COVID-19 vaccination, 92.3% of participants were vaccinated with at least two doses of a COVID-19 vaccine, with 28.6% participants receiving two doses and 63.7% receiving three doses. In terms of income, the largest proportion of participants fell within the range of $100,000 and above (22%), followed by $50,000-74,999 (14.9%) and $25,00-$49,999 (14.6%).

Table 2

Summary of sociodemographic information of participants

Descriptive Statistics		**Frequency**	**Percentage %**
Grouped Age	18 to 24	182	54.5%
	25 to 34	117	35.0%
	35 to 44	25	7.5%
	45 to 54	10	3.0%
Sex at birth	Woman	265	79.3%
	Man	69	20.7%
Gender	Woman	257	76.7%
	Man	69	20.6%
	You don`t have an option for me	9	2.7%
You may belong to one or more racial or cultural groups on the following list. Are you	aboriginal	3	0.9%
	black/African	51	15.3%
	East Asian	14	4.2%
	Latin American	4	1.2%

	Middle Eastern	21	6.3%
	Mixed Race	17	5.1%
	South Asian	21	6.3%
	White	203	60.8%
Education level completed	High school	46	13.7%
	Bachelor	175	52.1%
	Masters	94	28.0%
	PhD	21	6.3%
Are you vaccinated against COVID-19 ?	Prefer not to say	1	0.3%
	No	4	1.2%
	One dose	2	0.6%
	Two doses	96	28.6%
	Three doses	214	63.7%
	Four doses	19	5.7%
Total household income	Prefer not to say	29	8.6%
	Don`t know	38	11.3%
	$0-$10,000	21	6.3%
	$10,000 to $24,999	43	12.8%
	$25,000 to $49,999	49	14.6%
	$50,000 to $74,999	50	14.9%
	$75,000 to $99,999	32	9.5%
	$100,000 and above	74	22.0%

Descriptive Statistics for HL, eHL, SWB, and COVID-19 related health behaviours

Table 3 reports the descriptive statistics for Health Literacy (HL), eHealth Literacy (eHL), and Subjective Well-being (SWB). For HL, the minimum score is 0 and the maximum score is 6. The mean HL score is 5.31, with a standard deviation of 1.21. The negative skewness value of -2.253 for HL indicates that the distribution is skewed to the left. This implies that there are more participants who scored high on HL, with fewer scoring low. In practical terms, the majority of the sample seem to be well-versed in health literacy. However, the relatively large negative skewness might also suggest the presence of a few participants with extremely low health literacy, which pulls the mean down.

For eHL, the minimum score is 8 and the maximum score is 40. The mean eHL score is 22.96, with a standard deviation of 9.63. The eHL distribution is slightly skewed to the right with a skewness value of 0.133, indicating a balanced range in the ability of participants to use electronic health information. This almost symmetrical distribution could mean that the sample has a moderate level of comfort with electronic sources for health information, though a slight positive skew implies a small portion might lack experience or access to electronic resources.

Table 3 also reports that the minimum SWB score is 6 and the maximum score is 35. The mean SWB score is 24.09, with a standard deviation of 6.00. The distribution for SWB is slightly left-skewed, with a skewness value of -0.570. This suggests that most of the participants have relatively high levels of subjective well-being. This slightly left-skewed distribution could indicate that overall, the sample have a positive attitude towards their lives.

Table 4 summarizes the descriptive statistics for COVID-19 related health behaviors. The minimum value in this sample was 19, and the maximum value was 47. The mean score was 34.6377, with a standard deviation of 5.60811. The distribution for COVID-19 related health behaviors is also slightly left-skewed, with a skewness value of -0.271. This implies that more participants have higher scores, indicating positive COVID-19 related health behaviors. However, the skewness is only slightly negative, suggesting that while there is a general tendency towards positive health behaviors related to COVID-19, there is also a significant portion of the sample that has varying practices.

The kurtosis value for COVID-19 related health behaviors is -0.363, indicating that the distribution is slightly platykurtic, meaning that it is flatter compared to a normal distribution. This suggests that scores are relatively widely spread around the mean.

Table 3

Descriptive Statistics for HL, eHL, and SWB

	HL		eHL		SWB		Valid N (listwise)
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error	Statistic
N	336		330		336		328
Minimum	.00		8.00		6.00		
Maximum	6.00		40.00		35.00		
Mean	5.3095		22.9606		24.0863		
Std. Deviation	1.21411		9.62969		6.00261		
Skewness	-2.253	.133	.065	.134	-.570	.133	
Kurtosis	5.221	.265	-1.153	.268	-.314	.265	

Table 4

Descriptive Statistics for COVID-19 related health behaviours

	COVID-19 **related health behaviours**	
	Statistic	Std. Error
N	334	
Minimum	19.00	
Maximum	47.00	
Mean	34.6377	
Std. Deviation	5.60811	
Skewness	-.271	.133
Kurtosis	-.363	.266

Bivariate analysis of sociodemographic statistics

Table 5 provides descriptive statistics for HL, eHL, COVID-19 related health behaviours, and SWB, grouped by age, sex at birth, gender, education level, vaccination status, and total household income.

HL:

- Age Group: The mean scores are highest among the 25-34 age group and lowest among the 45-54 age group.
- Gender: The mean scores are slightly higher for women than for men.
- Racial or Cultural Group: The highest mean score was found among those who identify as white and the lowest mean score among those who identify as Black/African.
- Education Level Completed: The mean scores are highest among those who have completed a Masters and lowest among those who completed high school.
- Vaccination Status: The highest mean score was found among those who have received four doses of COVID-19 vaccine and the lowest among those with one dose.
- Total Household Income: The mean scores are highest among those with a total household income of $100,000 and above and lowest among those who did not report their income.

eHL:

- Age Group: The mean scores are highest among the 25-34 age group and lowest among the 45-54 age group.
- Gender: The mean scores are slightly higher for women than for men.
- Racial or Cultural Group: The highest mean score was found among those who identify as black/Africa and the lowest mean score among those who identify as Latin American.
- Education Level Completed: The mean scores are highest among those who have completed a PhD and lowest among those who completed high school.
- Vaccination Status: The highest mean score was found among those who did not report their vaccination status and the lowest score was found among individuals with three doses.

- Total Household Income: The mean scores for eHL are highest among those with a total household income of $100,000 and above and lowest among $0-10,000.

COVID-19 related health behaviours:

- Age Group: The mean scores are highest among the 35-44 age group and lowest among the 45-54 age group.
- Gender: The highest mean score was found among those who did not identify as men or women whereas the lowest was found among women.
- Racial or Cultural Group: The highest mean score was found among those who identify as East Asian and the lowest mean score was found among those who identify as Middle Eastern.
- Education Level Completed: The mean scores are highest among those who have completed highschool and lowest among those who completed PhD.
- Vaccination Status: The highest mean score was found among those who have received one dose of COVID-19 vaccine and the lowest was among those who received four doses.
- Total Household Income: The mean scores are highest among those with a total household income of $100,000 and above and lowest among those with a total household income of $0-10,000.

SWB

- Age Group: The mean scores are highest among the 25-34 age group and lowest among those who did not choose any option under the "Gender" category.

- Gender: The mean scores are highest among those who identify as women and lowest among those who did not choose any option under the "Gender" category.
- Racial or Cultural Group: The highest mean score was found in the white racial group and the lowest mean score was found among South Asians.
- Education Level Completed: The mean scores are highest among those who have completed a PhD and lowest among those who completed high school.
- Vaccination Status: The highest mean score was found among those who have received four doses of COVID-19 vaccine and the lowest score was found among those who received one dose.
- Total Household Income: The mean scores for subjective well-being are highest among those with a total household income of $100,000 and above and lowest among those with a total household income of $0-$10,000.

Table 5

Descriptive Sociodemographic Statistics for HL, eHL, COVID-19 Related Health Behaviours, and SWB

	Sociodemographic Information		HL	eHL	COVID-19 related health behaviours	SWB
Grouped Age	18 to 24	Mean	5.23	24.02	34.57	23.61
		Count	182	182	182	182
	25 t0 34	Mean	5.45	21.77	34.65	24.50
		Count	117	117	117	117
	35 to 44	Mean	5.20	22.63	34.42	24.44
		Count	25	25	25	25
	45 to 54	Mean	5.30	18.00	36.50	26.60
		Count	10	10	10	10
Sex at birth	Woman	Mean	5.31	23.24	34.59	24.56
		Count	265	265	265	265

	Man	Mean	5.30	21.83	34.83	22.32
		Count	69	69	69	69
Gender	Woman	Mean	5.31	23.27	34.54	24.70
		Count	257	257	257	257
	Man	Mean	5.28	21.95	34.65	22.67
		Count	69	69	69	69
	You don`t have an option for	Mean	5.44	21.22	36.67	19.00
	me	Count	9	9	9	9
You may	Aboriginal	Mean	4.33	23.33	37.67	23.33
belong to		Count	3	3	3	3
one or more	Black/African	Mean	4.24	24.38	35.41	22.29
racial or		Count	51	51	51	51
cultural	East Asian	Mean	5.36	21.79	38.57	25.14
groups on		Count	14	14	14	14
the following	Latin American	Mean	5.50	18.25	35.50	22.50
list. Are you		Count	4	4	4	4
	Middle Eastern	Mean	4.95	22.10	33.62	22.71
		Count	21	21	21	21
	Mixed Race	Mean	5.47	19.71	36.94	23.29
		Count	17	17	17	17
	South Asian	Mean	5.00	21.95	34.52	19.52
		Count	21	21	21	21
	White	Mean	5.64	23.36	33.99	25.15
		Count	203	203	203	203
Education	High school	Mean	4.85	22.58	35.93	22.07
level		Count	46	46	46	46
completed	Bachelor	Mean	5.38	22.43	35.28	24.19
		Count	175	175	175	175
	Masters	Mean	5.39	23.66	33.66	24.28
		Count	94	94	94	94
	PhD	Mean	5.38	25.14	30.86	26.76
		Count	21	21	21	21
Are you	Prefer not to say	Mean	5.00	35.00	33.00	24.00
vaccinated		Count	1	1	1	1
against	No	Mean	5.50	25.00	37.33	23.00
COVID-19 ?		Count	4	4	4	4
	One dose	Mean	3.50	23.00	38.50	16.50
		Count	2	2	2	2
	Two doses	Mean	4.83	23.84	33.74	23.02
		Count	96	96	96	96

	Three doses	Mean	5.50	21.96	35.50	24.48
		Count	214	214	214	214
	Four doses	Mean	5.68	28.94	28.74	26.05
		Count	19	19	19	19
Total household income	Prefer not to say	Mean	4.83	24.66	36.89	23.72
		Count	29	29	29	29
	Don`t know	Mean	5.24	23.16	34.53	22.50
		Count	38	38	38	38
	$0-$10,000	Mean	5.43	21.40	33.05	21.67
		Count	21	21	21	21
	$10,000 to $24,999	Mean	5.37	23.77	33.14	22.09
		Count	43	43	43	43
	$25,000 to $49,999	Mean	5.10	23.88	34.16	23.08
		Count	49	49	49	49
	$50,000 to $74,999	Mean	5.12	22.51	35.64	24.10
		Count	50	50	50	50
	$75,000 to $99,999	Mean	5.38	23.84	35.23	25.44
		Count	32	32	32	32
	$100,000 and above	Mean	5.70	21.41	34.55	26.96
		Count	74	74	74	74

Correlation results

Table 6 presents the results of Pearson correlations between eHL, COVID-19 related health behaviours, SWB, and HL. Pearson correlations were used to examine the relationships between HL, eHL, SWB, and COVID-19 related health behaviours. As shown in Table 2, There is a statistically significant negative correlation between eHL and COVID-19 related health behaviours ($r = -.445$, $p < .01$), indicating that those with higher eHL tend to engage in fewer COVID-19 related health behaviours. None of the relationships between other variables were deemed statistically significant.

Table 6

Results of Pearson correlations between HL, eHL, COVID-19 related health behaviours and SWB

		HL	eHL	COVID-19 RHB	SWB
HL	Pearson Correlation	1	-.086	-.042	.136*
	Sig. (2-tailed)		.118	.440	.013
	N	336	330	334	336
eHL	Pearson Correlation	-.086	1	-.445**	-.030
	Sig. (2-tailed)	.118		.000	.592
	N	330	330	328	330
COVID-19 RHB	Pearson Correlation	-.042	-.445**	1	-.065
	Sig. (2-tailed)	.440	.000		.235
	N	334	328	334	334
SWB	Pearson Correlation	.136*	-.030	-.065	1
	Sig. (2-tailed)	.013	.592	.235	
	N	336	330	334	336

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Hierarchical Regression analysis

Table 7 present the results of the hierarchical linear regression analysis that was conducted to examine the relationship between HL, eHL, SWB, and COVID-19 related health behaviours, controlling for sociodemographic variables (age, gender, race, education, income, and employment status. The dependent variable in the analysis was COVID-19 related health behaviors, while independent variables included health literacy (HL), electronic health literacy (eHL), subjective well-being (SWB), age, gender, race, education, income, and employment status.

The selection of COVID-19 related health behaviors as the dependent variable was based on the critical importance of understanding the factors that predict how individuals respond to health information and adopt behaviors to protect themselves and their communities against COVID-19. The independent variables were selected based on their potential relevance to health behaviors. For instance, eHL and HL were included to assess the role of health information literacy in influencing behaviors. Similarly, demographic and socio-economic variables such as age, gender, race, education, income, and employment status are often seen as significant factors affecting health behaviors. SWB was included to understand if an individual's well-being has any role in their health-related actions.

The initial regression analysis model identified eHL and education level as significant predictors of COVID-19 related health behaviours. The second regression model added age, yet only eHL and education level were significant predictors of COVID-19 related health behaviours. The third regression model added gender, yet only eHL and education level were significant predictors of COVID-19 related health behaviours. The fourth regression model added household income, yet only eHL and education level were significant predictors of COVID-19 related health behaviours. The fifth regression model added HL, yet it was only eHL and education level that were significant predictors of COVID-19 related health behaviours. In the final regression model that includes all variables, it was still only eHL and education level that were significant predictors of COVID-19 related health behaviours. Overall, results found that the significant predictors of COVID-19 related health behaviours are eHL and education level.

Table 7

Hierarchical regression

		Unstandardized Coefficient (B)	t	Sig.	95.0% Confidence Interval for B (Lower Bound)	95.0% Confidence Interval for B (Upper Bound)
1	(Constant)	45.103	24.434	.000	41.471	48.735
	Racial group	-.293	-2.489	.013	-.525	-.061
	Education level completed	-1.362	-3.817	.000	-2.064	-.660
	Are you vaccinated against COVID-19?	.083	.181	.857	-.816	.981
	Measuring eHL	-.247	-8.825	.000	-.302	-.192
2	(Constant)	44.703	23.691	.000	40.990	48.415
	Racial group	-.298	-2.527	.012	-.530	-.066
	Education level completed	-1.469	-3.951	.000	-2.200	-.737
	Are you vaccinated against COVID-19?	.073	.160	.873	-.826	.972
	Measuring eHL	-.242	-8.562	.000	-.298	-.187
	Grouped Age	.382	1.022	.308	-.354	1.118
3	(Constant)	44.368	20.854	.000	40.182	48.554
	Racial group	-.298	-2.521	.012	-.530	-.065
	Education level completed	-1.460	-3.911	.000	-2.194	-.725
	Are you vaccinated against COVID-19?	.089	.194	.846	-.816	.994
	Measuring eHL	-.242	-8.512	.000	-.298	-.186
	Grouped Age	.384	1.024	.307	-.354	1.121
	Gender	.188	.342	.733	-.895	1.272
4	(Constant)	44.245	20.484	.000	39.995	48.495

	Racial group	-.302	-2.539	.012	-.536	-.068
	Education level completed	-1.462	-3.910	.000	-2.197	-.726
	Are you vaccinated against COVID-19?	.082	.177	.859	-.825	.989
	Measuring eHL	-.241	-8.471	.000	-.297	-.185
	Grouped Age	.368	.972	.332	-.376	1.112
	Gender	.209	.377	.707	-.883	1.301
	Total household income	.042	.346	.729	-.197	.281
5	(Constant)	44.859	19.697	.000	40.378	49.340
	Racial group	-.265	-2.096	.037	-.514	-.016
	Education level completed	-1.438	-3.834	.000	-2.175	-.700
	Are you vaccinated against COVID-19?	.136	.293	.770	-.780	1.053
	Measuring eHL	-.244	-8.510	.000	-.300	-.187
	Grouped Age	.359	.948	.344	-.386	1.103
	Gender	.244	.438	.662	-.851	1.339
	Total household income	.053	.432	.666	-.187	.293
	Measure HL	-.212	-.853	.394	-.701	.277
6	(Constant)	45.097	18.542	.000	40.312	49.883
	Racial group	-.263	-2.073	.039	-.513	-.013
	Education level completed	-1.429	-3.792	.000	-2.170	-.687
	Are you vaccinated against COVID-19?	.145	.310	.756	-.774	1.065
	Measuring eHL	-.244	-8.501	.000	-.300	-.187
	Grouped Age	.361	.952	.342	-.385	1.107
	Gender	.218	.386	.700	-.893	1.329
	Total household income	.059	.477	.634	-.185	.304
	Measure HL	-.207	-.831	.407	-.698	.284

Measuring SWB	-.014	-.282	.778	-.108	.081

a. Dependent Variable: Covid-19 Related health behaviours

Discussion

The purpose of this study was to examine the relationship between COVID-19 related health behaviours and three independent variables: health literacy (HL), electronic health literacy (eHL), and subjective well-being (SWB). The study also included sociodemographic data as control variables. The discussion will examine the results of this relationship via the following themes: Socio-demographic statistics, socio-Economic status, eHL and COVID-19 related health behaviours, and HL and COVID-19 related health behaviours.

Socio-demographic statistics

Based on the bivariate analysis of sociodemographic statistics, the following information can be highlighted:

Age group: The mean scores for HL, eHL, COVID-19 related health behaviours, and SWB are highest among the 25-34 age group and lowest among the 45-54 age group. This indicates that young adults in their mid-20s to mid-30s have higher HL and engagement in preventive COVID-19 related health behaviours, and report higher levels of SWB.

Gender: The mean scores for HL, eHL, and SWB are slightly higher for women than for men. In terms of COVID-19 related health behaviours, the highest mean score was found among those who didn't identify as men or women whereas the lowest was found amongst women. This suggests that women may have better HL, be more engaged in preventive COVID-19 related health behaviours and have higher levels of subjective well-being.

Racial or cultural group: The highest mean scores for HL, eHL, COVID-19 related health behaviours, and SWB were found among white participants. The lowest mean score for HL was found among Black/African participants, for eHL was found among Latin American participants, for COVID-19 related health behaviours were found among Middle Eastern participants, and for SWB was found among South Asian participants. These findings suggest that there may be disparities in HL, engagement in COVID-19 related preventive health behaviours, and SWB among different racial and cultural groups.

Education level completed: The mean scores for HL, eHL, and COVID-19 related health behaviours are highest among those who have completed a higher level of education, such as a Masters or PhD. The mean score for SWB is also the highest among those who have completed a PhD. This suggests that education may promote better HL, engagement in COVID-19 related preventive health behaviours and SWB.

Vaccination status: The highest mean score for HL was found among those who have received four doses of COVID-19 vaccine, whereas the highest mean score for eHL was found among those who did not report their vaccination status. The highest mean score for COVID-19 related health behaviours was found among those who have received one dose of COVID-19 vaccine, whereas the highest mean score for SWB was found among those who have received four doses of COVID-19 vaccine. These findings suggest that vaccination status may be associated with HL, engagement in preventive health behaviours, and SWB.

Total household income: The mean scores for HL, eHL, COVID-19 related health behaviours, and SWB are highest among those with a total household income of $100,000 and above, and lowest among those with a total household income of $0-$10,000. This suggests that higher

income levels may be associated with better HL, engagement in preventive COVID-19 related health behaviours and SWB.

Socio-Economic Status

Socioeconomic status is regarded as a fundamental proximal factor in the conceptualization of HL, as posited by the HL framework developed by Sorensen et al. (2012). Socioeconomic status refers to an individual's or family's economic and social position in relation to others, and it has been consistently linked to disparities in health outcomes. Specifically, individuals from lower Socioeconomic status groups have been found to experience worse health outcomes than their higher Socioeconomic status counterparts (Sorensen et al., 2012). Hence, assessing the socioeconomic characteristics of the study sample in this investigation would offer valuable insights into the interpretation of the findings, and potentially account for any observed differences in HL, eHL, SWB, and COVID-19 related health behaviours among participants.

A total of 336 students completed the questionnaires with a mean age of 26.09 years (SD = 6.61). In comparison, the average age of university graduates in Canada (earliest degree level) is 23 years (Government of Canada, 2014); thus, this study reflected students who were older than the average university student. In terms of income, the largest proportion of participants fell within the range of $100,000 and above (22%), followed by $50,000-74,999 (14.9%) and $25,00-$49,999 (14.6%). This indicates that the sample is composed of individuals from a range of income levels. However, there is an overrepresentation of participants from higher income brackets as only 11% of Canadians make over $100,000 (Government of Canada, 2022c) whereas this sample had double the amount.

The racial breakdown of the sample was predominantly white (62.5%), with smaller proportions of Black/African (15.18%), Middle Eastern (6.85%), and South Asian (6.25%) participants. In comparison to the Canadian university population, a study by StatsCan on the profile of Canadian graduates at the bachelor level found that the racial breakdown of bachelor degree graduates from 2014 to 2017 and of the Canadian population aged 25 to 34 was: 17.1% of Asian graduates (South Asian, Chinese, Southeast Asian, West Asian, Korean, and Japanese); 3.6% of Black graduates; 1.1% of Latin American graduate; 1.8% of Arab graduates; 1% of mixed race graduates; and 70.8% of not visible minority graduates (Government of Canada, 2022b). It should be noted that as part of an exploration into the prevalence of race and racial discrimination at Canadian universities, CBC found that a majority of the country's largest universities lack a comprehensive understanding of the racial makeup of their student body, with over 60 schools reporting they do not gather this information; thus, there is not comprehensive demographic data to compare the study's sample to a global Canadian university student population (McDonald & News, 2017). Albeit, Other than the white participants, this study does not accurately reflect the racial demographic population of Canadian university students at the bachelor's degree level. This indicates that the sample is not representative of the diversity of the population. One of the byproducts of using a Convenience sampling method is that samples may have certain groups over- or under-represented. In this case, the sample was not representative of the general university student population, as the sample was limited to those who were accessible through the sampling convenience method.

In the present study, most participants identified as female (76.7%). An explanation for the overrepresentation of women in this sample can firstly be described by the fact that women make up a more significant proportion of university students in Canada, with approximately 60%

of university students identifying as female (Government of Canada, 2022d). Second, women tend to seek out health information more often, are more likely to participate in preventive health behaviours than men, tend to have a better understanding of health information, and are more likely to be engaged in self-care practices (Ek, 2015; Hiller, Schatz, & Drexler. 2017). Moreover, as women are often considered the primary caretakers in their families, this leads to a greater focus on health information and health-seeking behaviours (Ek, 2015; Hiller, Schatz, & Drexler. 2017). Conversely, men take more risks with health (Ek, 2015). Moreover, there are also cultural factors at play: some cultures place a greater emphasis on women's health and well-being, which may lead to increased health literacy and health-seeking behaviours (Ek, 2015; Hiller, Schatz, & Drexler. 2017).

In terms of access to healthcare and engagement in health communication, healthcare providers may exhibit a perceived bias towards female patients, leading to more comprehensive health information and care for women (Tannenbaum, Greaves, & Graham, 2016). As a result, women may be more likely to receive adequate and appropriate health information and care from healthcare providers than men.

Thirdly, maternal health concerns and their children's health may motivate women to be more engaged in health communication with healthcare providers (Lee et al., 2015). These concerns may prompt women to seek health information and advice from healthcare providers, leading to better health outcomes for both themselves and their children.

Lastly, women with higher education and income levels may have better access to health information and resources, leading to greater HL and engagement in preventive health behaviours (Dluhos-Sebesto et al., 2021). This is particularly true for women with access to education and resources that enable them to make informed health decisions and take preventive

health measures. This is in line with research indicating that women may tend to have higher HL than men (Lee et al., 2015).

In summary, the results suggest that the sample primarily comprises young, female, white, educated individuals from a range of income levels. This explains the higher than average HL, eHL, SWB, and COVID-19 related health behaviours.

eHL and COVID-19 related health behaviours

Overall, the findings of this study suggest that eHL is an essential factor in predicting COVID-19 related health behaviours. Under the pandemic setting and subsequent lockdowns, the world was increasingly digitized. With the widespread availability of digital platforms, access to COVID-19 related information was increasingly found online (Li et al., 2021; Patil et al., 2021). This access to information can lead to increased knowledge about the virus, and its impact on individuals, which in turn influences their health behaviour. eHL enables individuals to evaluate the health information available to them critically. The COVID-19 pandemic has increased the spread of misinformation about the virus, its symptoms and treatments (Li et al., 2021; Patil et al., 2021). With higher levels of eHL, individuals can distinguish between credible and unreliable sources and make informed decisions about their health behaviours.

However, dependence on technology can be a contraindicating factor: While eHL is crucial in providing access to information, individuals who rely solely on digital sources for health information can become over-reliant on technology. This can result in individuals not seeking additional sources of information or disregarding traditional health practices and beliefs (Mesko et al., 2017; Tonsaker, Bartlett, & Trpkov, 2014). The widespread availability of digital platforms can result in an overload of information, which can be confusing and overwhelming for individuals. As evidenced by the results in this study, eHL is prone to this phenomenon, as

individuals may be unable to distinguish between credible and unreliable sources, irrespective of their eHL levels. Furthermore, the digital platform is not immune to biases, and individuals may encounter sources of information that are influenced by personal beliefs or interests. This can result in unreliable or inaccurate information being disseminated, which can negatively impact an individual's eHL and their ability to adopt COVID-19 related health behaviours.

Moreover, eHL is dependent on access to technology and the internet. However, not all individuals have equal access to these resources, and those who do not may be unable to access accurate and reliable information about the COVID-19 pandemic (Roh & Won, 2023).

Additionally, while eHEALS is a reliable and valid measure of eHL, it is still based on self-reported data, which can be subject to response bias and social desirability (Del Giudice et al., 2018; Monkman et al., 2017). As a result, individuals may overestimate their eHL skills, which could potentially lead to overconfidence and a lack of willingness to seek out additional information or resources, especially when it comes to COVID-19 related health behaviours. There could be several reasons why someone with high eHL scores may not practice COVID-19 related health behaviours. For example, they may be misinformed or lack knowledge about the efficacy of certain preventative measures, they may have low levels of motivation or commitment to these behaviours, they may have social or cultural factors that impede them from practicing these behaviours, or they may face practical barriers in adopting these behaviours, such as lack of access to hand sanitizer or masks (Terry et al., 2022). In short, the results of this study provide evidence for the importance of HL and eHL in predicting COVID-19 related health behaviours. The significant negative correlation between eHL and COVID-19 related health behaviours found in this study also supports the idea that eHL may be a significant predictor of health behaviours in the context of COVID-19 in an ever-evolving digital world.

Other factors such as motivation, access, and sociocultural factors, also play a role in determining an individual's actual behaviours (Coughlin et al., 2020.

Why does HL not predict COVID-19 related health behaviours?

The finding that HL was not significantly correlated with COVID-19 related health behaviours was unexpected and warrants further investigation. It is interesting that HL does not predict COVID-19 related health behaviours. The complexity of COVID-19 information can explain this: COVID-19 is a highly complex disease, with new information emerging on a regular basis. This complexity makes it difficult for even the most health literate individuals to understand and make decisions related to the disease. Several factors may explain the lack of correlation between HL and COVID-19 related health behaviours. First, the complexity of the COVID-19 pandemic and the constantly evolving recommendations and guidelines may have overwhelmed the HL skills of individuals (Knottnerus, Heijmans, & Rademakers, 2022). The abundance of conflicting information and the rapid pace at which it was being disseminated may have made it difficult for individuals, regardless of their health literacy levels, to understand and make informed health decisions (Knottnerus, Heijmans, & Rademakers, 2022).

Second, previous research has suggested that health literacy is only one of many factors influencing health behaviours (Coughlin et al., 2020). Factors such as socio-demographic characteristics, cultural beliefs, and past experiences also play a role in determining health behaviours (Coughlin et al., 2020). In the context of the COVID-19 pandemic, these factors may have had a greater impact and taken precedence over health behaviours than health literacy.

Third, the measures used to assess health literacy may not have accurately captured individuals' health literacy levels in the context of the COVID-19 pandemic. The current HL measures were developed before the pandemic and may not have considered the unique

challenges and complexities posed by the COVID-19 pandemic. The measures lack items related to individuals' ability to understand and act on rapidly evolving health information, navigate complex digital health information and communication channels, and make informed decisions about their health in the context of a pandemic. This is an important issue because an accurate assessment of HL is essential for understanding how individuals access and utilize health information during the pandemic. Without accurate HL measures, it can be difficult for healthcare providers, public health officials, and policymakers to communicate important health information effectively and develop effective strategies for promoting health behaviours and preventing the spread of COVID-19.

As the HL framework states, applying health literacy skills may be difficult because of fear and anxiety. Fear and anxiety about COVID-19 can also play a role in determining health behaviours, regardless of an individual's level of health literacy. Also, the enormous amount of sources of information that individuals have access to when making decisions about COVID-19, such as social media, news outlets, and personal anecdotes, can distract from information gleaned from health experts and health organizations. This highlights the need for clear and consistent messaging from trusted sources of information. Healthcare providers, public health officials, and policymakers can play an important role in providing accurate and reliable information to the public through channels such as social media, news outlets, and public service announcements. Overall, addressing the challenges posed by fear and anxiety, as well as the abundance of information available on COVID-19, can be crucial in promoting effective health behaviours.

Additionally, the lack of correlation between HL and eHL is interesting because it depicts the difference between the two mechanisms. As stated in the literature review, HL and eHL

require different as there is more emphasis on searching and appraising health-related information online due to the vast amounts of information and resources available (Monkman et al., 2017). eHL requires proficiency in using digital devices and accessing online health information and the ability to evaluate and interpret this information critically. This includes skills such as navigating websites, searching for health information online and identifying credible sources of information. In contrast, HL focuses more broadly on an individual's ability to access, understand, and apply health information, regardless of the format in which it is presented.

In conclusion, the lack of a statistically significant relationship between HL and COVID-19 related health behaviours suggests that HL may not be a significant predictor of these behaviours in the context of the COVID-19 pandemic. This highlights the need for a better understanding of the factors that influence health behaviours in the context of a pandemic and the development of more comprehensive measures of HL that consider the unique challenges posed by COVID-19. In addition, further research is needed to understand better the interplay between health literacy and other factors in determining health behaviours in the context of the COVID-19 pandemic.

Limitations and Challenges

The present study has several limitations and challenges that should be acknowledged. Firstly, the small sample size of 336 participants is not representative of the entire population and the results may not generalize to other populations. The sample predominantly identified as female (76.7%) and white (62.5%) and the majority had completed at least a bachelor's degree (52.7%). In addition, convenience samples are not representative of the larger population and may be biased towards certain groups who are more easily accessible or more likely to

participate. This can result in findings that are not representative of the general population of university students in Canada. The lack of representativeness of the sample limits the ability to make inferences and predictions about the population based on the study results. Response bias is another potential limitation since the sample may only include individuals willing to provide complete and accurate responses, leading to over- or under-reporting of certain characteristics or experiences, affecting the validity of the findings.

The mean age of the participants was 25.3 years, which does not reflect the average age of a bachelors degree student (Government of Canada, 2014), and thus fails to capture a younger population that was intended in this study. The sample was skewed towards older and more educated students. This may limit the generalizability of the findings to other populations. The correlations between the variables are weak, which suggests that the relationships may not be substantial. Additionally, the study relied on self-report measures, which may be subject to bias or inaccurate reporting. This is evident in the eHEALS assessment, where participants scored high on the objective HL measure but low on the subjective eHL measure. This could indicate a discrepancy between their actual knowledge or ability to use digital health information and technology and their perception of their knowledge and ability. The participants may have a high level of knowledge and ability related to traditional HL skills (such as reading and understanding health information). However, they may not have the same level of knowledge and ability when using digital health resources, such as navigating health websites or using health apps. This result may suggest a need for targeted interventions to improve eHL among individuals with high HL scores. Such interventions may include training and education on using electronic health resources or improving the accessibility and usability of digital health resources to make them more user-friendly for individuals with different levels of eHL. Finally, the study used cross-

sectional data, meaning causality cannot be established. The observed associations between variables may be due to factors not measured or controlled for in the study.

It is essential to consider these limitations in the interpretation of the study's findings. The overrepresentation of certain demographic groups and the use of convenience sampling mean that the results may not be generalizable to the broader population of Canadian university students. Particularly, this sample's lack of representativeness in terms of race and gender demographics may impact the accuracy of the relationships observed between HL, eHL, SWB, and COVID-19 related health behaviors. Further studies with more diverse and representative samples are recommended for better generalizability and understanding of the relationships between these variables.

Future Research Directions

Based on the results of this study, several directions for future research could be pursued. One direction would be to replicate the study with a larger sample size to see if the findings hold up. Several more representative and rigorous sampling techniques could have been used in the present study to reduce the limitations and potential biases associated with convenience sampling, such as simple random sampling, stratified random sampling, cluster sampling, and multi-stage sampling. Future research could employ these sampling techniques to obtain a more representative sample of the population of interest. To increase the generalizability of the findings, future research should aim to investigate a unique sample, focusing on specific characteristics such as gender, race/ethnicity, and educational level. Additionally, populations of interest would be persons with disabilities as 1 in 5 Canadians over the age of 15 have a disability (Government of Canada, 2022a). People with disabilities may face unique challenges related to HL and eHL, such as difficulty accessing health information and services, so

conducting studies with this population can help identify these challenges and inform the development of accessible health information and services. Another population worth studying is the elderly as they are more prone to health issues and eHL challenges. This would yield more information on groups that are not usually studied. Moreover, larger sample sizes would allow for more precise estimates of associations and effects and would increase the power to detect significant effects.

The data analysis strategy could have been improved by adding more variables or controls, for example, including other factors that may affect COVID-19 related health behaviours such as access to healthcare, knowledge about COVID-19, or social support. In addition, future research could use objective measures rather than relying on self-report to improve the validity of the findings.

Lastly, collecting data over a more extended period would allow for examining the changes in COVID-19 related health behaviours over time and how they may be influenced by changes in HL, eHL, and SWB.

Conclusion

In conclusion, this study examined the relationship between COVID-19 related health behaviours and three independent variables: health literacy (HL), electronic health literacy (eHL), and subjective well-being (SWB). The study also included sociodemographic data as control variables. The results of this study indicated that the sample was primarily composed of young, female, white, educated individuals from a range of income levels, explaining the higher than average HL, eHL, SWB, and COVID-19 related health behaviours. Furthermore, eHL was found to be an important predictor of COVID-19 related health behaviours, highlighting the need for individuals to distinguish between credible and unreliable sources of information when

accessing health information. However, HL was not found to be a significant predictor of COVID-19 related health behaviours, suggesting that other factors, such as fear and anxiety, socio-demographic characteristics, and cultural beliefs, play a more prominent role in determining health behaviours in the context of COVID-19.

The study has several implications for healthcare providers, public health officials, and policymakers. Firstly, it is crucial to provide clear and consistent messaging from trusted sources of information to promote effective health behaviours. Secondly, the development of more comprehensive measures of HL and eHL that consider the unique challenges posed by COVID-19 is needed to assess individuals' HL levels accurately. Finally, addressing the challenges posed by the abundance of information available on COVID-19 can be crucial in promoting effective health behaviours.

Further research is needed to understand better the interplay between HL, eHL, and other factors in determining health behaviours in the context of the COVID-19 pandemic. Overall, this study provides valuable insights into the relationship between HL, eHL, SWB, and COVID-19 related health behaviours, highlighting the need for individuals to be able to navigate the complex digital health information landscape in the context of the COVID-19 pandemic.

References

An, L., Bacon, E., Hawley, S., Yang, P., Russell, D., Huffman, S., & Resnicow, K. (2021). Relationship Between Coronavirus-Related eHealth Literacy and COVID-19 Knowledge, Attitudes, and Practices among US Adults: Web-Based Survey Study. *Journal of Medical Internet Research*, 23(3), e25042–e25042. https://doi.org/10.2196/25042

Adler, N.E., Snibbe, A.C. (2003). The role of psychosocial processes in explaining the gradient between SES and health. *Current Directions in Psychological Science*, 12, 119-123.

Anderson, E. L., Steen, E., & Stavropoulos, V. (2017). Internet use and Problematic Internet Use: a systematic review of longitudinal research trends in adolescence and emergent adulthood. *International Journal of Adolescence and Youth*, 22(4), 430–454. https://doi.org/10.1080/02673843.2016.1227716

Beauchamp, A., Buchbinder, R., Dodson, S., Batterham, R. W., Elsworth, G. R., McPhee, C., Sparkes, L., Hawkins, M., & Osborne, R. H. (2015). Distribution of health literacy strengths and weaknesses across socio-demographic groups: a cross-sectional survey using the Health Literacy Questionnaire (HLQ). *BMC Public Health*, 15(1), 678–678. https://doi.org/10.1186/s12889-015-2056-z

Bonderski, V., Morrow, D. G., Chin, J., & Murray, M. D. (2018). Pharmacy-Based Approach to Improving Heart Failure Medication Use by Older Adults with Limited Health Literacy: Learning from

Interdisciplinary Experience. *Drugs & Aging*, 35(11), 951–957. https://doi.org/10.1007/s40266-018-0586-7

Bröder, J., Okan, O., Bauer, U., Bruland, D., Schlupp, S., Bollweg, T. M., Saboga-Nunes, L., Bond, E., Sørensen, K., Bitzer, E.-M., Jordan, S., Domanska, O., Firnges, C., Carvalho, G. S., Bittlingmayer, U. H., Levin-Zamir, D., Pelikan, J., Sahrai, D., Lenz, A., … Pinheiro, P. (2017). Health literacy in childhood and youth: a systematic review of definitions and models. *BMC Public Health*, 17(1), 361–361. https://doi.org/10.1186/s12889-017-4267-y

Corbeil, J.-P. (2006). The Canadian Component of the 2003 International Adult Literacy and Skills Survey (IALSS): The Situation of Official Language Minorities. Statistics Canada.

COVID-19 vaccine doses administered per 100 people. (n.d.). Our World in Data. Retrieved April 7, 2022, from https://ourworldindata.org/grapher/covid-vaccination-doses-per-capita

Czenczek- Lewandowska, E., Wyszyńska, J., Leszczak, J., Baran, J., Weres, A., Mazur, A., & Lewandowski, B. (2021). Health behaviours of young adults during the outbreak of the Covid-19 pandemic – a longitudinal study. *BMC Public Health*, *21*(1), 1038. https://doi.org/10.1186/s12889-021-11140-w

Del Giudice, P., Bravo, G., Poletto, M., De Odorico, A., Conte, A., Brunelli, L., Arnoldo, L., & Brusaferro, S. (2018). Correlation Between eHealth Literacy and Health Literacy Using the eHealth Literacy Scale and Real-Life Experiences in the Health Sector as a Proxy Measure of Functional Health Literacy: Cross-Sectional Web-Based Survey. Journal of Medical Internet Research, 20(10), e281–e281. https://doi.org/10.2196/jmir.9401

Dluhos-Sebesto, C., Jethwa, T. E., Bertasi, T. G. O., Bertasi, R. A. O., Nishi, L. Y. M., Pantin, S. A. L., Argenio, S. L., Shahsamand, A., Omololu, A., & Pujalte, G. G. A. (2021). Women's Health Information Survey: Common Health Concerns and Trusted Sources of Health Information Among Different Populations of Female Patients. *Women's health reports (New Rochelle, N.Y.)*, *2*(1), 173–181. https://doi.org/10.1089/whr.2020.0118

Ek, S. (2015). Gender differences in health information behaviour: a Finnish population-based survey. *Health promotion international*, *30*(3), 736-745. https://doi.org/10.1093/heapro/dat063

Government of Canada, S. C. (2014, December 1). *Postsecondary graduates, by location of residence at interview and level of study*. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710003101

Government of Canada, S. C. (2022a, May 27). *Better understanding the needs of Canadians with disabilities*. https://www.statcan.gc.ca/o1/en/plus/1040-better-understanding-needs-canadians-disabilities

Government of Canada, S. C. (2022b, June 6). *Profile of Canadian graduates at the bachelor level belonging to a group designated as a visible minority, 2014 to 2017 cohorts*. https://www150.statcan.gc.ca/n1/pub/81-595-m/81-595-m2022003-eng.htm

Government of Canada, S. C. (2022c, August 9). *Add/Remove data—Tax filers and dependants with income by total income, sex and age*. https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1110000801

Government of Canada, S. C. (2022d, November 22). *Proportion of male and female postsecondary graduates, by field of study and International Standard Classification of Education*. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710013502 Haun, J. N., Valerio, M. A., McCormack, L. A., Sørensen, K., & Paasche-Orlow, M. K. (2014). Health Literacy Measurement: An Inventory and Descriptive Summary of 51 Instruments. *Journal of Health Communication*, 19(sup2), 302–333. https://doi.org/10.1080/10810730.2014.936571

Holt, K. A., Overgaard, D., Engel, L. V., & Kayser, L. (2020). Health literacy, digital literacy and eHealth literacy in Danish nursing students at entry and graduate level: a cross-sectional study. *BMC Nursing*, 19(1), 22–22. https://doi.org/10.1186/s12912-020-00418-w

Johnson, V. R., Jacobson, K. L., Gazmararian, J. A., & Blake, S. C. (2010). Does social support help limited-literacy patients with medication adherence? A mixed methods study of patients in the

Pharmacy Intervention for Limited Literacy (PILL) study. *Patient Education and Counseling*, 79(1), 14–24.

Kimhi, S., Eshel, Y., Marciano, H., & Adini, B. (2020). A Renewed Outbreak of the COVID-19 Pandemic: A Longitudinal Study of Distress, Resilience, and Subjective Well-Being. *International Journal of Environmental Research and Public Health*, 17(21), 7743–. https://doi.org/10.3390/ijerph17217743

Knottnerus, B., Heijmans, M., & Rademakers, J. (2022). The role of primary care in informing and supporting people with limited health literacy in the Netherlands during the COVID-19 pandemic: a qualitative interview study. BMC primary care, 23(1), 1-7. https://doi.org/10.1186/s12875-022-01723-w

Kobau, R., Sniezek, J., Zack, M. M., Lucas, R. E., & Burns, A. (2010). Well-Being Assessment: An Evaluation of Well-Being Scales for Public Health and Population Estimates of Well-Being among US Adults. *Applied Psychology*: Health and Well-Being, 2(3), 272–297. https://doi.org/10.1111/j.1758-0854.2010.01035.x

Lanpher, M. G., Askew, S., & Bennett, G. G. (2016). Health Literacy and Weight Change in a Digital Health Intervention for Women: A Randomized Controlled Trial in Primary Care Practice. *Journal of Health Communication*, 21(sup1), 34–42. https://doi.org/10.1080/10810730.2015.1131773

Lee, H. Y., Lee, J., & Kim, N. K. (2015). Gender Differences in Health Literacy Among Korean Adults: Do Women Have a Higher Level of Health Literacy Than Men? *American Journal of Men's Health*, *9*(5), 370–379. https://doi.org/10.1177/1557988314545485

Li, S., Cui, G., Kaminga, A. C., Cheng, S., & Xu, H. (2021). Associations Between Health Literacy, eHealth Literacy, and COVID-19–Related Health Behaviours Among Chinese College Students: Cross-sectional Online Study. *Journal of Medical Internet Research*, *23*(5), e25600. https://doi.org/10.2196/25600

Lopez Bernal, J., Andrews, N., Gower, C., Gallagher, E., Simmons, R., Thelwall, S., Stowe, J., Tessier, E., Groves, N., Dabrera, G., Myers, R., Campbell, C. N. J., Amirthalingam, G., Edmunds, M., Zambon,

M., Brown, K. E., Hopkins, S., Chand, M., & Ramsay, M. (2021). Effectiveness of Covid-19 Vaccines against the B.1.617.2 (Delta) Variant. *New England Journal of Medicine*, *385*(7), 585–594. https://doi.org/10.1056/NEJMoa2108891

Macfie. (2013). Towards a new definition of history. Rethinking History, 17(3), 401–412. https://doi.org/10.1080/13642529.2013.774730

Mansfield, E. D., Wahba, R., Gillis, D. E., Weiss, B. D., & L'Abbé, M. (2018). Canadian adaptation of the Newest Vital Sign©, a health literacy assessment tool. Public Health Nutrition, 21(11), 2038–2045. https://doi.org/10.1017/S1368980018000253

McDonald, J., & News ·, L. W. · C. (2017, March 21). *Why so many Canadian universities know so little about their own racial diversity | CBC News*. CBC. https://www.cbc.ca/news/canada/race-canadian-universities-1.4030537

Meskó, B., Drobni, Z., Bényei, É., Gergely, B., & Győrffy, Z. (2017). Digital health is a cultural transformation of traditional healthcare. mHealth, 3, 38. https://doi.org/10.21037/mhealth.2017.08.07

Monkman, H., Kushniruk, A. W., Barnett, J., Borycki, E. M., Greiner, L. E., & Sheets, D. (2017). Are Health Literacy and eHealth Literacy the Same or Different?. *Studies in health technology and informatics*, 245, 178–182.

Morris, S., Fawcett, G., Brisebois, L., & Hughes, J. (2018, November 28). A demographic, employment and income profile of Canadians with disabilities aged 15 years and over, 2017. Retrieved April 2, 2022, from https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2018002-eng.htm

Neter, E., & Brainin, E. (2017). Perceived and Performed eHealth Literacy: Survey and Simulated Performance Test. *JMIR Human Factors*, 4(1), e2–e2. https://doi.org/10.2196/humanfactors.6523

Ng, E., & Omariba, D. W. R. (2014). Immigration, generational status and health literacy in Canada. *Health Education Journal*, *73*(6), 668–682. https://doi.org/10.1177/0017896913511809

Nguyen, L. H. T., Vo, M. T. H., Tran, L. T. M., Dadaczynski, K., Okan, O., Murray, L., & Van Vo, T. (2021). Digital Health Literacy About COVID-19 as a Factor Mediating the Association Between the Importance of Online Information Search and Subjective Well-Being Among University Students in Vietnam. *Frontiers in Digital Health*, *3*. https://www.frontiersin.org/article/10.3389/fdgth.2021.739476

Norman, C. D., & Skinner, H. A. (2006). eHEALS: The eHealth Literacy Scale. *Journal of Medical Internet Research*, 8(4), e27–e27. https://doi.org/10.2196/jmir.8.4.e27

Patil, U., Kostareva, U., Hadley, M., Manganello, J. A., Okan, O., Dadaczynski, K., Massey, P. M., Agner, J., & Sentell, T. (2021). Health Literacy, Digital Health Literacy, and COVID-19 Pandemic Attitudes and Behaviours in US College Students: Implications for Interventions. I*nternational Journal of Environmental Research and Public Health,* 18(6), 3301–. https://doi.org/10.3390/ijerph18063301

Platto, S., Xue, T., & Carafoli, E. (2020). COVID19: An announced pandemic. *Cell Death & Disease*, *11*(9), 799. https://doi.org/10.1038/s41419-020-02995-9

Pongou, R., Ahinkorah, B. O., Mabeu, M. C., Agarwal, A., Maltais, S., & Yaya, S. (2022). Examining the association between reported COVID-19 symptoms and testing for COVID-19 in Canada: A cross-sectional survey. *BMJ Open*, *12*(3), e056229. https://doi.org/10.1136/bmjopen-2021-056229

Robinson, C., & Graham, J. (2010). Perceived Internet health literacy of HIV-positive people through the provision of a computer and Internet health education intervention. *Health Information and Libraries Journal*, 27(4), 295–303. https://doi.org/10.1111/j.1471-1842.2010.00898.x

Roh, M., & Won, Y. (2023). Impact of Online-Delivered eHealth Literacy Intervention on eHealth Literacy and Health Behaviour Outcomes among Female College Students during COVID-19. International journal of environmental research and public health, 20(3), 2044. https://doi.org/10.3390/ijerph20032044

Rootman, I., & Gordon-El-Bihbety, D. (2008*). A vision for a health literate Canada report of the Expert Panel on Health Literacy*. Canadian Public Health Association.

Rosenbaum, J. E., Johnson, B. K., & Deane, A. E. (2018). Health literacy and digital media use: Assessing the Health Literacy Skills Instrument – Short Form and its correlates among African American college students. *Digital Health*, 4, 2055207618770765–2055207618770765. https://doi.org/10.1177/2055207618770765

Sentell, T., Vamos, S., & Okan, O. (2020). Interdisciplinary Perspectives on Health Literacy Research Around the World: More Important Than Ever in a Time of COVID-19. *International Journal of Environmental Research and Public Health*, 17(9), 3010–. https://doi.org/10.3390/ijerph17093010

Sorensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J. M., Slonska, Z., & Brand, H. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health*, 12(1), 80–80. https://doi.org/10.1186/1471-2458-12-80

Squiers, L., Peinado, S., Berkman, N., Boudewyns, V., & McCormack, L. (2012). The Health Literacy Skills Framework. *Journal of Health Communication*, 17(sup3), 30–54. https://doi.org/10.1080/10810730.2012.713442

Tannenbaum, C., Greaves, L., & Graham, I. D. (2016). Why sex and gender matter in implementation research. *BMC medical research methodology*, *16*(1), 1-9. https://doi.org/10.1186/s12874-016-0247-7

Terry, E., Cartledge, S., Damery, S., & Greenfield, S. (2022). Factors associated with COVID-19 vaccine intentions during the COVID-19 pandemic; a systematic review and meta-analysis of cross-sectional studies. BMC Public Health, 22(1), 1-16. https://doi.org/10.1186/s12889-022-14029-4

Tasnim, F., Sadraei, A., Datta, B., Khan, M., Choi, K. Y., Sahasrabudhe, A., Vega Gálvez, T. A., Wicaksono, I., Rosello, O., Nunez-Lopez, C., & Dagdeviren, C. (2018). Towards personalized

medicine: the evolution of imperceptible healthcare technologies. *Foresight (Cambridge*), 20(6), 589–601. https://doi.org/10.1108/FS-08-2018-0075

Tonsaker, T., Bartlett, G., & Trpkov, C. (2014). Health information on the Internet: gold mine or minefield?. , 60(5), 407–408.

Toussaint, L. L., Cheadle, A. D., Fox, J., & Williams, D. R. (2020). Clean and Contain: Initial Development of a Measure of Infection Prevention Behaviours During the COVID-19 Pandemic. *Annals of Behavioural Medicine*, 54(9), 619–625. https://doi.org/10.1093/abm/kaaa064

Usher, K., Durkin, J., & Bhullar, N. (2020). The COVID-19 pandemic and mental health impacts. *International Journal of Mental Health Nursing*, *29*(3), 315–318. https://doi.org/10.1111/inm.12726

Visscher, K. L., & Hutnik, C. M. L. (2015). Reprint of: Health literacy in Canada and the ophthalmology patient. *Canadian Journal of Ophthalmology*, *50*, S40–S46. https://doi.org/10.1016/j.jcjo.2015.04.008

Appendix A: Research Ethics Board - approval

04/05/2022

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-04-22-7843
Titre du projet / Project Title	Relationship Between Health Literacy (HL), eHealth Literacy (eHL), Subjective Well-being (SWB) and COVID-19 Related Health Behaviors Among Canadian College Students: A Cross-Sectional Study
Type de projet / Project Type	Thèse de maîtrise / Master's thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	04/05/2022
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	03/05/2023

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Malik DJINADOU	École interdisciplinaire des sciences de la santé / Interdisciplinary School of Health Sciences	Chercheur Principal / Principal Investigator
Sanni YAYA	École de développement international et mondialisation / School of International Development and Global Studies	Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments

04/05/2022

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée "Conditions Spéciales ou Commentaires". Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout évènement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special Conditions or Comments". The "Renewal/Project Closure" form must be completedfour weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Kim THOMPSON
Responsable d'éthique en recherche / Protocol Officer
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board**

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