Biochemistry and Cell Biology

OPEN ACCESS | Article

Analysis of financial challenges faced by graduate students in Canada

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Abstract

Graduate students are vital to the creation of research and innovation in Canada. The National Graduate Student Finance Survey was launched in 2021 by the Ottawa Science Policy Network to investigate the financial realities of Canadian graduate students. Closing in April 2022, the survey received 1305 responses from graduate students representing various geographical locations, years of study, fields of education, and demographic backgrounds. The results capture a snapshot into graduate student finances, including an in-depth analysis of stipends, scholarships, debt, tuition, and living expenses. In its entirety, we found that the majority of graduate students are facing serious financial concerns. This is largely due to stagnant funding for students both from federal and provincial granting agencies and from within their institutions. This reality is even worse for international students, members of historically underrepresented communities, and those with dependents, all of whom experience additional challenges that impact their financial security. Based on our findings, we propose several recommendations to the Tri-Council agencies (Natural Sciences and Engineering Research Council, Social Science and Humanities Research Council, and Canadian Institute for Health Research) and academic institutions to strengthen graduate student finances and help sustain the future of research in Canada.

Key words: Graduate Students, Canadian Research, Stipends, Funding, Scholarships, Tri-Council

Introduction

Graduate students play a large role in the research and innovation ecosystem in Canada. These students have already completed a bachelor's degree and are enrolled in a master's or doctoral degree. Most graduate degrees include full-time, independent research in collaboration with a Principal Investigator or supervisor, who is a faculty member at a university. This work requires laborious training and creates the foundation of research in Canada. Research has shown that one-third of publications feature PhD students as either authors or co-authors (Lariviére 2012), exemplifying the crucial role that graduate students play in research and academic publications.

Since graduate students are often enrolled in full-time studies, many receive a stipend intended to offset living costs so that they can focus on their studies. The source of this funding for graduate students can be complex. In Canada, funding comes from two main sources: (1) directly through scholarships, such as those provided by the three federal granting agencies, known as the Tri-Council (Natural Sciences and Engineering Research Council (NSERC), Social Science and Humanities Research Council (SSHRC), and the Canadian Institute for Health Research (CIHR)) or (2) indirectly through their supervisor's research grants and(or) department funding. As such, graduate student pay is often referred to as a stipend, since it is often a fixed pay, independent from work performed. Stipends can vary among graduate students and depend on many factors. For example, some students may be required to complete teaching assistantships (TAs) in which they assist a professor with instructional responsibilities or research assistantships (RAs) in which they assist a professor or instructor with additional research activities such as performance of clerical, laboratory, or technical tasks as part of their stipend.

The value of graduate student stipends can be set by universities, faculties, departments, and supervisors. It appears that, in the absence of any other government guidance, federal Tri-Council scholarship values have set the precedent for stipend values. However, it is important to acknowledge that these scholarships have not changed in value since 2003. Additionally, there has been little increase in the number of available Canadian scholarships over the years. A 2018 report from the Science and Policy Exchange (SPE) revealed that 91% of graduate students were largely displeased with

the number of Tri-Council scholarships available for graduate students (Science and Policy Exchange 2020). Furthermore, 79% replied that they would like to see an increase in the value of the awards. This 2018 report eloquently displayed the dissatisfaction among graduate students in regard to the value and number of federal scholarships, as well as the perceived financial security that comes with obtaining these scholarships.

During the COVID-19 pandemic, financial concerns of graduate students became even more prominent, with Statistics Canada reporting that over two-thirds of continuing postsecondary students were very or extremely concerned about the financial impacts of the pandemic (Wall 2020). The Toronto Science Policy Network's *COVID-19 Graduate Student Report* has also revealed that finances were at the forefront of worries for graduate students during the pandemic (Toronto Science Policy Network 2020).

These financial concerns for graduate students have continued, with inflation recently hitting a 40-year high, causing an increase in everyday expenses (Scherer and Smith 2022). While inflation affects all those in Canada, graduate students can be considered a particularly vulnerable group because their stipend values do not reflect average living costs. The Canadian housing market has also witnessed a large increase in real-estate prices. While the majority of graduate students are not in a position to purchase their own homes, rental prices across Canada are increasing at unprecedented rates (Chen 2022).

Given these pressures, graduate students have been actively advocating for increases to graduate student scholarships and funding in Canada. Most notably, our fellow student-led science policy networks have been advocating for increased financial support for graduate students for many years. In response to the release of the *Fundamental Science Review in 2017,* commonly known as the Naylor Report (Advisory Panel for the Review of Federal Support for Fundamental Science 2017), the SPE started a campaign called #Students4TheReport that urged the government to implement the report's 32 recommendations. The SPE then launched a survey entitled *Rethinking Federal Research Funding* that investigated the opinions of graduate students and postdoctoral fellows on federal awards from the Tri-Council Agencies (SSHRC, NSERC, and CIHR). This report became a key piece of evidence in the formation of the Canadian Council of Academies' *Degrees of Success* Report that investigated barriers for PhD students when transferring into the labour market (Council of Canadian Academies 2021).

Despite this work, there is a lack of national data on graduate student finances, especially for the vast majority of graduate students who do not hold a federal scholarship. This survey aimed to investigate the state of graduate student finances in Canada. From 1305 responses of graduate students representing various geographical locations, years of study, fields of education, and demographic backgrounds, we examined costs, tuition, debt, sources of funding, reported financial struggle, and other financial indicators. As a result of these analyses, we propose six recommendations to better support graduate students and enable them to more fully focus on research. Our findings will be essential in implementing changes to support the Canadian research ecosystem. In addition, by sharing and bringing awareness to the stories and financial struggles of graduate students, we hope to humanise this issue.

Materials and methods

Survey development

The "National Graduate Students Finance Survey" was conceptualised and designed by members of the Ottawa Science Policy Network (OSPN) in collaboration with additional authors. The goal of the survey was to generate a comprehensive report on graduate student finances to use this information as leverage following the 2021 Federal Election and to launch a campaign to improve the well-being of graduate students in Canada. We aimed to report on the current status of stipends for master's and doctoral students as funded through the Tri-Council Agencies: the CIHR, NSERC, and SSHRC. Survey questions were carefully designed and best efforts were made to frame the questions objectively. The survey questions can be found in the supplementary file. According to the Tri-Council Policy Statement (TCPS-2), ethics review/approval was deemed unnecessary as "ethics review/approval is not required for projects that are considered Quality assurance and quality improvement studies, as these don't typically meet the purpose of research." Article 2.5 of the TCPS-2 states "Quality assurance and quality improvement studies, program evaluation activities, and performance reviews, or testing within normal educational requirements when used exclusively for assessment, management or improvement purposes, do not constitute research for the purposes of this Policy, and do not fall within the scope of REB review."

Survey distribution

From October to December 2021, using a list of all Canadian universities, we collected emails from graduate student associations, societies, departmental groups, and clubs that were accessible online. The survey was sent out by email between 10 December 2021 and 14 December 2021, with follow-up emails sent in the following weeks. The survey was open from 10 December 2021 until 14 April 2022. To reach a broad audience, the survey was advertised on social media platforms, including Twitter and Instagram. In line with our organisation's commitment to bilingualism, our survey was accessible in both of Canada's official languages (English and French).

Data policy

Responses to the survey are held as confidential by the OSPN, a student organisation at the University of Ottawa. Aggregated, anonymous, or de-identified data may be shared with representatives of student associations, university administrations, advocacy groups, legislatures, and governments across Canada, including data subsets where appropriate.

Although we did not collect identifying information (e.g., respondent names), individuals may still be identifiable by

combining data. To protect anonymity, we will only publish or share subsets of data generated by combining responses of two or more questions when there are at least five responses in all categories. Any numerical data will only be published or shared as summary statistics (for example, mean and standard deviation) or as binned data (such as a histogram). Responses will never be shared or published in such a way that links together all an individual's responses.

Raw data collected in the survey will be retained for a period of seven years after which it will be deleted. Any data published or shared with other organisations will be retained indefinitely. Once the analysis of the data has concluded, access will only be granted to the OSPN president (or other OSPN members that the OSPN president determines are responsible for data custody).

Data preprocessing

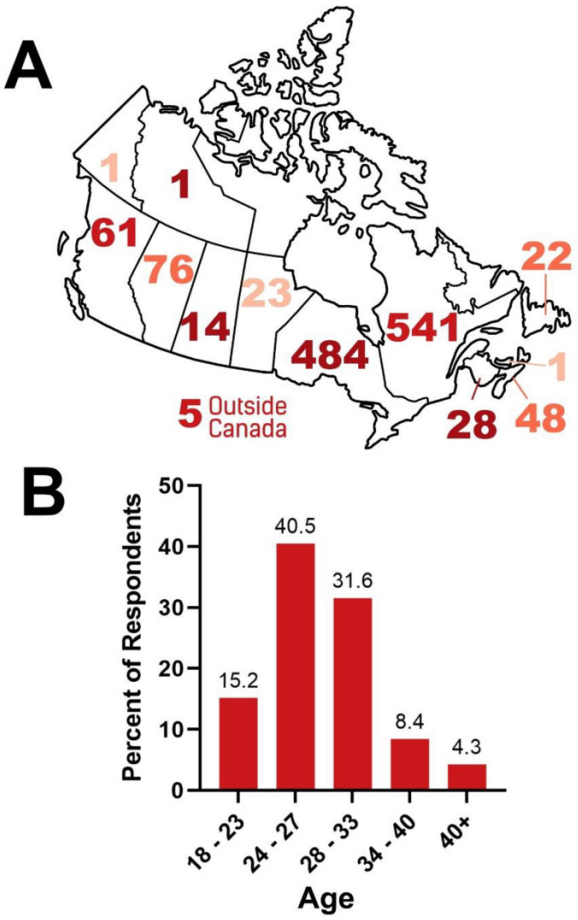
Data preprocessing occurred prior to analysis. Based on the unique identifiers provided for each survey entry and demographic information, 14 respondents were determined to be duplicates (i.e., the same individual filled in the survey twice) and were removed. As data analysis was performed in English, all French responses were translated into English. Numerical data were transformed into a consistent format (e.g., removing comma separators and $ symbols), but no numerical values were changed. In cases where the authors felt there was an obvious entry error or possible misunderstanding of the question, the responses were excluded from the analyses.

For some questions, where a free-form response was an option, responses were classified into groups to better enable comparisons. This was done for the following survey sections: current level of study Q2, ethnic identities Q8, gender identity Q9, field of study Q14, living environment (urban, suburban, rural) Q23, ownership status of accommodation Q24, who else the respondent lived with Q25, and sources of financial support Q27. In these classifications, effort was taken to retain the meaning of a response, especially for demographic information, and reclassification was based on all information available and best judgement. A copy of the unprocessed survey answers has been retained.

Statistics and data visualization

Throughout this report we used a significance threshold of 5% (i.e., $P < 0.05$). This means that for findings to be claimed significant, there is a greater than 95% probability that any difference detected is not solely due to random variation in sampling. However, it does not provide any information about why two (or more) groups may differ and does not take into account possible underlying factors—only that the difference is unlikely to be due to statistical chance alone. For comparing categorical data, the χ^2 test was performed using the categories presented in the plot or other summary data. For numerical data comparisons, a two-sample Kolmogorov–Smirnov (KS) test or Kruskal–Wallis (KW) test was used to compare the means when more than two categories existed. When comparing more than two categories, the statistical test does not provide information about how or which categories differ—only that the total extent of differences seen are unlikely to be due to randomness of sampling.

Fig. 1. Geographic location and age: (A) number of respondents from each province and territory ($n = 1305$) and (B) age category of respondents by % ($n = 1305$).



For data visualisation, bar graphs were created using GraphPad Prism 9.5.0; donut charts using R 4.2.1 (R Core Team 2022) and the lessR package (Gerbing 2021); and violin and QQ-plots were created using Python 3.8.10 with the statsmodels package (Seabold and Perktold 2010).

Results and discussion

Demographics of survey respondents

One aim of our survey was to assess the financial situation of graduate students across Canada, including students from varying programs, fields of study, and ages. We received a total of 1305 responses, 1030 of which were in English and 275 in French. Nearly all respondents were registered as full-time students (96.7%), with only a small percentage registered in part-time programs (2.3%). Students that resided in QC and ON made up 78.6% of respondents, with 484 respondents from ON and 541 from QC (Fig. 1A). This is consistent with Statistics Canada data from the National Graduates Survey that showed QC and ON made up 73.8% and 73.7% of master's and PhD graduates, respectively (Statistics Canada 2019). Ad-

ditionally, over 70% of respondents were between the ages of 24 and 33 (Fig. 1B). Again, this is consistent with the Statistics Canada data that showed an average graduate student's age was 31 and 35 upon graduation from master's and PhD programs, respectively (Statistics Canada 2019). This provides confidence that the conclusions made in this survey are a valid representation of the overall graduate student profile in Canada.

A majority of respondents (57.6%) were pursuing a doctoral degree and nearly all were in a research-stream program (Fig. 2A). Similarly, the majority (60.9%) of master's student respondents were in the research stream, while the remaining were in course-based (19.8%) and professional master's programs (19.3%) (Fig. 2A). Responses across years of study were evenly dispersed (Fig. 2B). Survey respondents were primarily in science-based programs, including physical science (26.3%), medical sciences (23.8%), life sciences (23.5%), and social sciences (16.4%) (Fig. 3). Arts and humanities students comprised 7.7% of respondents (Fig. 3). A small percentage of business students (1.6%) and law students (0.5%) also responded to the survey (Fig. 3). As such, our overall findings are most representative of graduate students in STEM-related fields, which encompassed 73% of our respondents. This is higher than the 46.4% of students in science-related graduate degrees, as shown in the Canadian Association for Graduate Studies 2019 survey. This survey also estimated that there were about 63 000 graduate students in Canada. Additional demographic data can be found in Supplementary Table 1.

Tuition remains a large financial burden for graduate students

Tuition is one of the largest expenses for graduate students in Canada and is primarily regulated by provincial governments. According to Statistics Canada, the average tuition for Canadian graduate students is about $7437 per year (up 1.7% from last year) (Statistics Canada 2022*a*). NS graduate students have the highest tuition, on average $10 591 per year, with ON ($9385) and BC ($9994) close behind. Comparatively, QC has the lowest average tuition for graduate students, at an average of $3582 per year (Statistics Canada 2022*a*).

Universities can use different tuition fee structures, with various opportunities for tuition rebates and waivers. Tuition freezes, which were implemented in ON during the COVID-19 pandemic, can also affect the rising tuition costs across the country. In addition to tuition fees, students are required to pay ancillary fees throughout their education. These can include fees for fitness or athletic services, technology use, public transit, health and dental plans, etc.

To assess the financial situation of graduate students, we investigated tuition variance among students. We found that the average annual tuition paid by respondents across Canada was $7518 for domestic students (see the analysis of international student costs below). The lowest average cost of tuition was reported in NL at $5016.27 per year, while the highest average was reported in ON at $8972.46 per year, with NS following behind at $7770 (Fig. 4). The highest tuitions were among four provinces in both our survey and the Statistics Canada data: ON, NS, NB, and BC.

Tuition remains a large burden on graduate student finances, though it is questionable whether these costs are factored into university funding packages. For example, one respondent stated "My stipend total this year (including additional TA work) was $29 000. From that, ~$6000 was deducted for tuition. $23 000/year is not enough to live on—this is below the low income threshold that qualifies you for assistance program (ex: Leisure Access Pass) in Edmonton. Except as students we are exempt from these programs."

To further characterise tuition distribution among respondents, we asked graduate students to report their out-of-pocket payments. This accounts for students' tuition waivers, which are offered through universities to subsidise the cost of tuition. Across domestic students, the average out-of-pocket tuition was $3226. Our results reflect a bimodal distribution, with the vast majority of respondents either paying 0%–10% or 90%–100% (Fig. 5), where 82.6% of domestic graduate students either pay less than 10% or more than 90% of their tuition out of pocket, highlighting an all-or-none approach to tuition finances. This variation in out-of-pocket tuition payments could partly be attributed to money that some students receive through scholarships. When broken down by scholarship status, we found that domestic respondents who held a government award paid significantly less tuition out of pocket (KS test, $P < 10^{-5}$), with 70% of award holders paying 10% or less of their tuition out of pocket compared with 37.3% for those who did not hold a government award (Fig. 6). However, it is important to note that the bimodal distribution was still seen for students who do not hold a government award, suggesting that other factors also contribute.

We also hypothesised that this trend may impact the financial situation of graduate students paying either 0%–10% or 90%–100% of their tuition out of pocket. To assess this, respondents in either group were cross-compared with how they ranked their financial situation (Fig. 7). We found a significant difference (chi2 test, $P = 0.011$) between these two groups, with those who paid over 90% of tuition out of pocket more likely to be struggling financially.

Graduate students in Canada struggle to pay many costs of living

As described in the introduction, Canada is currently experiencing a 40-year inflation high, resulting in higher costs of living for all Canadians. In combination with the lingering effects of the COVID-19 pandemic, graduate students are particularly financially vulnerable, considering slow and inflexible funding models. To better understand how graduate students are spending their finances, we investigated their housing costs, area of residence, living situation, and monthly expenses.

Our findings show that over 80% of respondents were renting, with less than 10% owning homes (Fig. 8A). This is concerning compared to recent Statistics Canada data profiling home ownership. For young adults aged 25–29 years, 36.5% owned their homes. For those aged 30–34 years, homeownership rates were 52.3% (Statistics Canada 2022*b*). This indicates a large financial burden experienced by graduate students compared to their peers. One respondent remarked:

Fig. 2. Level and year of study: (A) program and current study level of survey respondents by % ($n = 1303$). The doctoral category includes professional doctoral (e.g., EdD, PharmD, and DBA), research stream doctoral (PhD), course-based doctoral, and MD PhD. (B) Current year of study of survey respondents by % ($n = 1297$).

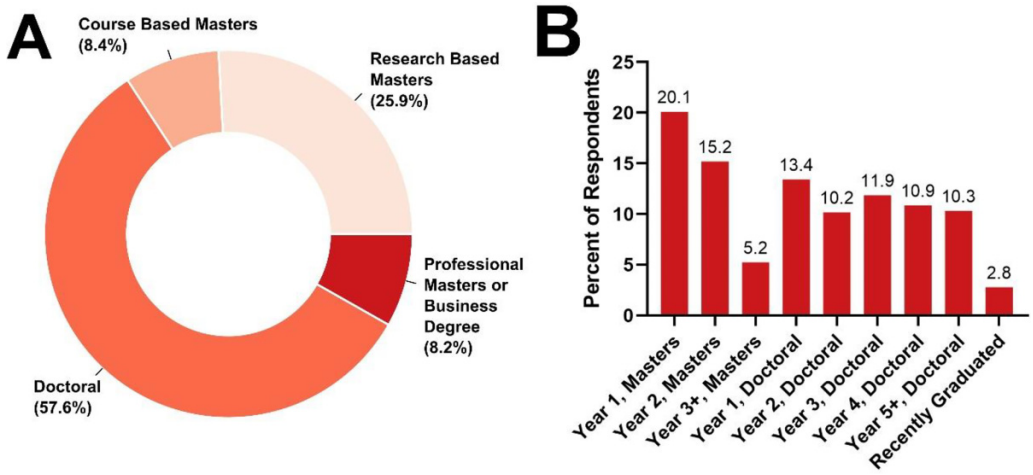


Fig. 3. Field of study. Respondents self-reported their field of study from seven categories: arts and humanities, business, law, life sciences, medical sciences, physical sciences (engineering, physics, mathematics, etc.) and social sciences ($n = 1305$). If respondents indicated multiple fields of study or an option not listed in the survey, they were categorized into one of the seven categories based on their answers for analysis purposes.

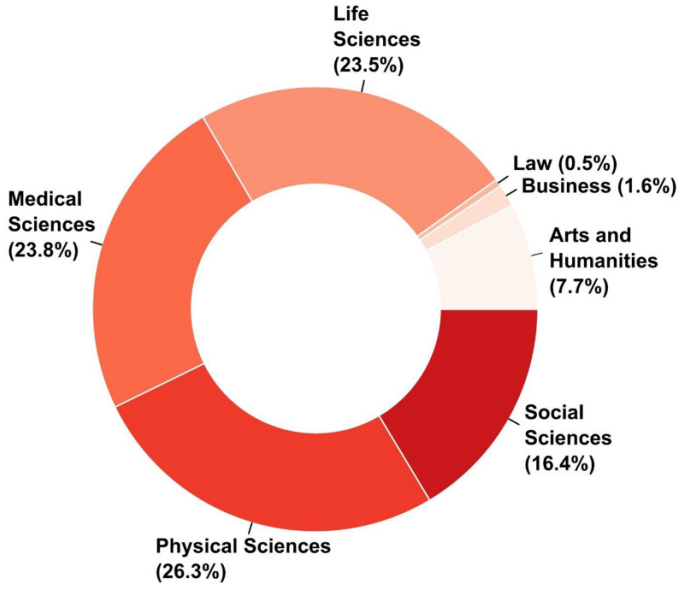
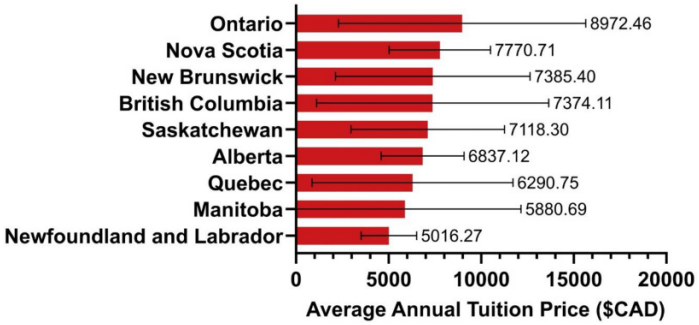


Fig. 4. Annual tuition fees. Average annual tuition reported by respondents in Canadian dollars by province ($n = 886$). Categories that had less than five responses were excluded (PE, NT, YT, and outside of Canada). Bars represent mean values ± SD.



"I had to take cash advances on my credit card and borrow money from family to get by… As such I am still paying off debts which has delayed accomplishing milestones (like buying a house and starting a family) that others my age are currently doing. Bottom line graduate students should be paid at least a minimum wage full-time salary as taking on secondary jobs to supplement income is just not possible if we want to graduate on time" and another respondent noted that "after groceries and rent, [their] funding leaves [them] with a negative cashflow position." While others age-matched are building wealth and investing in their future, graduate students are subjected to the insecurity of the rental market.

Three-quarters of respondents lived in urban areas (74.5%), while the remainder lived in suburban areas (20.4%) and in rural areas (4.7%) (Fig. 8B). Most respondents lived with other people, such as a partner, roommate(s), or family (Fig. 8C), while 25% lived alone. A large majority of our respondents did not have dependents (Fig. 8D), while the remaining 13% had one or more dependents (further analysis of those with dependents can be found further below).

Based on those who paid rent, a quarter of respondents (25.3%) paid $500–$750 monthly (Fig. 8E). Most respondents paid between $500–$1500 in rent, a wide range that depends on location, roommate situation, and other factors. One percent of respondents (14/1305) did not have stable housing.

Fig. 5. Domestic respondent percent tuition paid out of pocket. Percent of tuition paid out of pocket after any applicable scholarships for domestic respondents ($n = 885$). Tuition paid out of pocket was divided by the total annual tuition fees for each respondent to calculate the %.

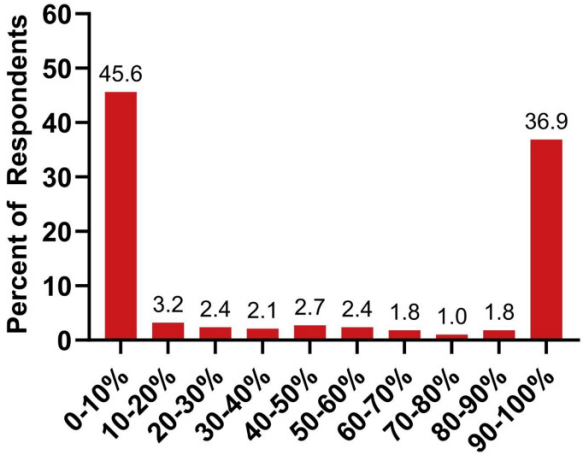
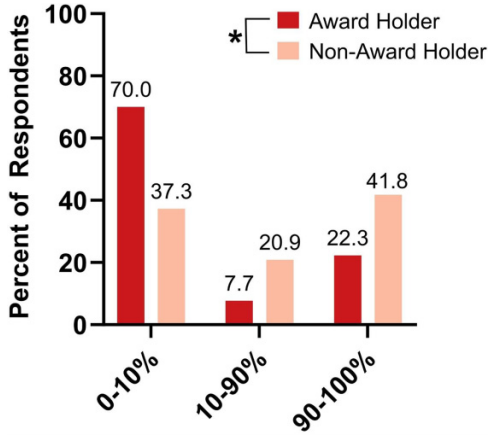


Fig. 6. Domestic student percent tuition paid out of pocket by award holder status. Percent of tuition paid out of pocket after any applicable scholarships for domestic students with a government award ($n = 220$) and without a government award ($n = 665$). Tuition paid out of pocket was divided by the total annual tuition fees for each respondent to calculate the percentage. $^{*}P < 0.05$, KS test (award holders vs. non-award holders).

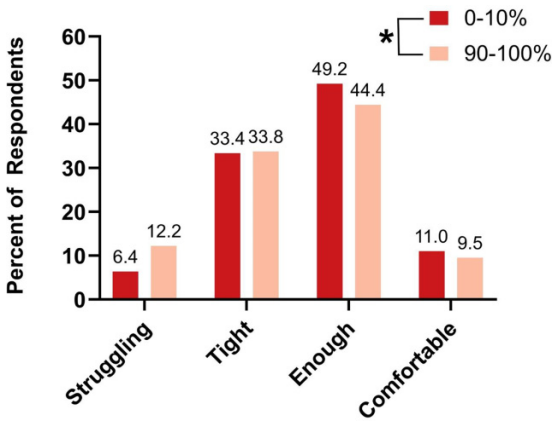


Monthly expenses for respondents were surveyed across different categories (Fig. 9). The highest expense, aside from rent (Fig. 8E), were groceries, with $100–$400 spent monthly by over 70% of respondents.

Canadian graduate students are experiencing financial stress

Between low pay, increasing costs of living, and accumulating debt, it is clear that financial stress is a major concern for many graduate students. Not only does financial stress impact graduate students' well-being and ability to complete their studies, but insufficient savings and outstanding debt can impact their future financial security. This has become a dominant narrative across research ecosystems as many students are speaking out on these financial struggles in Canada (Marhnouj 2022) and in other countries (Woolston 2022).

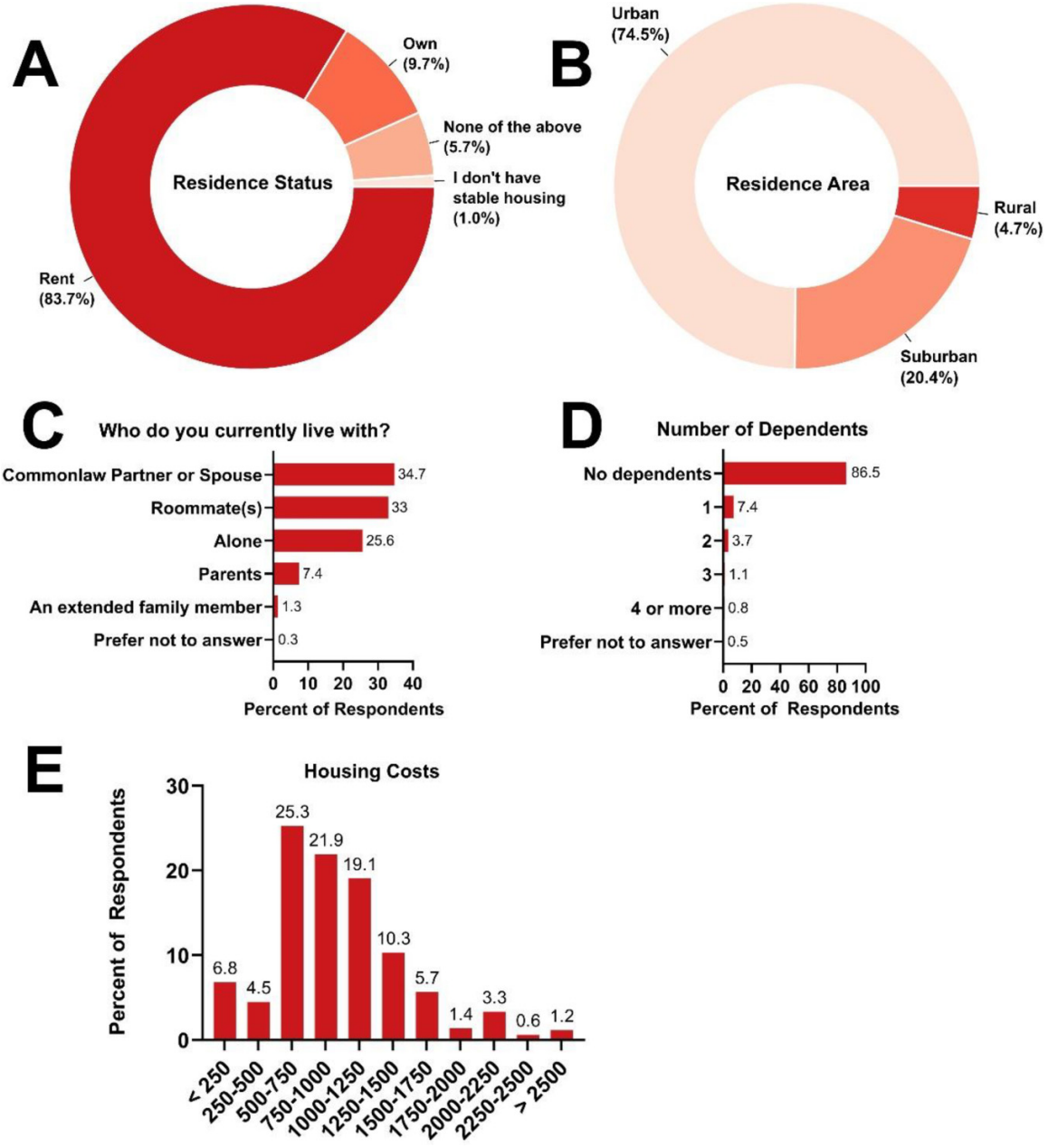
Fig. 7. Financial situation of low (0%–10%) vs. high (90%–100%) % tuition paid out of pocket respondents ($n = 1004$). $^{*}P < 0.05$, χ^2 test (0%–10% vs. 90%–100%).



To investigate this question in graduate students across Canada, we asked survey respondents to identify their comfort levels with their current financial situation. Our team examined how concerned students were about various financial stresses, including living expenses, debt, and emergency funds. To investigate students' financial status, we asked participants to choose which most appropriately defined their current financial situation: comfortable (I am very comfortable financially. I have enough money that I do not need to worry about monthly expenses and spend as I would like.), enough (I have enough. My finances are a bit tight but I live within my means and can afford to provide for myself.), tight (every month is tight, but I am getting by. I am often making sacrifices to pay for necessities.), and struggling (I am struggling financially. I often do not have enough to make ends meet.) Nearly half of all respondents (43.4%) identified that they were either frequently struggling to make ends meet or that their tight finances forced them to make sacrifices to afford necessities (Fig. 10A). Less than 10% of students stated that they were very comfortable with their current financial situation (Fig. 10A). Unsurprisingly, those who identified as struggling to make ends meet generally had the lowest stipend values, whereas those who identified as being very comfortable with their financial situation had the highest (Fig. 10B). One student even stated that they had to "drop out of [their] Masters program due to finances and having to work full time to afford the cost of living." This student also highlighted how the "faculty [they were] in did not support students working externally yet offered very few alternatives to afford both tuition, living expenses, and debt payments."

The majority of respondents (85.7%) expressed experiencing stress/anxiety about finances at some point during their graduate studies. Meanwhile, 54.7% experienced difficulty

Fig. 8. Residence situation: (A) residence status of respondents by % ($n = 1305$); (B) area of residence by % ($n = 1305$); respondents who listed areas other than urban, rural, or suburban were re-categorized into one of the three; (C) current living arrangements of respondents (multiple selections possible) by % ($n = 1305$); (D) number of dependents reported by respondents by % ($n = 1305$); and (E) monthly housing costs ($CAD) by % of respondents ($n = 1291$).

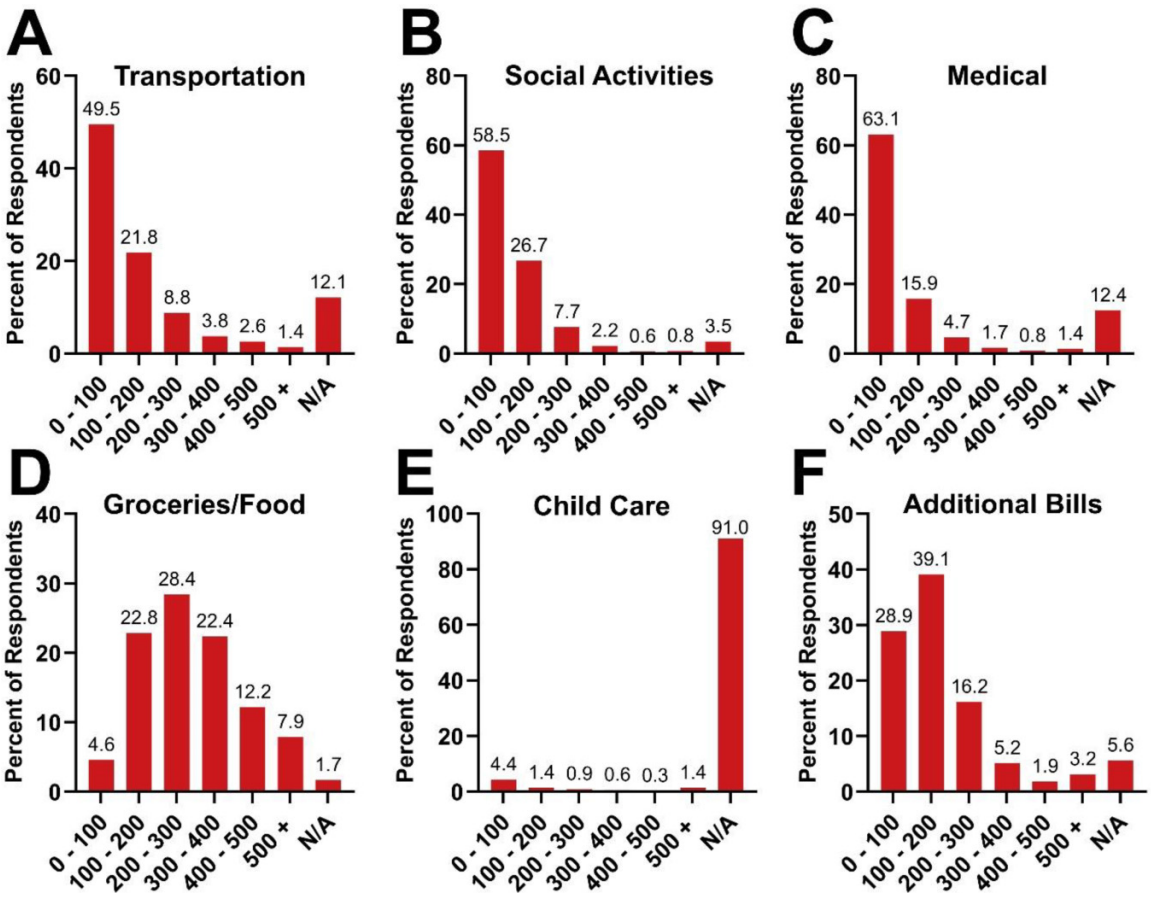


budgeting, and 30.7% have considered leaving their studies due to financial struggles alone (Fig. 11A). Concern about insufficient funds for living expenses was common among respondents, with over 30% having experienced concern about rent and food (Fig. 11A) and 27.2% either "always" or "often" worrying about their ability to pay for bills (Fig. 11B).

The standard advice from financial experts and the recommendation by the Financial and Consumer Agency of Canada is to ideally have at least 3–6 months of savings for living expenses (Financial Consumer Agency of Canada 2022). Only half of our survey respondents met this recommendation, with 52.3% having only 0–3 months of living expenses saved (Fig. 11C) and 53.7% of students either "always" or "often" worrying about their ability to pay for emergency expenses (Fig. 11B). These findings highlight that graduate students are vulnerable to unexpected financial challenges.

As an expected consequence, graduate students worry about their future financial security. Nearly 60% of respondents indicated that they either "always" or "often" worry about future financial security, and a similar number (57%)

Fig. 9. Monthly Expenses. Respondents were asked to share their average monthly expenses based on range values in each category: (A) transportation ($n = 1305$), (B) social activities ($n = 1305$), (C) medical ($n = 1305$), (D) groceries/food ($n = 1305$), (E) child care ($n = 1305$), and (F) additional bills ($n = 1297$). Data are shown by the % of respondents for each category.

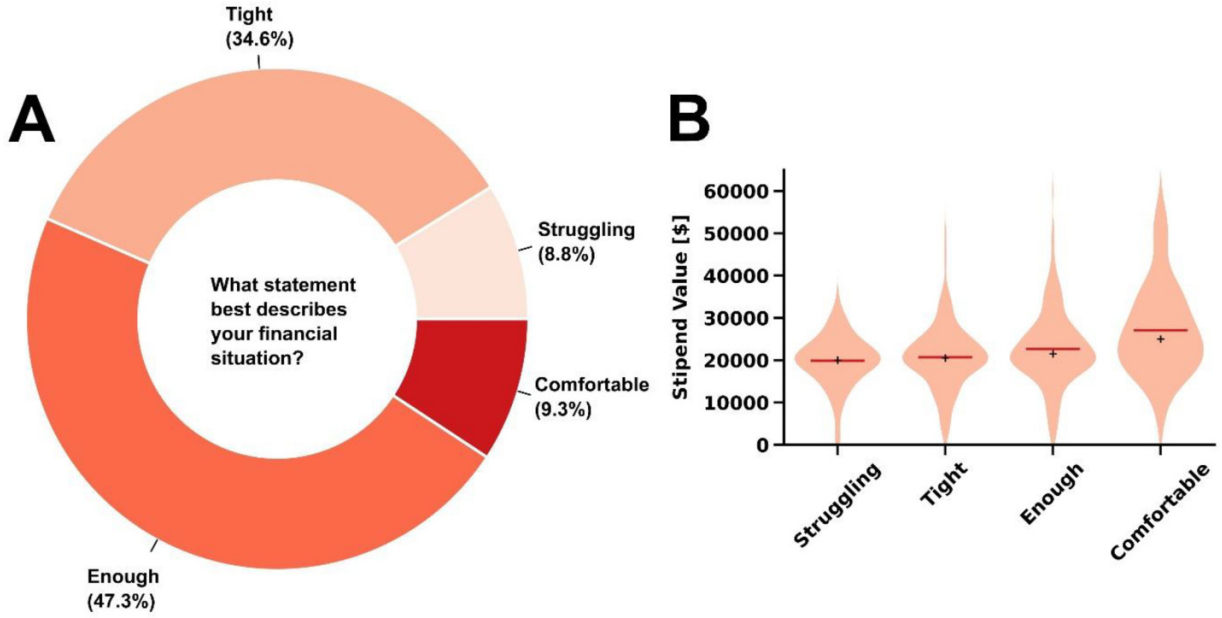


indicated "always" or "often" worrying about their ability to obtain a job in the future (Fig. 11B). A key contributor to this may be the accumulation of debt throughout one's university studies, as over half of respondents (52.2%) had some outstanding debt, the majority of which had over $10 000 owed (Fig. 12A). Indeed, respondents with outstanding debt reported worrying about future financial security more often than respondents with no outstanding debt ($P < 10^{-5}$, χ^2 test) (Fig. 12B). A higher percentage of respondents with outstanding debt also reported struggling financially compared to those with no outstanding debt ($P < 10^{-5}$, χ^2 test) (Fig. 12C). Reliance on debt seems to partly stem from a lack of parental support, as only 20% of students with debt received financial support from parents, compared to 30% of students with no debt having received parental support ($P = 0.000028$, χ^2 test) (Fig. 12D). Additionally, doctoral students had a higher amount of debt on average than master's students ($34 370 for doctoral vs. $29 272, $24 942, and $28 903 for course-based, research-based, and professional and business master's students, respectively; Fig. 13A). This is unsurprising given the increased length of study, but note that master's students and doctoral students still reported similar responses regarding their financial situations (Fig. 13B).

Graduate students in Canada often have to work outside of their studies

Non-academic work completed outside of a graduate student's studies, to supplement income, is often considered taboo as it can be frowned upon or, in some cases, is against university regulations. Academic institutions can prevent graduate students from accessing alternative forms of income by restricting the number of hours they are permitted to work outside of their studies. For example, McGill University allows graduate students up to a maximum of 12 h work per week outside of their studies to maintain full-time status (McGill University 2022). In 1994, the Ontario Council on Graduate Studies, of which 21 universities across ON are members, implemented the 10 h rule, which restricts the number of hours graduate students can work outside of their studies to 10 h per week (Ontario Council on Graduate Studies 2021). Scholarships issued by the Ontario Government also adhere to this rule and regulate the amount of time another establishment can employ a student. There is growing awareness of the problems arising from the 10 h rule. For example, the University of Waterloo recently cited that there was a "strong desire to provide greater flexibility in employment hours" and changed the requirements of the 10 h rule to now allow for a student to work up to 20 h per

Fig. 10. Financial situation. (A) Respondents were asked what best describes their financial situation: comfortable (I am very comfortable financially. I have enough money that I do not need to worry about monthly expenses and spend as I would like.), enough (I have enough. My finances are a bit tight but I live within my means and can afford to provide for myself.), tight (every month is tight, but I am getting by. I am often making sacrifices to pay for necessities.), and struggling (I am struggling financially. I often do not have enough to make ends meet.). Data are shown by % ($n = 1303$). (B) Violin plot of respondents' financial situation and stipend value ($n = 1303$). The red line and + sign represent the mean and median stipend value of respondents in each group, respectively.



week (University of Waterloo 2022). In our survey, one respondent noted that "[m]ost graduate students in our department work full-time jobs on top of completing their studies AND TA [teaching assistant] or RA [research assistant] positions. The department complains about students not finishing their programs within a short amount of time, yet they won't pay us more and strongly advise against/look down on students who work over the 10 hour/week 'limit'." Abolishing the 10 h rule has increasingly become a topic of conversation concerning financial struggle among graduate students. In provinces outside of ON, this is less of an issue as many universities/provinces have higher limits on work outside of studies (for example, the University of Winnipeg has a limit of 35 h per week).

To investigate external employment of graduate students and gain insight into their work–study balance, we asked respondents whether they were externally employed (or get paid for a service) outside of their graduate studies. This included any money that is made in addition to their stipend. Many graduate students work as TAs, and this was counted as additional work if the payment was not included or required as part of their stipend.

More than half of all respondents (55.6%) worked in addition to their studies (Figs. 14A, 14B). Of this majority, nearly half worked less than 10 h per week, while the other half worked over 10 h per week. This includes 18.5% who worked between 5 and 10 h/week and 17.8% who worked between 10 and 20 h/week (Fig. 14C). A small % of respondents (6.5%) worked over 30 h per week.

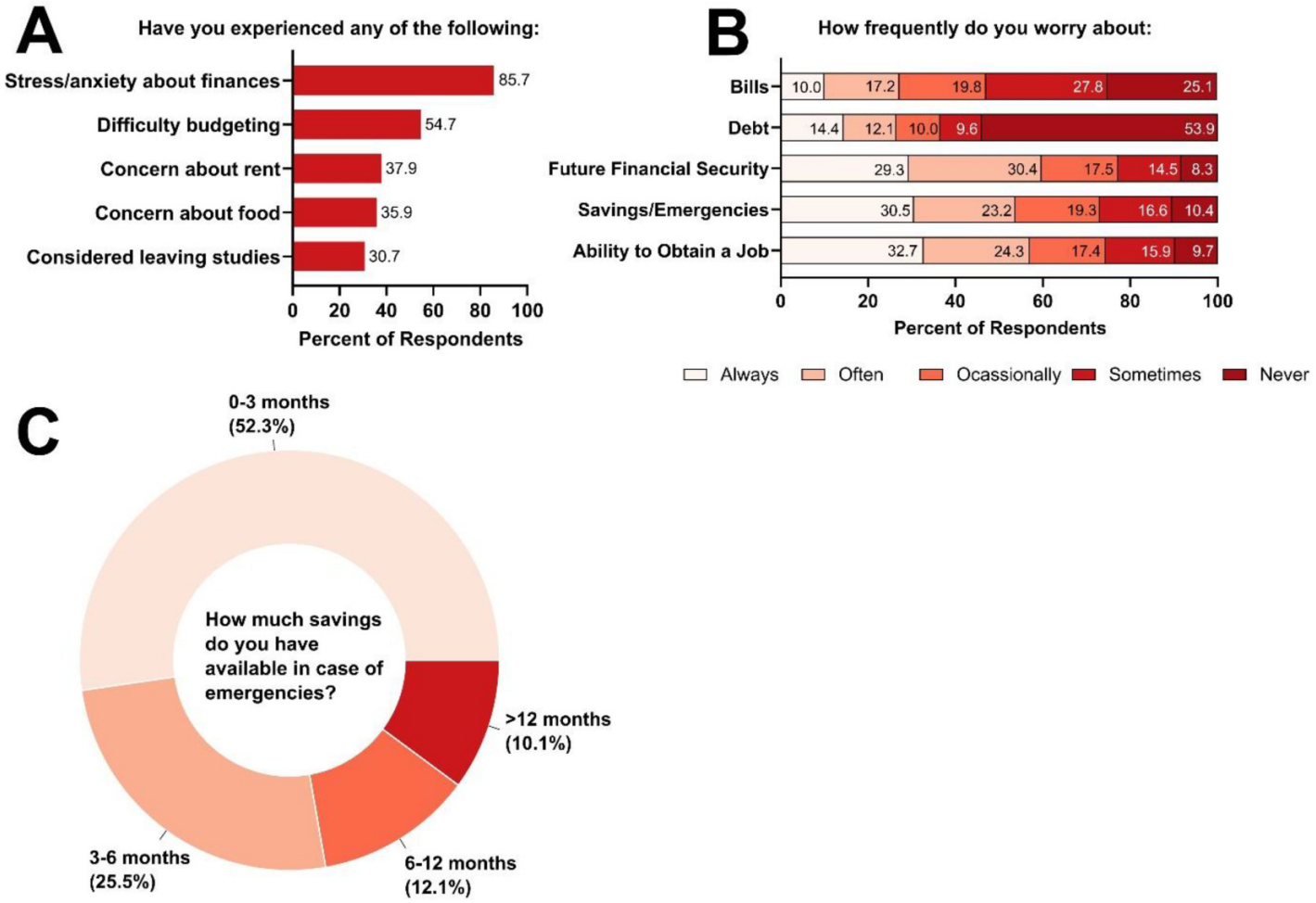
Additionally, when looking at financial struggles, respondents who worked were significantly more worried about their ability to pay back student debt compared to those who did not work (χ^2 test, $P = 0.036$) (Fig. 15). Other financial concerns were similar between the working and non-working groups.

Graduate students experience errors in stipend payments

Graduate students depend on their stipends for living costs; however, some graduate students have experienced "stipend errors," defined as a disruption in the regularly scheduled payment of a stipend. Our survey sought to understand the stipend errors experienced by graduate students using questions based on a study conducted by the Dalhousie Working for Inclusion in Chemical Sciences Group (Dalhousie Working for Inclusion in Chemical Sciences Group 2021).

When asked whether survey respondents experienced any errors regarding stipend payments, over 60% of respondents indicated they had not experienced any errors (Fig. 16A). In contrast, 27% of respondents stated they received late stipend payments. Students also had errors in getting paid too little, too much, or had their stipend payments put towards a uni-

Fig. 11. Financial stressors. (A) Concerns and stress experienced by respondents (multiple selections possible) by % ($n = 1178$). (B) Respondents were asked how frequently they worry about their ability to obtain a future job in their chosen field, savings/ability to pay for emergency expenses, future financial security, ability to pay back their student debt, and ability to pay bills. Data are shown by % in each category ($n = 1305$). (C) Amount of savings, measured by months of living expenses, that respondents have available for emergencies, by % ($n = 1264$).



versity expense/fee (Fig. 16A). More than one in three respondents (36.4%) have experienced at least one error in stipend payments (Fig. 16B).

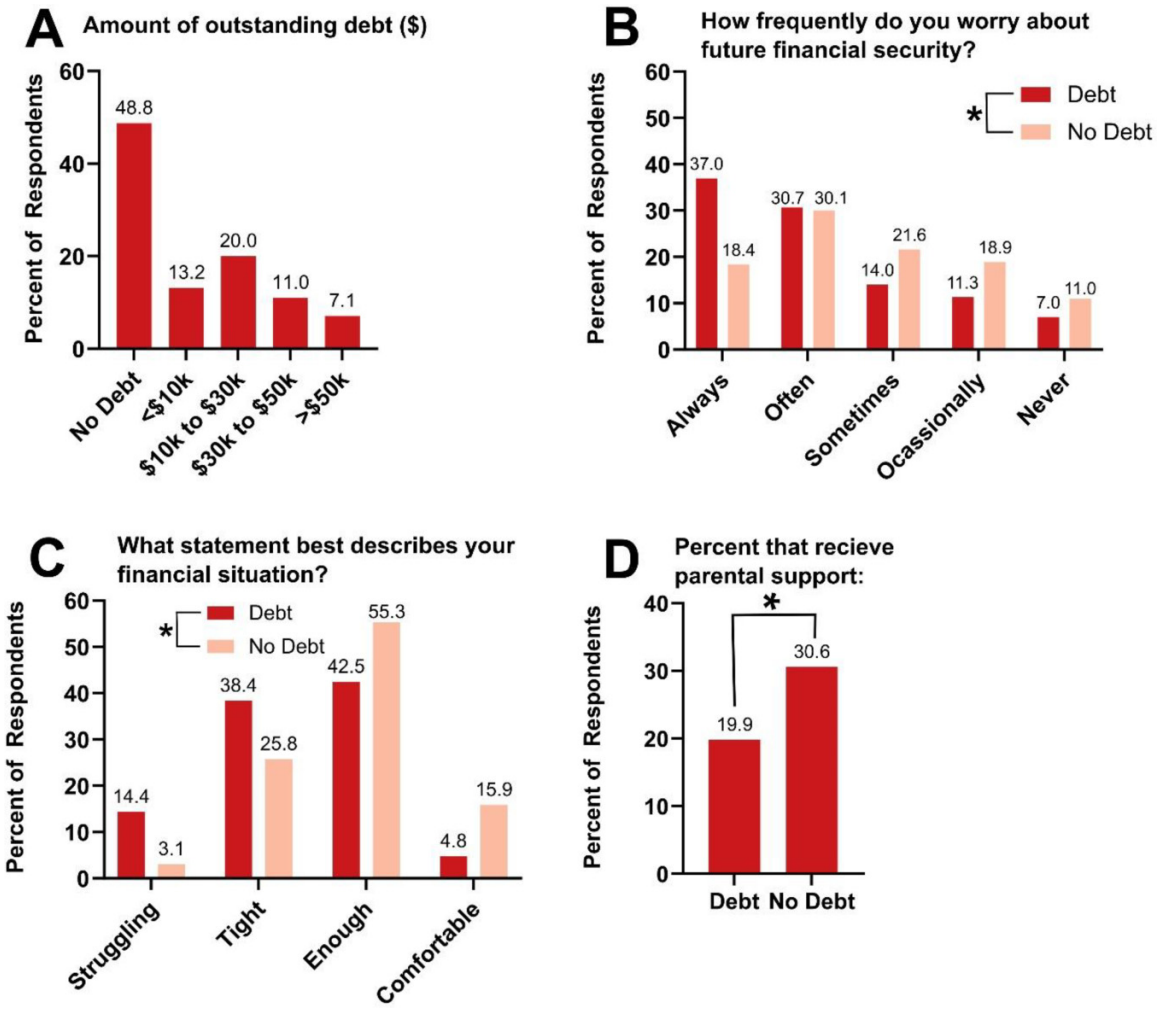
Personalized responses demonstrated that stipend errors can seriously affect graduate students' finances, time, and energy. For example, one student noted they were "not enrolled by the financial department to receive payment for over two months," while other students had stipend payments that were anywhere from 8 weeks to 3 months late. One student said their stipend was "mistakenly cancelled" and it took "a lot of back and forth with profs and admin" to receive it. Students also stated that their "stipend payment was put towards a university expense/fee without [their] prior knowledge."

Since this process largely depends on the university administration that is responsible for stipend payments, these analyses will need to be assessed on a university and(or) department level basis to properly determine the impacts of stipend errors. While our results show that stipend errors occur, future work should identify why this is happening and how this can be improved to alleviate student financial stress in this area.

Graduate students are not always reimbursed in a timely manner for out-of-pocket research costs

While the cost of living continues to increase at record rates and stipends remain stagnant, many graduate students are not equipped to deal with unexpected expenses. With only 9.3% of respondents having felt comfortable financially (Fig. 10A), we were concerned about the impact of upfront research expenses paid by graduate students for their financial security. These types of expenses can include purchasing lab equipment and paying for trips related to field work, software, parking, and academic conferences. Field work and conferences, in particular, can incur hundreds of dollars in expenses for travel fees. Additionally, these costs may require

Fig. 12. Financial situation by debt status. (A) amount of outstanding debt of respondents in ranges by % ($n = 1130$). (B) Financial situation of respondents with debt ($n = 584$) or no debt ($n = 555$). (C) Financial situation of respondents with debt ($n = 584$) or no debt ($n = 555$). Data are shown by the % of respective debt status. (D) Parental support of respondents with debt ($n = 584$) or no debt ($n = 555$). $^*P < 0.05$, χ^2 test (debt vs. no debt).

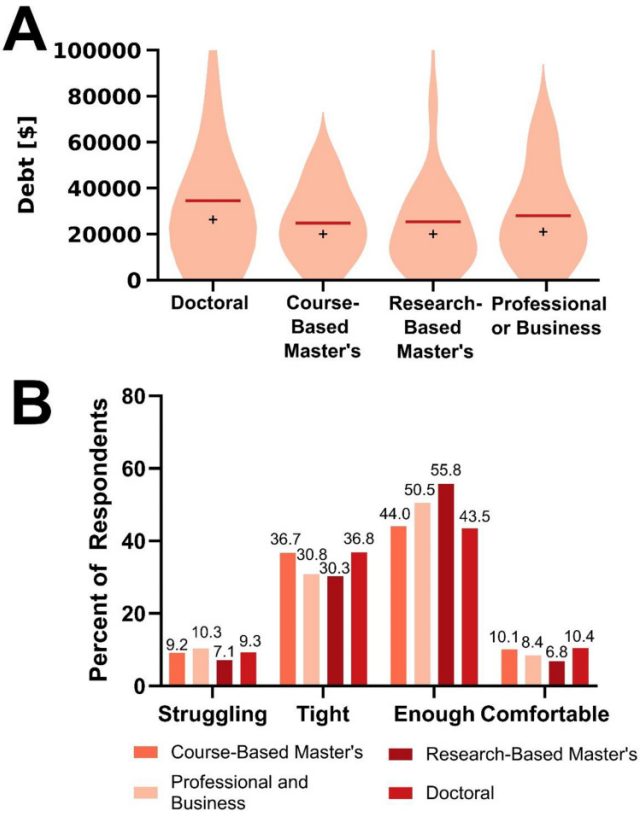


payment months in advance of a specific date. A delay in reimbursement, or absence of one, could lead to increased interest on credit card charges and(or) lack of money to pay for standard living expenses.

To determine the extent to which this situation may occur, we surveyed respondents on out-of-pocket academic expenses and the timing of their reimbursement. Over 50% of respondents, in doctoral (73.6%) or research-based master's degrees (52.5%), have previously paid for academic expenses upfront (Fig. 17A). For graduate students in course-based professional and business master's degrees, the percentage of respondents was lower at 34.81%. Within these proportions, we focused on expenses that needed to be paid out of pocket. Approximately 10%–15% of graduate students in a research-based master's (10.6%) or doctoral degree (14.6%) were required to pay these expenses. A higher proportion of students in course-based professional and business master's degrees (26.1%) were required to do the same. On average, students in course-based programs paid less in upfront academic expenses but were required to do so largely out of pocket or without reimbursement. As there may be some overlap in respondents who answered that they paid out-of-pocket expenses and those who answered that they failed to be reimbursed, further examination may be required for these concerns.

The vast majority of students waited longer than a week for reimbursements (Fig. 17B). Only 35.9% of students in research-based master's degrees, 39.9% of students in doctoral degrees, and 27% of students in course-based professional or business master's degrees were reimbursed within 4 weeks. Between 4% and 9% of respondents were required to wait more than 3 months to be reimbursed. Having to wait periods of over a month can impact financial security, as students have regular monthly expenses such as rent, utilities, credit card bills, etc. One student commented that "for conferences and plane tickets, [they] could only request a reimbursement after the conference has actually happened. This means I pay the conference fee and 6 months later I can get it reimbursed." Thus, waiting for reimbursements is likely

Fig. 13. Financial situation by level of study. (A) Violin plot of average debt of research-based master's ($n = 337$) and doctoral respondents ($n = 750$) in Canadian dollars (CAD). The red line and + sign represent the mean and median stipend values of respondents in each group, respectively. (B) Financial situation of research-based master's ($n = 337$), course-based master's ($n = 109$), professional and business master's ($n = 107$), and doctoral ($n = 750$) respondents. Data are shown by the % of respective level of study.



to have impacted the ability of the survey's respondents to pay for their living expenses. Of these, 23.1% of students in course-based master's degrees, 13.4% of students in doctoral degrees, and 9.4% of students in course-based professional and business master's degrees have indicated this was the case (Fig. 17C).

This survey provides a cursory overview of the effects of upfront academic expenses on graduate students and has highlighted this as a real issue. Future work should aim to provide a more detailed picture of this issue and how it impacts students. For example, while we did not ask about the nature of these expenses, it may be valuable to delve further into the expenses students were asked to pay for, such as whether the expense was considered mandatory or not? Did students feel like they had a choice in the decision? What is the total amount of expenses students have paid for? Additionally, one of the risks with waiting for expenses is that if a student paid for it through a credit card and doesn't receive their reimbursement on time, then interest will begin to increase. This interest will not be covered by the eventual reimbursement.

Analysis of graduate student funding and support

Funding for graduate students in Canada is complex as it comes from various sources and is regulated on multiple levels. While some universities set minimum funding levels for student stipends, this can vary greatly between departments and even faculty within a university.

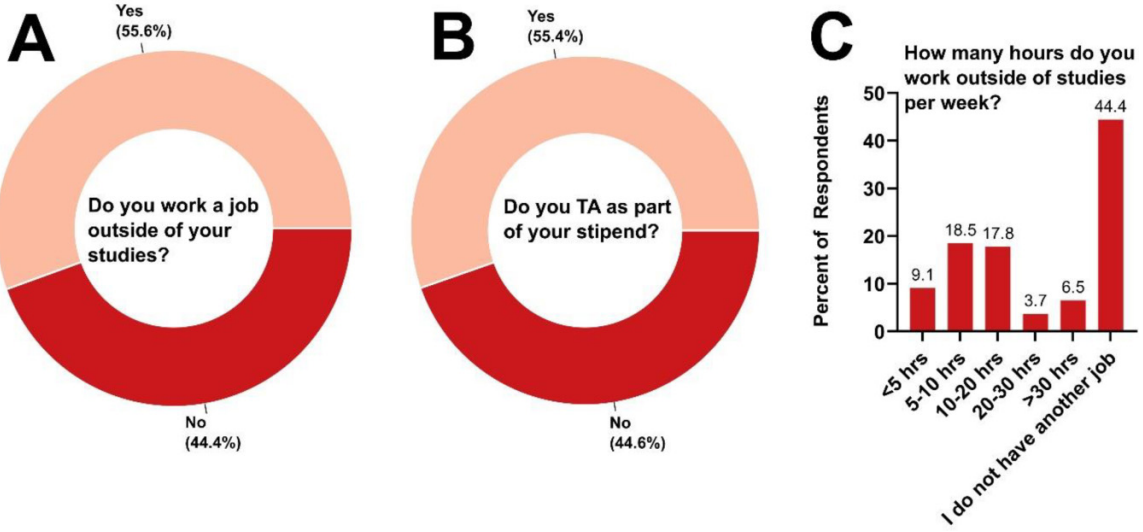
Over 70% of respondents declared that they received a stipend (Fig. 18A). The remaining 30% reported that they did not receive a stipend at all. Of these, 73% felt that they should receive a stipend (Fig. S3).

The average stipend reported was $23 750 for doctoral students, $19 725 for research-based master's students, $16 813 for course-based master's students, and $13 113 for business and professional master's students (Fig. 18B). If we consider the context of a typical 40 h work week, this becomes an average hourly pay of $9.18/h for a master's student and $11.43/h for a PhD student. This is well below the $15/h minimum wage implemented by the federal government (Employment and Social Development Canada 2022*a*) and does not account for the many graduate students who work over the average 40 h standard.

Based on the Likert scale of satisfaction (1 as very unhappy and 5 as very happy) (Likert 1932), almost half the respondents (46%) felt unhappy about their stipend value, which highlights an issue with current stipend values (Fig. 19). When asked about their ideal stipend values, respondents reported an average of $33 619 for doctoral students, $29 213 for research-based master's students, $26 912 for course-based master's students, and $22 705 for business and professional master's students (Fig. 20). The SPE's *Rethinking Federal Research Funding Report* found that respondents' ideal value of federal scholarships was $21 000 for a master's student and $35 000 for a PhD student (Science and Policy Exchange 2020). In our results, master's students reported a much higher ideal stipend value compared to their current average funding, which puts them well below the poverty line (Statistics Canada 2022*c*). Further, the ideal value of $21 000 from the SPE survey would still fall below the poverty line in the vast majority of the country.

We asked respondents to share the source of their stipend. The majority of respondents (67%) were funded through their supervisor (Fig. 21A). Less than half (45.2%) were funded from their department/faculty. While national and provincial awards exist, only 20% were funded through federal awards, and 11.5% of respondents were funded through provincial awards. Most respondents (77%) reported only having 1–2 funding sources (Fig. 21D). The length of funding also varied from under 6 months to 4 years (Fig. 21C). About 45.1% of students have experienced either an increase or decrease in their stipend value: 25.9% have received an increase, 6.5% have received a decrease, and 12.7% have received both an increase and a decrease at some point in their studies (Fig. 22A). The top-reported cause of a stipend increase was that the respondent received a scholarship (further information about scholarships can be found below). Otherwise, respondents reported that their supervisor gave a stipend raise or their student association ne-

Fig. 14. Work outside of studies: (A) respondents were asked whether they work a job outside their studies, by % ($n = 1305$), (B) respondents indicated whether being a Teaching Assistant (TA) was a condition of their stipend ($n = 914$), and (C) number of hours respondents worked outside of studies per week, by % ($n = 1305$).



gotiated to increase student stipends (Fig. 22B). Conversely, the top reasons for students' stipends decreasing were a change in TA hours, their scholarship ending, or their supervisors decreasing their funding (Fig. 22B). In general, scholarships, TA hours, and the supervisor's financial status were the largest determinants of student stipend values.

Inadequate finances affect graduate students in all fields of study

Graduate student experiences, especially regarding financial situations, vary greatly depending on the field of study due to differences in tuition prices, stipend values, work expectations, and scholarship access.

Statistics Canada reported in 2022/2023 that students' tuition varied substantially across degrees. For example, those studying business, management, and public administration paid the highest tuition, averaging $14 272 per year. Graduate students in STEM fields, such as computer and information sciences and engineering, were on the higher end of tuition costs, paying an average of $8902 and $7454 per year, respectively. Comparatively, humanities graduate students had lower tuition on average at $4753 per year (Statistics Canada 2022*b*).

We were interested in exploring how tuition, stipend payments, and work varied among graduate students in different fields of study and whether these contributed to differences in financial struggle. We asked students to report their annual tuition fees, including ancillary fees. Unsurprisingly, business students had the highest annual tuition (Fig. 23), which was similar to what was reported by Statistics Canada. Physical sciences, medical sciences, and law students reported annual tuition costs above $9000, while social sciences, life sciences, and arts and humanities students paid over $8000 per year (Fig. 23).

Whether students receive a stipend depends on the program and degree type. The majority of students in the life sciences, physical sciences, and medical sciences reported receiving a stipend: 87.6%, 77.6%, and 71.4%, respectively (Fig. 24A). In comparison, only 49.5% and 44.4% of students in the arts and humanities and social sciences, respectively, receive a stipend. Business students were least likely to receive a stipend, with only 33.3% reporting receiving one. This disparity between programs is likely a consequence of stipends typically only being granted to students in research-based programs, which tend to be more common in the natural sciences. While the average stipend value was consistent across programs (Fig. 24B), the most common sources for stipends differed. Funding by supervisors was the most common stipend source for life sciences, physical sciences, and medical sciences students, followed by funding from the department/faculty and then TAs (life sciences and physical sciences) or federal awards (medical sciences) (Table 1). In contrast, for arts and humanities and social sciences students, the department/faculty was the most common stipend source, followed by TAs and then federal awards (arts and humanities) and supervisors (social sciences).

As expected, a larger percentage of students in programs receiving fewer stipends, particularly arts and humanities and social sciences, reported working outside of their studies (71.3% and 77.1%, respectively) (Fig. 25). In comparison, students in programs that more frequently receive stipends (e.g., life sciences, medical sciences, and physical sciences) were less likely to report working outside of their studies (44.6%, 54.3%, and 47.7%, respectively).

Financial awards support graduate student research

As previously outlined, graduate students fund their studies through different sources, including fed-

Fig. 15. Work outside of studies—financial situation. How frequently do respondents who work or don't work worry about their (A) ability to pay bills, (B) ability to pay back their student debt, (C) future financial security, (D) savings/ability to pay for emergency expenses, and (E) ability to obtain a future job in their chosen field. Data are shown by % of respondents in each category: work ($n = 727$) and no work ($n = 578$). $^{*}P < 0.05$, χ^2 test (work vs. no work).

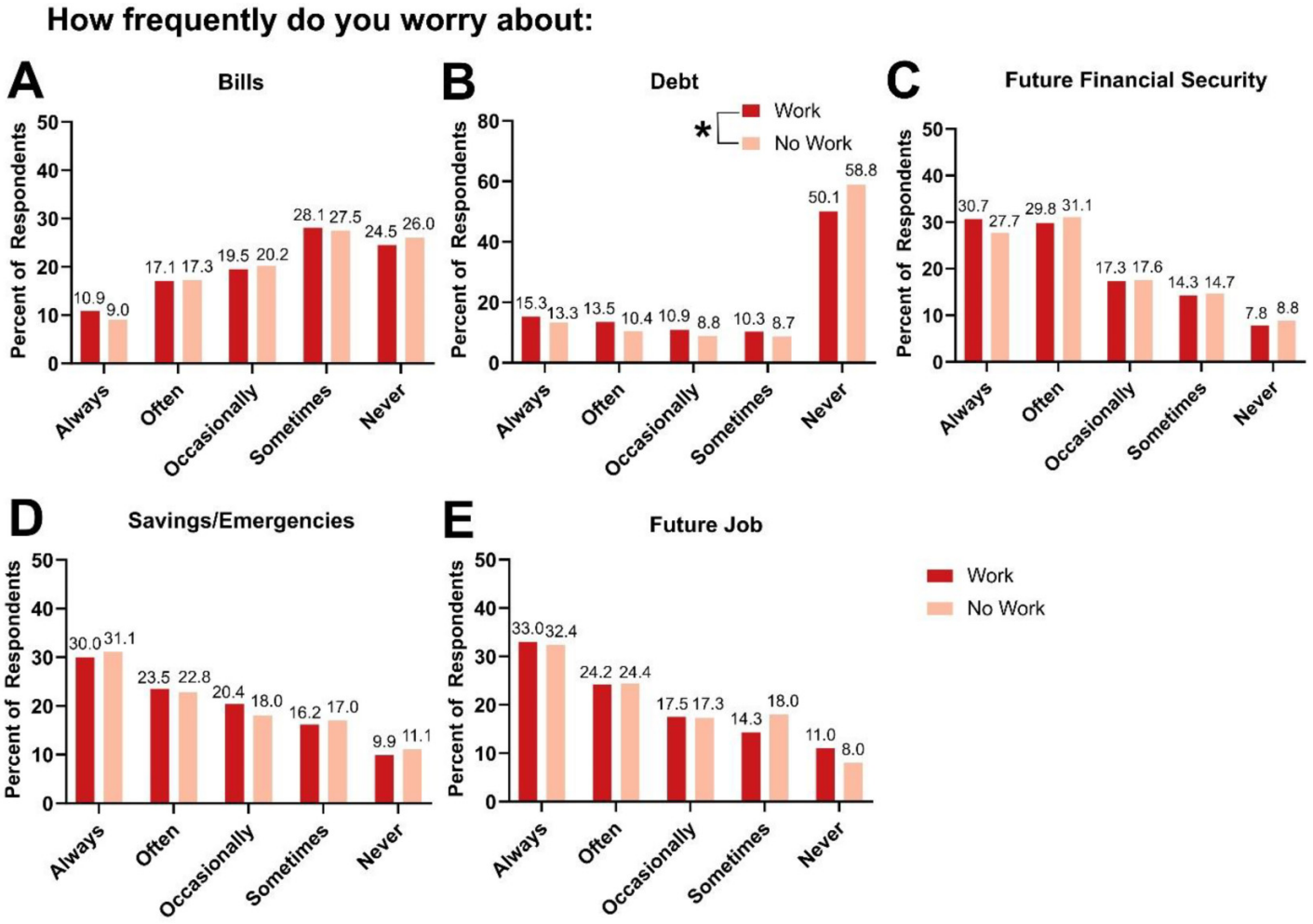
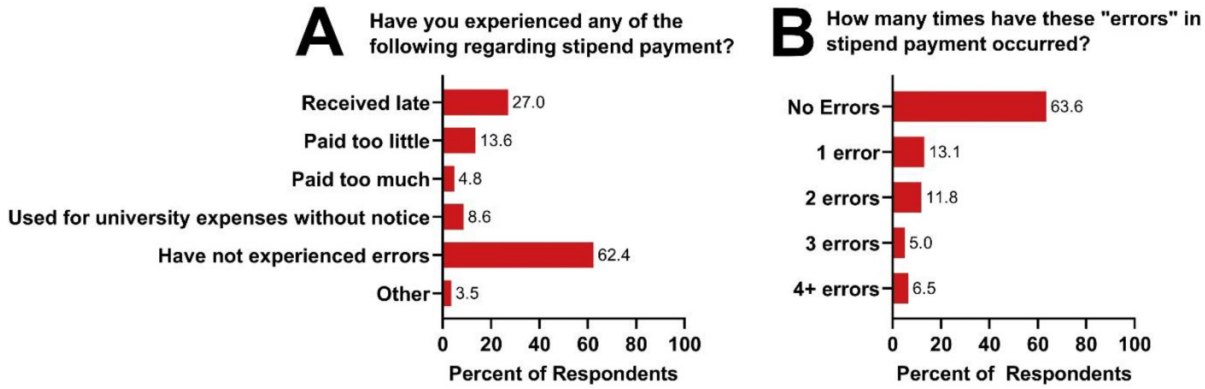
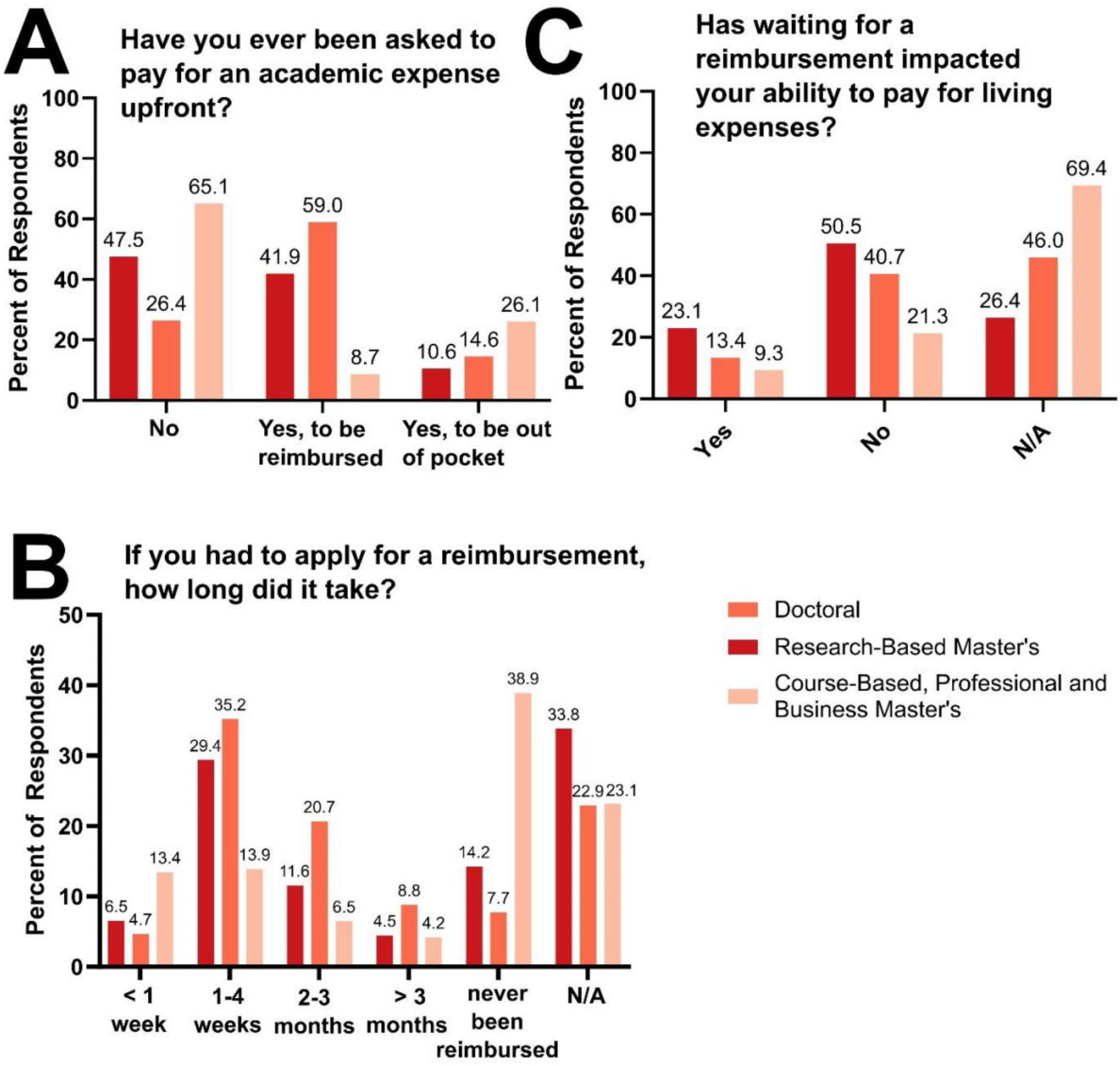


Fig. 16. Stipend errors. (A) Respondents were asked whether they ever experienced any errors regarding stipend payments (multiple selections possible) by % ($n = 914$). An "error" was defined as a *disruption in the regular scheduled payment of your stipend.* (B) Number of times respondents experienced an "error" in stipend payments, by % ($n = 914$).



eral/provincial/institutional scholarships, bursaries/grants, federal/provincial student loans, bank loan/line of credit, family/spousal/partner support, employment pay, employer support, institutional stipends, and personal savings. Though the list of potential monetary support for students may initially appear extensive, the amount of available funding for

Fig. 17. Reimbursements. (A) Respondents indicated whether they have been asked to pay an academic expense upfront, separated by doctoral ($n = 768$), research-based master's ($n = 341$), and course-based, professional, and business master's ($n = 218$) programs. (B) Respondents indicated how long it took to receive a reimbursement, separated by doctoral ($n = 750$), research-based master's ($n = 337$), and course-based, professional, and business master's ($n = 216$) programs: 3–6 month, 6–12 month, and >12 month categories were combined due to too few respondents. (C) Respondents indicated whether waiting for the reimbursement impacted their ability to pay for living expenses, separated by doctoral ($n = 750$), research-based master's ($n = 337$), and course-based, professional, and business ($n = 216$) programs.

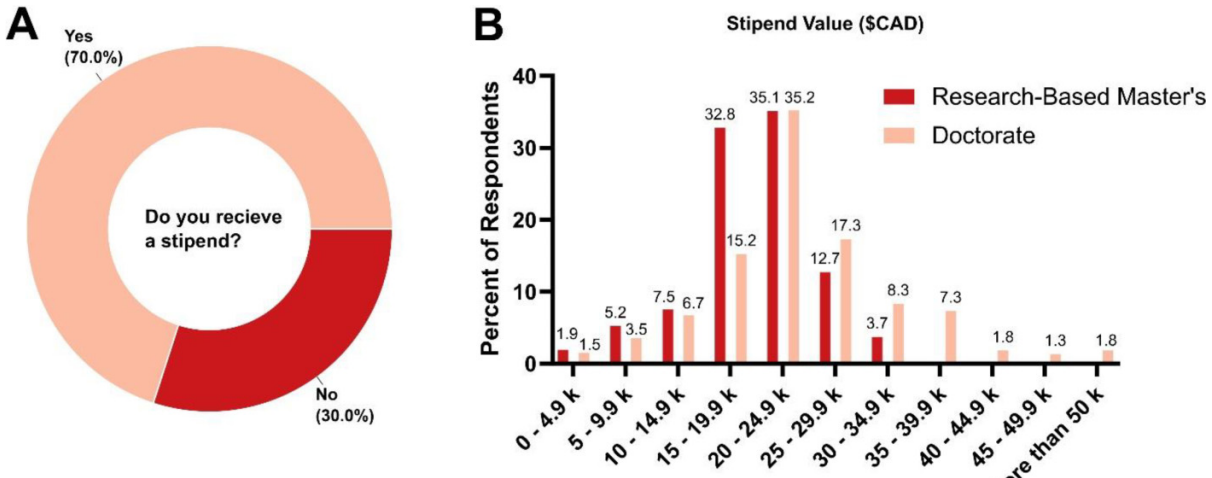


a given student depends on their living situation and varies greatly.

In Canada, awards are granted to students who display a high level of academic achievement and are intended to encourage graduate students to dedicate more time to their studies (Table 2). The awards are primarily distributed by three federal research funding groups: the NSERC, the SSHRC, and the CIHR, which together form the Tri-Councils Agency. In addition to federal research awards, there are also provincial awards for graduate students. For example, the Ontario Graduate Scholarship is allocated through a merit-based program and available for application by students of varying academic disciplines across the province. Each award is jointly funded by the Province of Ontario (66%) and the university offering the award (33%). Fonds de recherche du Québec (FRQ) is another provincial organisation known to recognize excellence in research. Every year, FRQ provides financial support to many students by offering awards, from master's training scholarships to doctoral scholarships. Similar provincial graduate scholarships are offered in BC (BC Gov News 2021), AB (Government of Alberta n.d.), and NS (Communications Nova Scotia 2023).

Of 1305 survey respondents, 17.2% of doctoral and 13.4% of research-based master's students reported receiving a federal award, while 11.2% of doctoral and 5.0% of research-based master's students reported receiving a provincial award

Fig. 18. Stipend status. (A) Respondents were asked whether they received a stipend, by % ($n = 1305$). (B) Stipend value of respondents in research-based master's ($n = 268$) or doctorate ($n = 600$) studies. Data are shown by the % of students in the respective level of study. (C) Average and median stipend value of respondents in research-based master's ($n = 268$), course-based master's ($n = 19$), business or professional master's ($n = 21$), or doctorate ($n = 600$) studies.



C

	Doctorate	Research Master's	Course Master's	Business & Professional
Average	$23,749.68	$19,724.69	$16,812.63	$13,113.19
Standard Deviation	$9,024.50	$6,065.99	$12,144.30	$5,983.74
Median	$22,000.00	$20,000.00	$13,000.00	$13,577.00

Fig. 19. Stipend satisfaction: respondents were asked whether they were happy with the value of their stipend based on the Likert scale of satisfaction (1 as very unhappy and 5 as very happy), by % ($n = 914$).

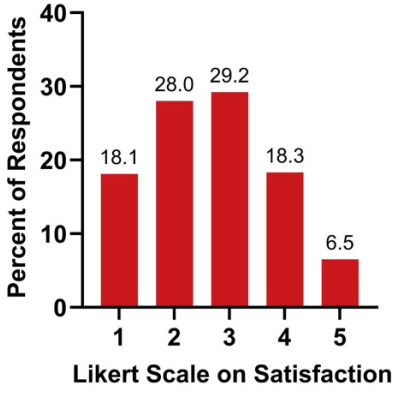
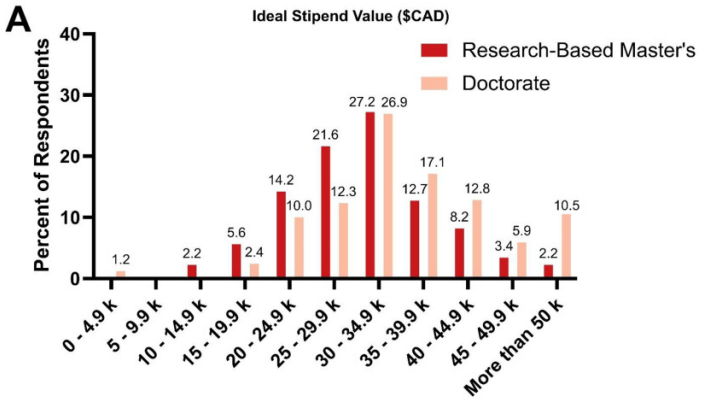


Fig. 20. Ideal stipend. (A) The ideal stipend value shared by respondents in research-based master's ($n = 267$) or doctorate ($n = 592$) studies who responded "yes" to receiving a stipend. Data are shown by the % of students in the respective level of study. (B) Average and median of ideal stipend value of respondents in research-based master's ($n = 267$), course-based master's ($n = 17$), business or professional master's ($n = 21$), or doctorate ($n = 592$) studies.



B

	Doctorate	Research Master's	Course Master's	Business & Professional
Average	$33,619.16	$29,212.93	$26,911.76	$22,704.76
Standard Deviation	$10,525.67	$11,046.15	$12,535.24	$21,661.38
Median	$32,000.00	$30,000.00	$24,000.00	$20,000.00

(Fig. 26). These award recipients represent high-calibre students who have not only achieved acceptance into competitive graduate research programs but have also been identified as the top scholars within this strong research categorization. In surveying graduate students in Canada, we wanted to identify whether the intended goals of federal and provincial awards were being achieved by the current 2021 award values (Canadian Institutes of Health Research 2014) and how the financial well-being of award and non-award holders varied.

Fig. 21. Stipend sources. (A) Current sources of stipend of respondents (multiple selections possible) ($n = 914$). Other includes institutional scholarships, research assistantships, and university scholarships. (B) Length of time funded through current sources of stipend ($n = 914$). (C) Previous sources of stipend, not including current stipend sources (multiple selections possible) ($n = 914$). Other includes Mitacs and institutional scholarships. (D) Number of current stipend sources ($n = 914$). Data are shown by percentage.

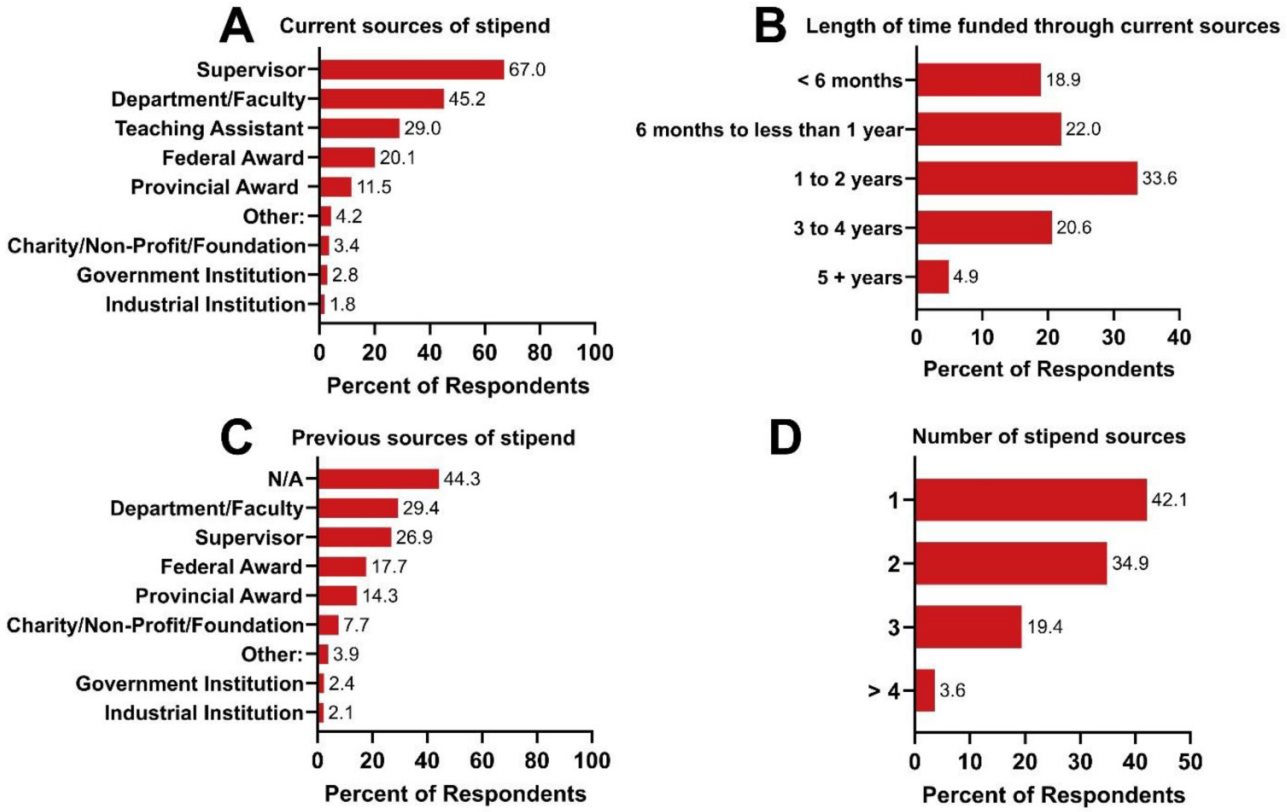
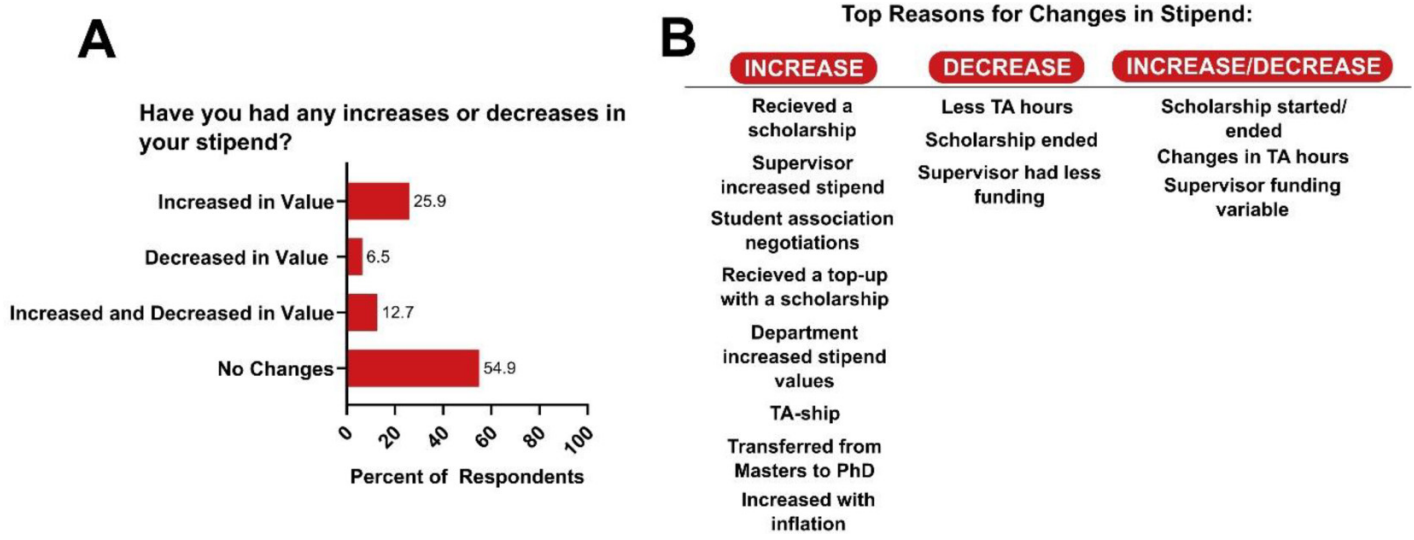


Fig. 22. Stipend changes: (A) reported increases and decreases in student stipend values ($n = 914$) and (B) top reasons for the reported change in stipend values, broken down as increase, decrease, or both an increase and a decrease.



In comparing responses of the financial concerns of award and non-award holders, awardees reported having less financial concern for bills (significant difference at $P < 10^{-5}$ level using a χ^2 test) and savings/emergencies (significant difference at $P = 0.032$ level using a χ^2 test) than non-award holders (Fig. 27). When asked how much savings students have available in case of emergencies, award holders were significantly more likely than non-award holders to have 6+ months of liv-

Fig. 23. Tuition fee by field of study. Average annual tuition in CAD by field of study based on survey responses ($n = 1305$). Respondents self-reported their field of study from seven categories. If respondents indicated multiple fields of study or an option not listed in the survey, they were categorized into one of the six categories based on their answers for analysis purposes. Bars represent mean ± SD.

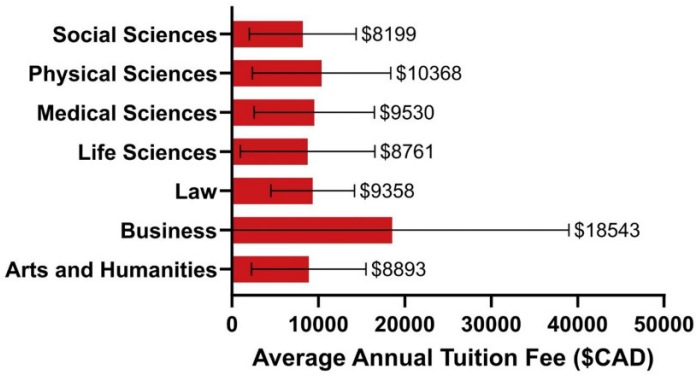
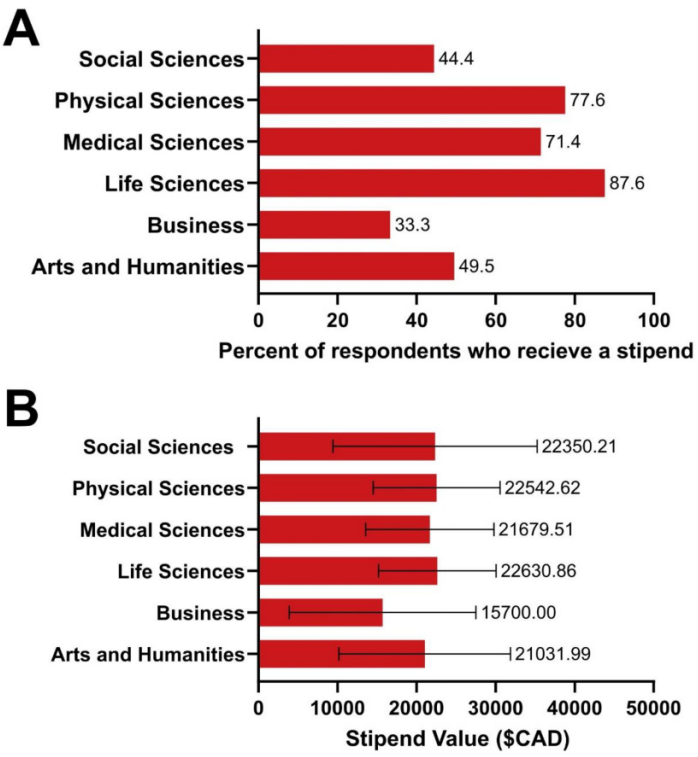


Fig. 24. Field vs. stipend. (A) Respondents were asked whether they receive a stipend, categorized by field of study. Responses are shown as a % of respondents who responded yes to receiving a stipend ($n = 914$). (B) Average stipend value in Canadian dollars (CAD) of respondents by their field of study. Arts and humanities ($n = 101$), business ($n = 21$), life sciences ($n = 307$), medical sciences ($n = 311$), physical sciences (engineering, physics, mathematics, etc.) ($n = 344$), and social sciences ($n = 214$). Law was excluded due to less than five responses. Bars represent mean ± SD (B).



ing expenses saved (χ^2 test, $P = 0.00011$), though we note that less than 30% of respondents in both categories claimed to have these funds available (Fig. 28). The survey revealed that award holders have less outstanding student debt compared to non-award holders, at $14 260 and $17 977, respectively (Fig. 29). Furthermore, when asked to describe their current financial situation, award holders were less than half as likely to respond as "struggling" and more than twice as likely to respond as "comfortable" compared to non-award holders, a significant difference at the $P < 10^{-5}$ level (χ^2 test) (Fig. 30). Overall, 48.4% of non-award holders and 38% of award holders responded as either "struggling" or "tight" to describe their current financial situation. These survey findings are not surprising, considering that awards can help guarantee an income for graduate students that may or may not be provided to non-awardees.

Surprisingly, however, the survey responses demonstrated that awardees are nonetheless preoccupied with financial concerns during their graduate program. For example, when asked how frequently they worry about financial concerns including bills, savings/emergencies, and future financial security, over 66% of award holders responded having financial concern through responses of "always," "often," or "sometimes." Over 44% of award holders responded having concerns for financial debt (Fig. 27). These findings highlight the inability of current federal and provincial award values to effectively enable graduate award holders to fully concentrate on their studies. When graduate students were asked what their ideal stipend value would be, 26% of respondents stated $30 000–$34 999 (Fig. 20). This value range falls close to the value of the current Canadian Graduate Scholarships-Doctoral (CGS-D) award at $35 000 per year.

Additionally, we examined financial incentives received by graduate students after receiving an award (Fig. 31). The most popular incentive was an additional "top-up" of their stipend (27% of respondents), typically from their supervisor. This is typically granted to the student in cases where the scholarship replaces a stipend previously paid by their supervisor. Since the supervisor no longer needs to pay the student's stipend, some will choose to pay the student a smaller additional amount on top of their award. Additionally, 17% of respondents reported receiving a scholarship meant to cover their tuition fully, and 14% received a scholarship meant to cover their tuition partially. This is often granted by the student's department/university in the form of an "Excellence Scholarship" or "Tuition Waiver."

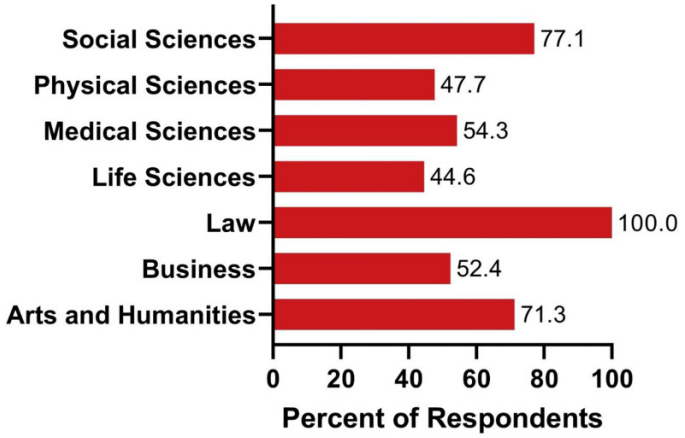
Interestingly, 5.5% of award holders reported a decrease in their total amount of take-home money. This could be due to specific situations where the value of awards is less than the stipend value they were previously receiving. An additional concern is that these awards are defined for a period of time that often does not cover the entirety of their studies. Although not fully captured in this study, future efforts should identify what happens to students' financial situations following the end of their award. It was noted various times in the personalized responses that students often did not have guaranteed funding after their scholarship ended. For exam-

Table 1. Top funding sources by field of study.

Field of study	Ranking	Funding source	Percent of respondents
Arts and humanities	1	Department/faculty	64.00%
	2	Teaching assistant	46.00%
	3	Federal award	22.00%
Life sciences	1	Supervisor	75.09%
	2	Department/faculty	44.61%
	3	Teaching assistant	31.60%
Medical sciences	1	Supervisor	74.77%
	2	Department/faculty	30.63%
	3	Federal award	17.57%
Physical sciences	1	Supervisor	90.99%
	2	Department/faculty	55.86%
	3	Teaching assistant	34.68%
Social sciences	1	Department/faculty	67.37%
	2	Teaching assistant	50.53%
	3	Supervisor	33.68%

Note: Top three funding sources by field of study (multiple selections possible): arts and humanities ($n = 50$), business ($n = 21$), life sciences ($n = 269$), medical sciences ($n = 222$), physical sciences (engineering, physics, mathematics, etc.) ($n = 267$), and social sciences ($n = 95$). Business and law was excluded due to less than five responses. Data are shown as a % of respondents by field of study.

Fig. 25. Work by field of study. Respondents were asked whether they work a job outside of their studies, categorized by field of study: arts and humanities ($n = 101$), business ($n = 21$), law ($n = 7$), life sciences ($n = 307$), medical sciences ($n = 311$), physical sciences (engineering, physics, mathematics, etc.) ($n = 344$), and social sciences ($n = 214$). Data are shown as a % of respondents who responded yes to working outside of their studies.



ple, one student comments "For example, [my scholarship] will end in August 2022, and my stipend for my research assistantship will not be adjusted to compensate for the $13 000 net loss in my annual compensation. For myself and others in my position, this will be an extremely large financial burden as we attempt to complete the final years of our graduate studies."

Graduate students from underrepresented groups are more likely to struggle financially

Diversity is essential among graduate students to foster generations of scientists with diverse perspectives and ideas. This will be vital to innovation as we tackle future challenges in society. Per the Dimensions charter: "equity, diversity and inclusion strengthen the research community, the quality, relevance and impact of research, and the opportunities for the full pool of potential participants." (Government of Canada 2019). A 2019 *Survey of Postsecondary Faculty and Researchers* from Statistics Canada showed that postdoctoral fellows and PhD students are increasingly more diverse than the previous generation of researchers. In fact, 50% of postdoctoral fellows and 39% of PhDs who responded to the survey reported belonging to a visible minority group.

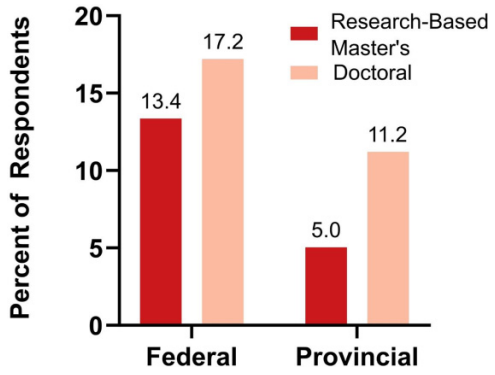
Despite the presence and increasing prevalence of diverse groups, women, Indigenous peoples, and visible minorities still face inequities and barriers to inclusion in graduate programs, including lack of representation among those who receive federal doctoral and master's level scholarships (Baskaran et al. 2021). Additionally, it has been found that those who identified as women, visible minorities, individuals with disabilities, and Indigenous were all less likely to receive research funding (Statistics Canada 2020). Factors such as eligibility, duration of awards, and evaluation criteria are significant barriers to promoting equity, diversity, and inclusion (EDI) in graduate programs. While targeted investments, such as new funding in Budget 2022 for Black Scholars (Department of Finance Canada 2022), and recent changes to evaluation criteria, such as NSERC's New Guidelines on Contributions to Research, Training, and Mentoring, which expands the definition of "excellence" (National Sciences and Engineering Research Council of Canada 2022), are steps in

Table 2. Summary of Federal Tri-Council Awards.

Award title	Federal research funding agency	Value per year ($CAD)	Maximum duration	Tenure	Eligibility
Canadian Graduate Scholarships—Master's (CGS-M)	Tri-agency	$17 500	1 year	Eligible Canadian institution	Canadian citizen, permanent resident of Canada, or a protected person under subsection 95(2) of the Immigration and Refugee Protection Act (Canada). Completed between 0–12 months in program
Vanier Canada Graduate Scholarships	Tri-agency	$50 000	3 years	Eligible Canadian institution	Canadian citizen, permanent resident of Canada, foreign citizens. Completed <20 months in program. Completed <32 months in program
Canadian Graduate Scholarships—Doctoral (CGS-D)	Tri-agency	$35 000	3 years	Eligible Canadian institution	Canadian Citizen, permanent resident of Canada, or a protected person under subsection 95(2) of the Immigration and Refugee Protection Act (Canada). Completed <24 months in program. Completed 36 months in program
NSERC Postgraduate Scholarships—Doctoral (PGS-D)	NSERC	$21 000	3 years	Eligible Canadian institution or foreign institution	Canadian citizen, permanent resident of Canada or a protected person under subsection 95(2) of the Immigration and Refugee Protection Act (Canada). Completed <24 months in program
SSHRC Doctoral Fellowships	SSHRC	$20 000	1–4 years	Eligible Canadian institution or foreign institution	Canadian citizen, permanent resident of Canada or a protected person under subsection 95(2) of the Immigration and Refugee Protection Act (Canada). Completed <24 months in program
Doctoral Foreign Study Award (DFSA)	CIHR	$30 000	3 years	Foreign institution	Canadian Citizen, permanent resident of Canada or a protected person under subsection 95(2) of the Immigration and Refugee Protection Act (Canada). Completed <24 months in program

Note: A summary of NSERC, SSHRC, and CIHR awards for master's and PhD students, including the funding agency, value, and eligibility requirements.

Fig. 26. Federal and provincial award holders. Percent of respondents who have received an award based on level of study: research-based master's ($n = 337$) and doctoral ($n = 750$). Award-holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.).



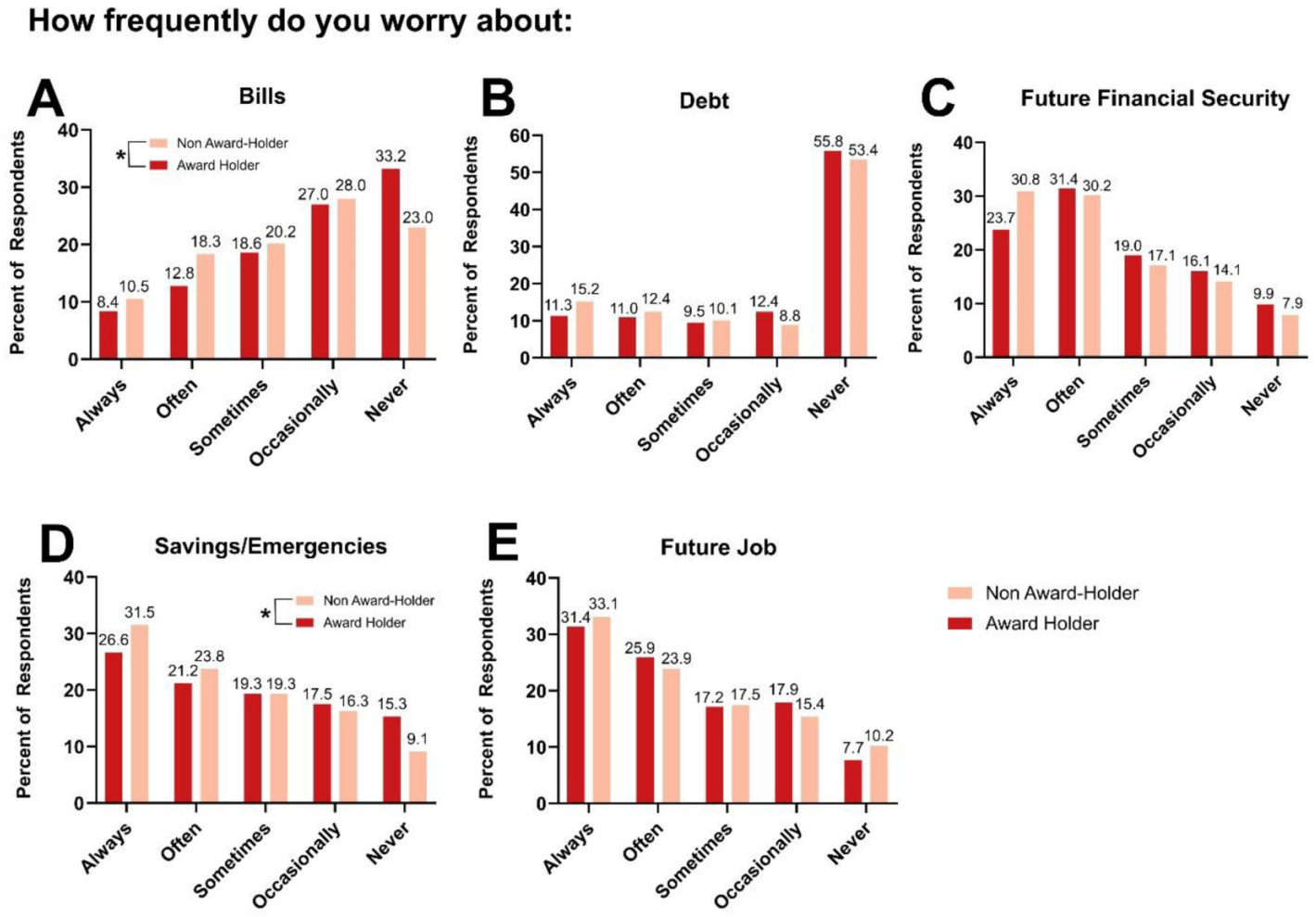
the right direction, there is still work to be done to ensure accessibility of graduate degrees.

This lack of support can lead to a lack of diversity in academia, and this concern was recognized by respondents in our survey. One respondent remarked that they "think that paying students such low stipends (i.e., below the poverty line) is really discouraging EDI in academia and is ensuring that already privileged people are the only ones that have access to higher education." From the data we collected, we aimed to understand the financial struggles of underrepresented groups of graduate students to further identify barriers of entry into graduate degrees in Canada.

Gender-based analysis

Women composed the majority of the survey sample (63.2%), followed by men (32.8%) and respondents who identified as non-binary, gender-fluid, agender, genderqueer, trans, two-spirit, or gender non-conforming (4.0%; category definitions in Supplementary file) (Fig. 32). There were no significant differences in average stipend values among gender groups (KW test, $P = 0.78$) (Fig. 33). Across all gender groups, approximately half viewed their financial situations as "Struggling" or "Tight," with slightly higher numbers among men; however, the differences between groups were not significant (χ^2 test, $P = 0.053$) (Fig. 35). It appears that respondents who identified as either non-binary, gender-fluid, agender, genderqueer, trans, two-spirit, or gender non-

Fig. 27. Financial situation by award holder status. How frequently respondents, based on award holder status, worry about their (A) ability to pay bills, (B) ability to pay back their student debt, (C) future financial security, (D) savings/ability to pay for emergency expenses, and (E) ability to obtain a future job in their chosen field. Data are shown by % in each category: non-award holder ($n = 1031$) and award holder ($n = 274$). Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.). $^{*}P < 0.05$, χ^2 test (award holder vs. non-award holder).



conforming were less likely to have received a government award compared to those who did, though again this difference was not significant (χ^2 test, $P = 0.058$) (Fig. 34).

With the low sample size of gender-diverse individuals in this study, cross-analyses for these metrics were not conclusive. Future efforts should target to better understand the specific financial struggles of these graduate students.

Respondents largely identified as White (66.5%) (Fig. 36). There were no significant differences (χ^2 test, $P = 0.73$) seen in the proportion of domestic students that received a government award (Fig. 38). No significant differences in average stipend values were found for domestic students (KW test, $P = 0.35$) (Fig. 37). There were significant differences (χ^2 test, $P = 0.043$) in the reported level of financial struggle of domestic students with Black, Latin American, Middle Eastern, and South Asian students more likely to report struggling or feeling tight financially than East Asian, Southeast Asian, or White students (Fig. 39). Among international students, there were also significant differences (χ^2 test, $P = 1.7 \times 10^{-4}$), with Middle Eastern, South Asian, and Southeast Asian (not shown in the figure due to small sample size) students reporting financial struggle at a much higher rate. The discrepancy between the financial stress of domestic and international Southeast Asian students may be due to a small sample (with only 17 students and 11 international students).

Indigenous students

The 2021 Census reported that 1.8 million Indigenous peoples reside in Canada. Of these 1.8 million Indigenous individuals, approximately 1.048 million people identify as First Nation, 625 000 identify as Metis, and 70 000 identify as Inuit, representing the three main categories of Indigenous peoples in Canada (Statistics Canada 2022*d*). Indigenous partic-

Fig. 28. Amount of savings by award holder status. Amount of savings, measured by months of living expenses, that respondents have available for emergencies, by award holder status. Data are shown by % in each category: non-award holder ($n = 1031$) and award holder ($n = 274$). Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.). $^{*}P < 0.05$, χ^2 test (award holder vs. non-award holder).

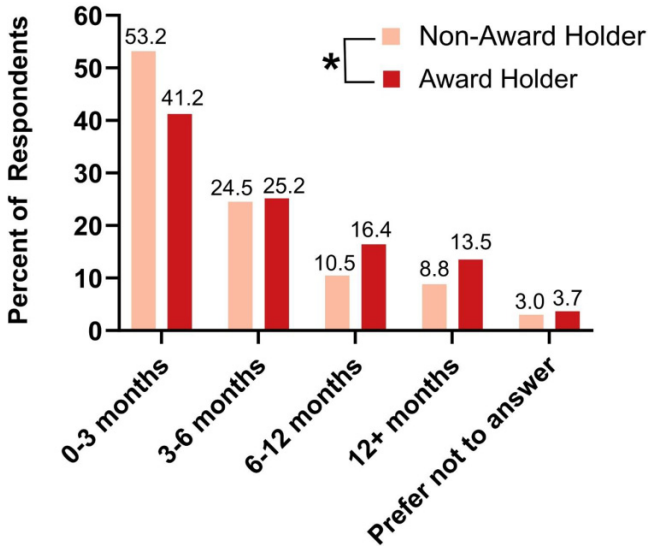
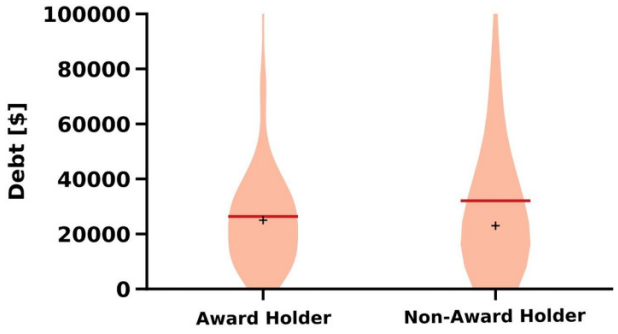


Fig. 29. Average debt by award holder status. Violin plot of average debt of respondents by award holder status. Data are shown by % in each category: non-award holder ($n = 1031$) and award holder ($n = 274$). Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.).The red line and + sign represent the mean and median debt value of respondents in each group, respectively.



ipation in graduate programs surveyed was low. Indigenous respondents consisted of only 1.2% of our survey population, while 0.8% of individuals preferred not to answer this question (Fig. 40). Proportionally, this is consistent with a 2020 Statistics Canada report showing that 1.7% of PhD students identified as indigenous (Statistics Canada 2020). While Indigenous peoples in Canada belong to three broad groups:

Fig. 30. Financial situation by award holder status. Financial situation of non-award holder ($n = 1031$) and award holder ($n = 274$) respondents. Data are shown by the % of respective award statuses. Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.). $^{*}P < 0.05$, χ^2 test (award holder vs. non-award holder).

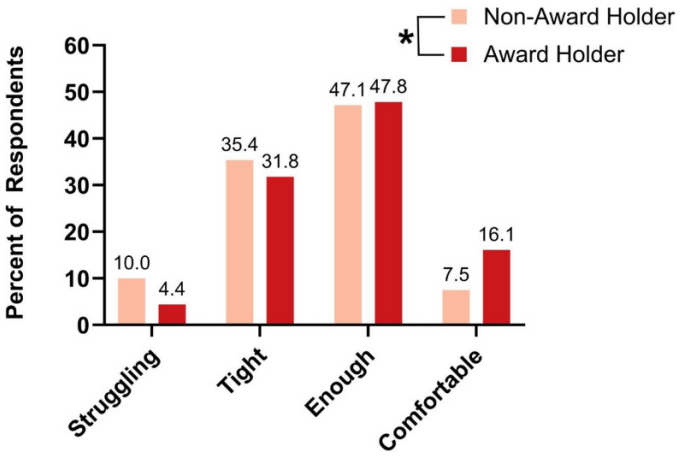
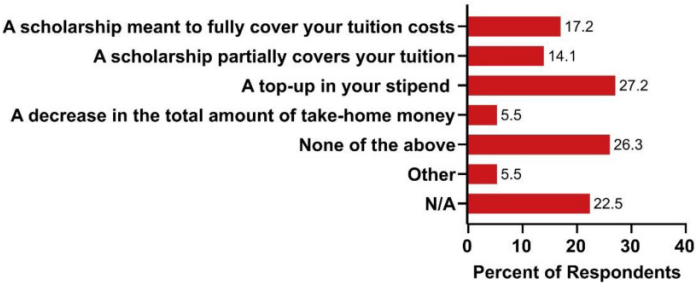


Fig. 31. Scholarship incentives. Respondents were asked whether they received additional incentives or changes in their financial compensation after receiving their scholarships ($n = 941$). Other includes scholarship that is subtracted from stipend (no top up) and funding caps.



Inuit, Metis, and First Nations, our survey did not collect any further identifying information among the Indigenous respondents.

Some concerning trends could be seen between Indigenous and non-Indigenous graduate students in the findings. There was a significant reduction (KS test, $P = 0.0012$) in the average stipend value for Indigenous respondents ($13 682) compared to non-Indigenous respondents ($22 286) (Fig. 41). There was no significant difference (χ^2 test, $P = 0.42$) in the responses of Indigenous (33.3%) and non-Indigenous (43.7%) individuals that their financial situation was struggling or tight (Fig. 42). The small sample in our dataset indicates that it could be important for a more detailed investigation into these discrepancies.

Fig. 32. Gender identity. Gender identity of all respondents by % ($n = 1305$) (multiple selections possible). Definitions are located in Supplementary file. GNC, gender non-conforming.

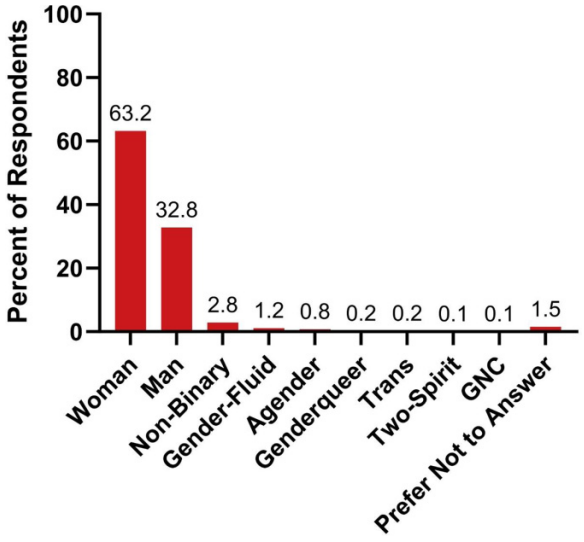
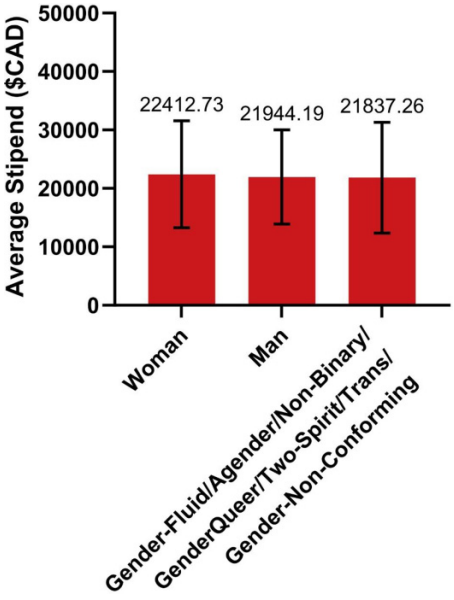


Fig. 33. Average stipend by gender identity. Average stipend value of respondents by their gender identity: woman ($n = 547$), men ($n = 328$), and gender-fluid/agender/non-binary/genderqueer/two-spirit/trans/gender non-conforming ($n = 37$). Bars represent mean ± SD.



Individuals with dependents

A dependent is an individual who relies on others, such as parents and family members, for financial support. We assessed the relevance of graduate students having dependents for their financial struggles. Survey data revealed that the majority of respondents have no dependents (86.5%), while having one dependent (7.4%) or more than one dependent was less common (5.7%) (Fig. 43). In general, having dependents corresponded with increased financial struggle, as more respondents with dependents classified their finan-

Fig. 34. Award holder status by gender identity. Percent of respondents who have received an award by their gender identity: woman ($n = 825$), men ($n = 428$), and gender-fluid/agender/non-binary/genderqueer/two-spirit/trans/gender-non-conforming ($n = 62$). Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.).

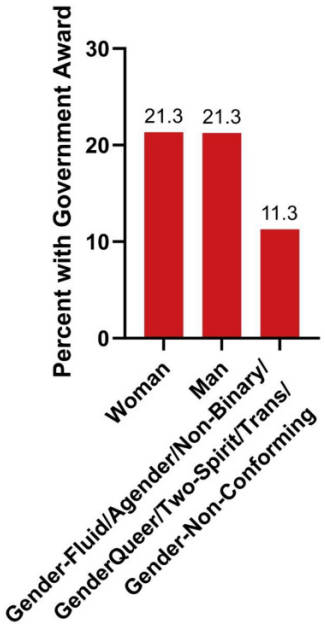


Fig. 35. Financial situation by gender identity. The financial situation of respondents by their gender identity: woman ($n = 825$), men ($n = 428$), and gender-fluid/agender/non-binary/genderqueer/two-spirit/trans/gender non-conforming ($n = 62$). Enough and comfortable responses were grouped to ensure more than five responses in this category. *Ethnicity-based analysis.*

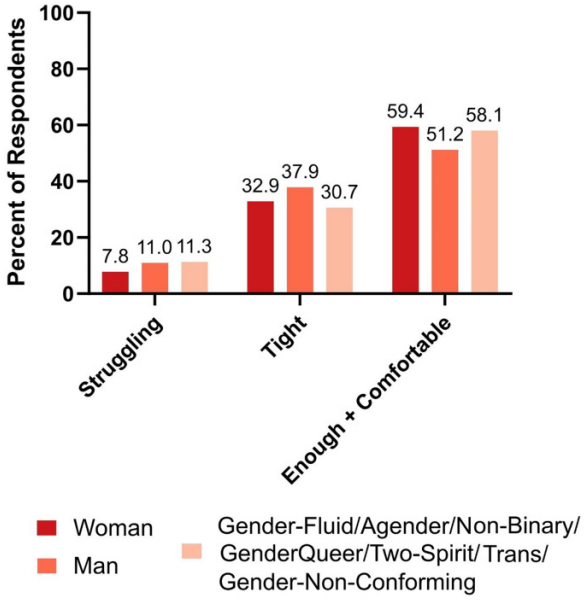


Fig. 36. Ethnic identity. The % of respondents reporting selected ethnic identity (multiple selections possible) ($n = 1300$).

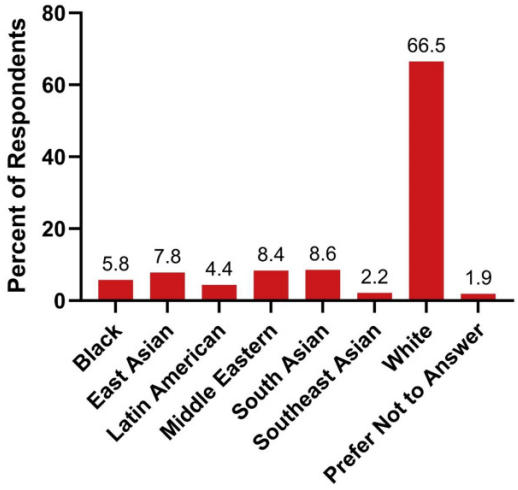
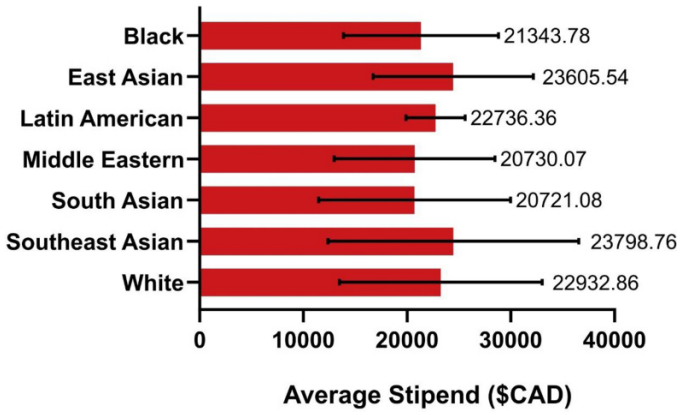


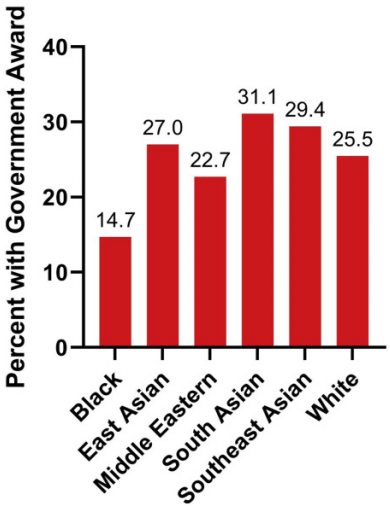
Fig. 37. Average stipend by ethnic identity. Average stipend value of domestic student respondents by their ethnic identity: Black ($n = 23$), East Asian ($n = 54$), Latin American ($n = 11$), Middle Eastern ($n = 29$), South Asian ($n = 36$), Southeast Asian ($n = 11$), and White ($n = 415$).



cial situation as struggling (15%) or tight (42.4%), in comparison to those without dependents (7.8% and 33.6%, respectively) (Fig. 44). This could potentially be a consequence of the struggle of older graduate students with dependents to access need-based funding. One respondent noted that "awards and bursary applications are geared to young students and not at all applicable to adult homeowners of students with families/children. Adult learners are effectively excluded from needs-based support."

Whether a graduate student has dependents or not, they have some contribution to the average debt accumulated in graduate studies. Respondents without dependents accumulated an average debt of $30 889, while those with one dependent averaged $34 933 debt (Fig. 45). As the number of dependents increased, the average debt decreased to below

Fig. 38. Award holder status by ethnic identity. The % of respondents who are domestic students and have received an award by their ethnic identity: Black ($n = 75$), East Asian ($n = 102$), Middle Eastern ($n = 109$), South Asian ($n = 112$), Southeast Asian ($n = 28$), White ($n = 868$). Latin American not shown due to small sample size. Award holder status is defined as being selected to receive a federal or provincial award. This does not include any other awards that were indicated (admission scholarships, institutional scholarships, etc.).



$26 000 (Fig. 45). The majority of graduate students, whether they have dependents or not, have rental accommodations. As the number of dependents increased, there was a slight decrease in the average number of respondents that lived in rental properties and an increase in respondents who owned their homes (Fig. 46A).

We also surveyed respondents on their average monthly housing costs (mortgage or rent). On average, the monthly housing costs tend to be higher for graduates with more dependents, which could be attributed to the requirements of a larger living space. While graduate students with no dependents had an average monthly housing cost of $898, the average monthly housing costs also increased as the number of dependents increased (one dependent—$1204, two dependents—$1439, three dependents—$1034, and four or more dependents $1541) (Fig. 46B).

Individuals living with disabilities

A disability is defined by the Canadian Government as a physical, mental, intellectual, cognitive, sensory, learning, and communication impairment or a functional limitation, whether visible or not and permanent, temporary, or episodic in nature, which hinders a person's full and equal participation in society when they face a barrier. According to the 2017 Canadian Survey on Disability, 22% of the Canadian population aged 15 years or older (approximately 6.2 million individuals) had one or more disabilities (Statistics Canada 2018). It has been well documented that individuals with a

Fig. 39. Financial situation by ethnic identity. (A) The financial situation of domestic student respondents by their ethnic identity: Black ($n = 34$), East Asian ($n = 74$), Latin American ($n = 16$), Middle Eastern ($n = 44$), South Asian ($n = 45$), Southeast Asian ($n = 17$), White ($n = 695$). (B) The financial situation of international student respondents by their ethnic identity: Black ($n = 41$), East Asian ($n = 28$), Latin American ($n = 41$), Middle Eastern ($n = 65$), South Asian ($n = 67$), White ($n = 173$). Southeast Asian excluded due to too few responses. Tight/struggling responses were combined to ensure more than five responses in the grouped categories. $^{*}P < 0.05$, χ^2 test.

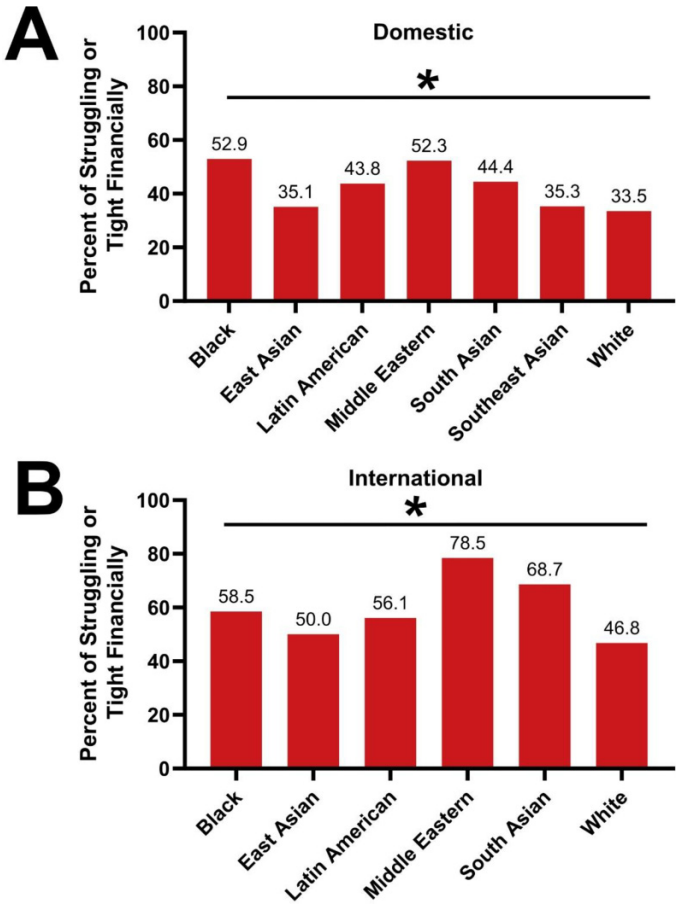


Fig. 40. Indigenous identity. The % of respondents who identified as Indigenous (First Nations, Métis, or Inuit) ($n = 1305$).

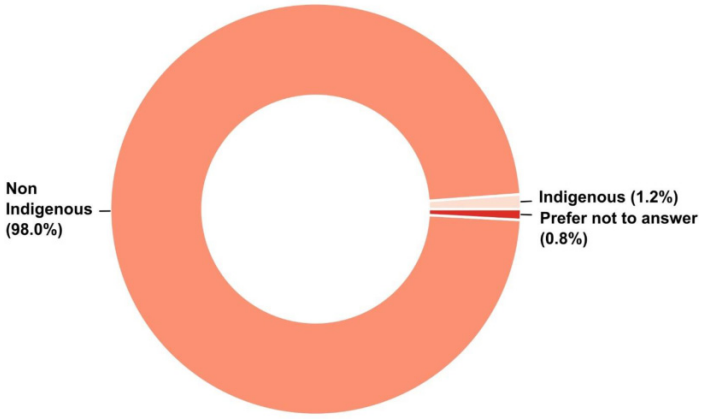


Fig. 41. Average stipend by Indigenous identity. Average stipend value of respondents who identify as Indigenous: Indigenous ($n = 11$) and non-Indigenous ($n = 890$). Bars represent mean ± SD.

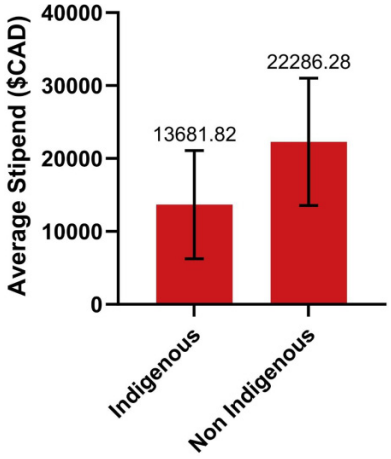
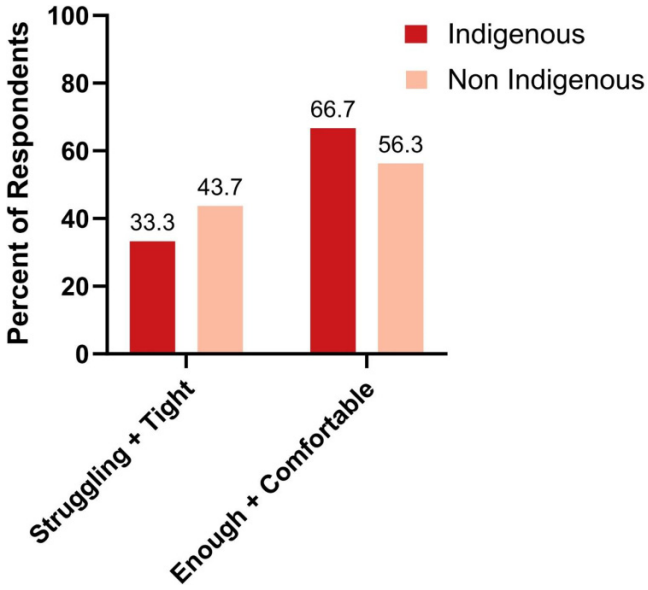


Fig. 42. Financial situation by Indigenous identity. Financial situation of respondents who identify as Indigenous: Indigenous ($n = 15$) and non-Indigenous ($n = 1279$). Enough/comfortable and tight/struggling responses were combined to ensure more than five responses in the grouped categories.



disability face numerous obstacles and challenges in society. Some government aid programs for students with disabilities exist. For example, the Canada Student Grant for Students with Disabilities enables students to apply for grants up to $4000 per academic year through provincial granting agencies (Employment and Social Development Canada 2022*a*). In addition, local funding opportunities exist with grants and

Fig. 43. Number of dependents. The % of respondents with each number of dependents ($n = 1305$).

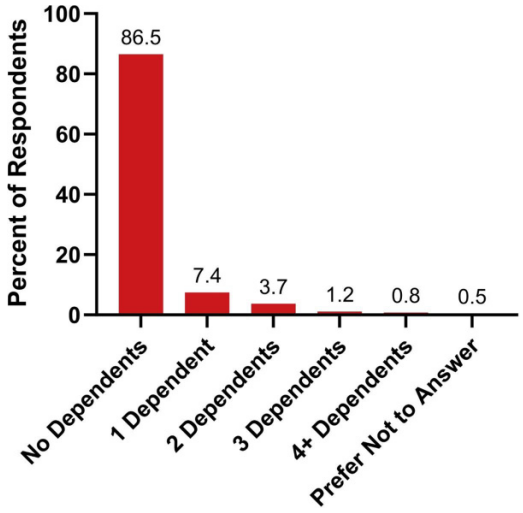
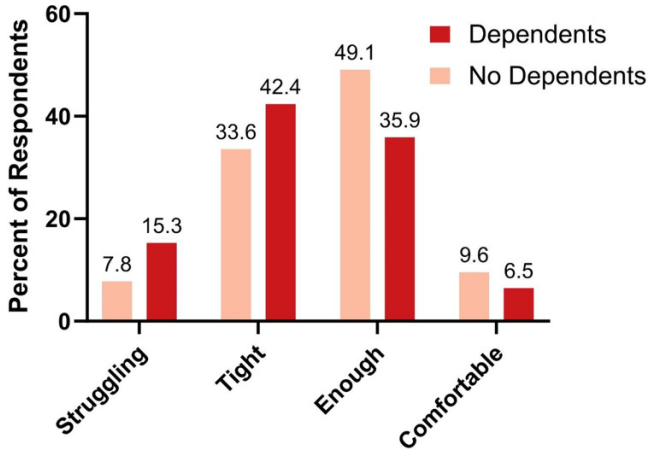


Fig. 44. Dependents and financial situation. The financial situation of respondents with or without dependents: dependents ($n = 170$) and no dependents ($n = 1129$). Dependents includes one or more dependents and were combined to ensure more than five responses.



bursaries for individuals with disabilities at each academic institution. In addition to government funding, the National Education Association of Disabled Students (NEADS) is an organisation founded in 1986 designed to support full access to education and employment for post-secondary students and graduates across Canada. NEADS offers disabled students services such as student debt reduction, increased campus involvement, experience, and help with postgraduate employment. Academic institutions can provide and accommodate services for individuals with disabilities through means such as note-taking, visual language interpretation, captioning for virtual learning, accessibility in campus/classroom, testing/exam accommodation, and tutoring services designed for each disability and learning requirement.

We collected data on whether respondents identified as having a disability and whether it impacted their graduate school success and financial status. Overall, the majority of respondents (87.4%) stated that they did not identify with a disability, 10.3% identified as having a disability, and 2.3% of respondents preferred not to answer this question (Fig. 47). Respondents with a disability had an average stipend value similar to those without a disability ($23 134.83 vs. $22 120.41, respectively) (Fig. 48). In addition, graduate students with a disability received an award/scholarship at similar proportions individuals without a disability, 21.5% and 20.9%, respectively (Fig. 49). While not significant, a larger percentage of students with a disability indicated that they are financially "struggling" or "tight" compared to those without a disability. Our survey reported that 10.4% of graduate students with a disability were "struggling," while only 8.4% of graduate students without a disability were struggling (Fig. 50). In addition, 38.5% of graduate students with a disability were feeling "tight" on their finances, while only 34.0% of graduate students without a disability responded similarly (Fig. 50). Results showed that 51.1% of respondents with a disability were comfortable with their financial status, while 57.4% of respondents without a disability were comfortable with their finances. Respondents noted that things like "counselling, physical therapy, and prescription medications are both not accounted for in stipend values and not covered by public insurance here in Canada," which can disproportionately affect graduate students with disabilities. Another student noted that "disability also increases costs by extending the length of people's programs, costing them many thousands of dollars in tuition and fees." Certainly, academic institutions have made progress with maintaining accessibility and offering support/services, but our survey highlights that individuals with disabilities are struggling or are tight with their finances, thus identifying a need for more governmental support.

International graduate students face larger financial struggles than domestic students

International students composed 21% of master's and 37% of doctoral students in Canada, with this proportion rising to nearly 50% for those studying in STEM (Statistics Canada 2022*e*). This is comparable to the 31.6% of survey respondents to our survey who were international students (Supplementary Table 1).

International students can face additional challenges compared to domestic students, such as legal limits on the number of hours they can work off campus, which has recently been suspended until the end of 2023 (Immigration, Refugees and Citizenship Canada 2022), ineligibility for most Canadian government scholarships, as well as other struggles. One notable difference between international and domestic graduate students is the amount they pay in tuition, with 39% of international students reporting annual fees over $15 000 compared to only 3% of domestic students (Fig. 51). While 28% of international students have their tuition entirely covered by additional scholarships or higher stipends, over 66% must pay for at least part of their tuition out of pocket (Fig. 52).

Fig. 45. Dependents and debt. (A) Violin plot of the average student debt for those respondents who have student debt conditional on the number of dependents ($n = 577$). The red line and + sign represent the mean and median stipend value of respondents in each group, respectively. (B) The proportion of respondents who have student debt conditional on the number of dependents ($n = 1305$).

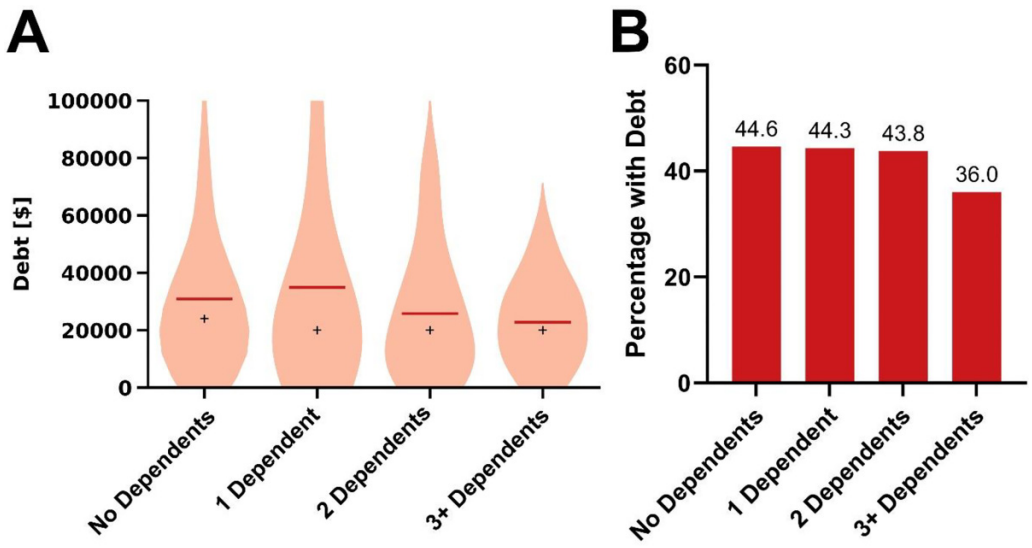
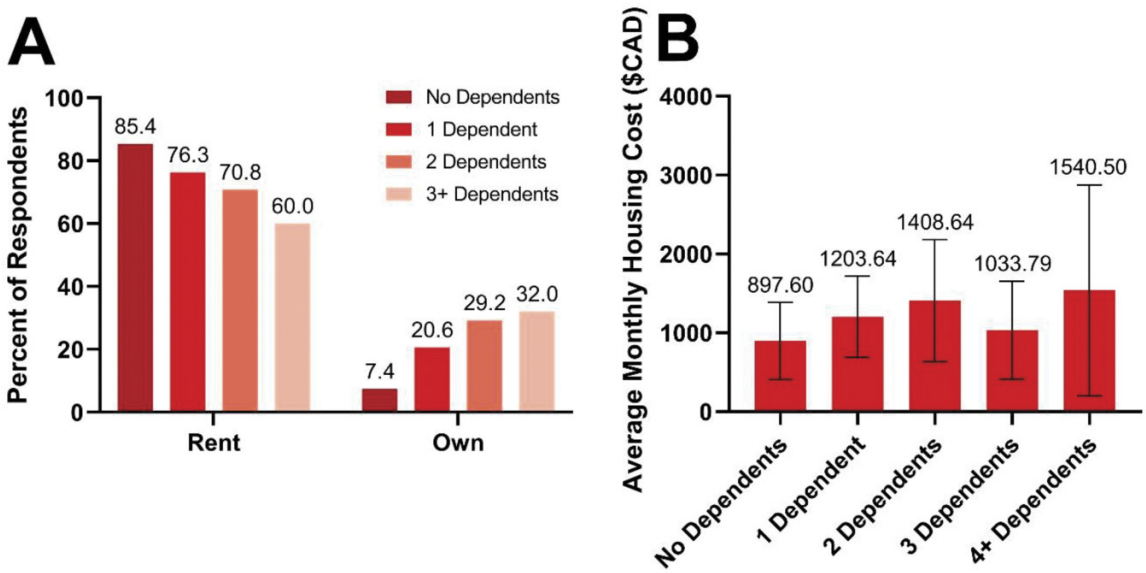


Fig. 46. Dependents and housing. (A) The percentage of respondents who rent or own (does not add up to 100% due to other living statuses) conditional on the number of dependents they have ($n = 1305$). (B) The average monthly cost of housing for respondents conditional on the number of dependents ($n = 1283$). Bars represent mean ± SD.



International students were found to be significantly (χ^2 test, $P < 10^{-5}$) more likely to report that they are "struggling" to make ends meet or that their finances are "tight," with over 50% falling into these categories (Fig. 53). Concerns over one's ability to pay for bills, financial security, and emergency expenses were also significantly higher (χ^2 test, P values of $<10^{-5}$, 0.002, and $<10^{-5}$, respectively). The survey reported 44% of international students were "always worried" about their ability to pay for emergency expenses compared to 24% of domestic students (Fig. 54). The amount of emergency savings held by international students was also significantly different (χ^2 test, $P < 10^{-5}$), with 70% of international students having less than three months of expenses saved compared to 44% of domestic students (Fig. 55). This is despite international students generally paying less in rent (Fig. 56).

Fig. 47. Disability status. The percentage of respondents who identify with a disability ($n = 1305$).

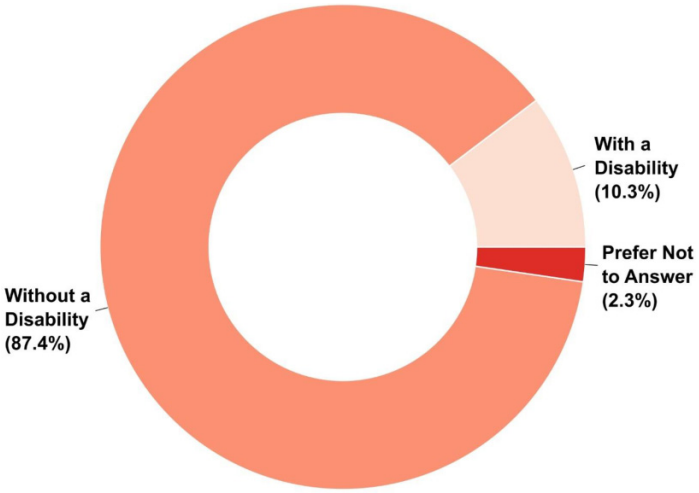
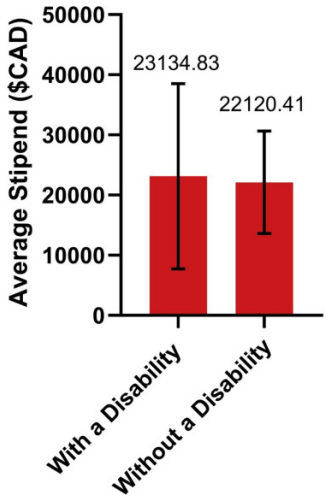


Fig. 48. Average stipend by disability status. The average stipend in Canadian dollars (CAD) of respondents with ($n = 93$) or without ($n = 794$) a disability. Bars represent mean ± SD.



Additionally, there were large differences in how international graduate students received funding. Only 13% of international students received government scholarships compared to 26% of domestic students (Fig. 57). This is likely due to the lack of eligibility of international students for many federal and provincial scholarships. In fact, the only federal scholarship that international students can apply for is the prestigious Vanier Scholarship. An evaluation report of the Vanier Scholarship shows that only 13% of Vanier awardees are international scholars (Canadian Institutes of Health Research 2014). Since these awards, valued at $50 000, are much higher than other federal awards, they are highly competitive and have since failed at their original objective of attracting and recruiting prestigious students from outside of Canada (Canadian Institutes of Health Research 2014).

Fig. 49. Award holder status by disability status. The percentage of respondents with ($n = 135$) or without ($n = 1140$) a disability who indicated receiving a government award.

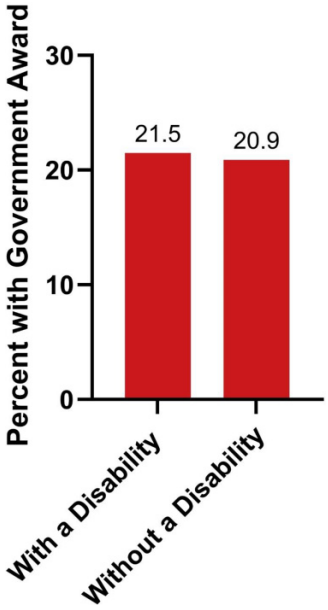
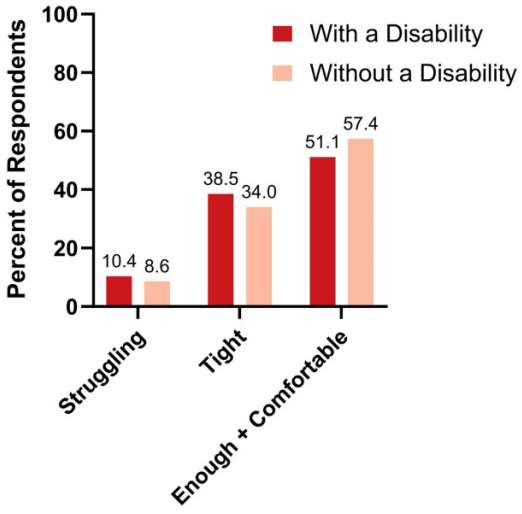
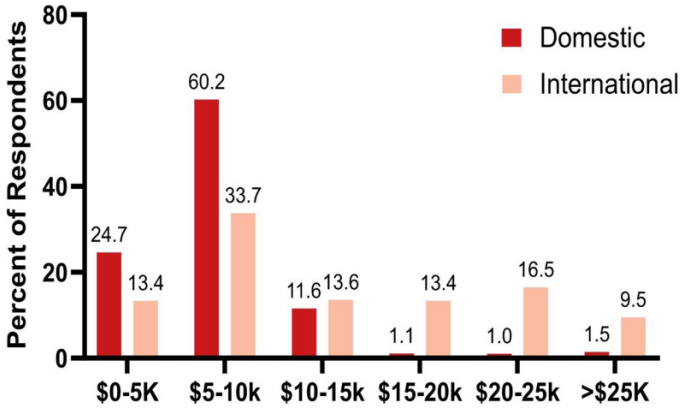


Fig. 50. Financial struggle by disability status. The percentage of respondents with ($n = 135$) or without ($n = 1140$) a disability who identified their financial status as being either struggling, tight, or enough + comfortable. Enough/comfortable responses were combined to ensure more than five responses in the grouped categories.



Further, at the time this survey was conducted, there were limitations on the number of hours international students were allowed to work outside of their studies. This hinders the ability for students to supplement their income and puts them at increasing risk of financial insecurity. International student respondents worked less outside of their studies compared to domestic students (Fig. 58). Recently these limits

Fig. 51. Tuition fees. The annual tuition and other mandatory fees separated by domestic ($n = 892$) and international ($n = 412$) students.



have been suspended (Immigration, Refugees and Citizenship Canada 2022). The restriction for international students to work less than 20 h per week during school semesters has been temporary removed to allow for more additional income and to supplement labour shortages. Similarly, far fewer international student respondents indicated receiving stipends larger than $27 000 compared to domestic students, which may be due to the lack of access to federal scholarships (Fig. 59).

Next steps and recommendations

1. **Increase federal funding (through the Tri-Councils) for graduate students in the form of research grants and scholarships**

The conclusions of this survey support the current recommendation of the Support Our Science campaign (Support our Science 2022). Put simply, we advocate for an increase in the *value* and *number* of graduate student scholarships at academic institutions across Canada to account for increased inflation and enrolment into graduate programs since 2003 (i.e., the last time these awards were increased):

a) Increase in the *value* of Tri-Council scholarships—we recommend harmonising all federal Tri-Council scholarships to a *minimum* of $25 000 for master's students and $35 000 for PhD students. This aligns with the ideal stipend values declared by our survey respondents (Fig. 19). Careful consideration should go into this decision as it can set the standard for stipends at the university level.

b) Increase in the *number* of Tri-Council scholarships—our survey has found that about 20% of students are funded through federal scholarships, while 12% are funded through provincial scholarships (Fig. 21). We recommend increasing the number of students who are funded through these scholarships by 50% annually to account for increased enrolment into graduate programs (Statistics Canada 2022*f*). While the number of graduate students in Canada has doubled between 2002 and 2019, we have seen decreases in the number of Tri-Council scholarships available resulting in increased competition and lower success rates for these competitions. By increasing the number of these awards, it would increase the overall percentage of graduate students funded and remove some financial burden from supervisors and principal investigators to fund these students out of their grant funding.

c) Increase the value of Tri-Council *research grants*—we recommend a specific increase in research grants (e.g., discovery grants, etc.) that will allow for supervisors to increase the stipends of graduate students. Our survey shows that the majority of students (67%) are funded through their supervisors (Fig. 21). Future work should investigate the structural and policy changes needed to ensure that the increases in monetary value of research grants are directly funding and supporting graduate students. Careful consideration should be taken to ensure that financial support for students is increased and not simply being put towards funding for additional students at the current low pay rates.

2. **Implement a standard for stipends in Canada and establish transparency practices for university departments**

Many survey respondents cited confusion in variation and inconsistencies in aspects of stipends. In many ways, this confusion has contributed to the challenges faced by groups advocating for stipend increases. From university and department websites, it is often unclear what funding packages are available for graduate students, and this information can often be buried under policy jargon in academic regulations. Transparency of this information is vital to allow students to make informed decisions about their graduate school pursuits.

Additionally, we recommend developing a standardised approach to defining a stipend for graduate students. This includes shifting terminology to more effectively communicate the "take-home" value of stipends to ensure that students can live above the poverty line. Specifically, this means the amount of a students' stipend that remains *after* paying tuition and mandatory expenses. This distinction is important as tuition remains one of the largest costs for students, and students who pay tuition out of pocket have increased financial struggles (Fig. 7). This goes in hand with increasing transparency of stipends, including stipulations, requirements, timelines, and limitations for graduate students.

As such, we propose the following calculation for universities to establish a minimum stipend for their students:

$$\underline{\text{Minimum stipend}} = \text{Tuition} + \text{average cost of rent} + \$550/\text{month for additional fees} + \$500/\text{month for a PhD student}$$

In this case, tuition would include any ancillary, program, or incidental fees associated with the student's tuition (i.e., all cumulative mandatory tuition fees for the student). This

Fig. 52. Tuition paid out of pocket. The percentage of tuition paid out of pocket separated by domestic ($n = 886$) and international ($n = 406$) students.

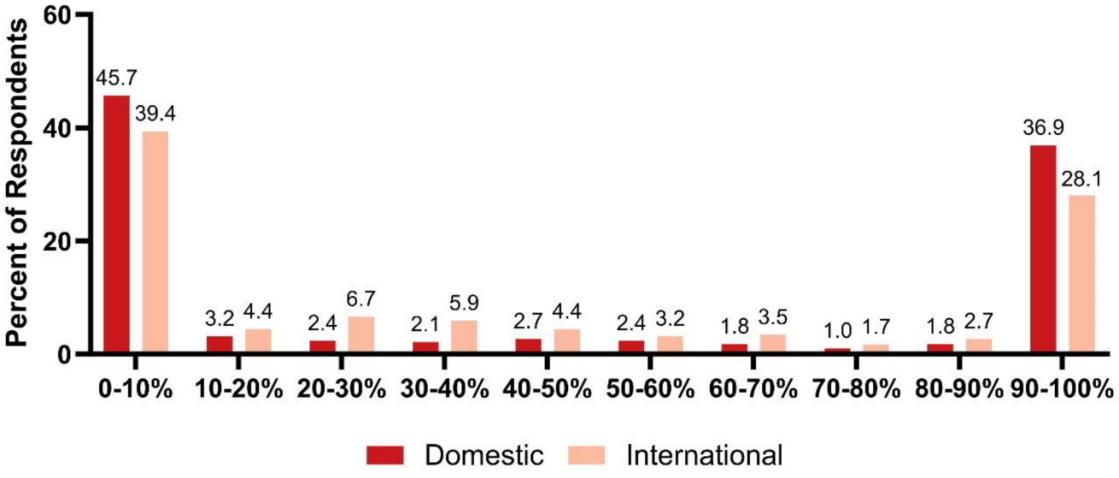
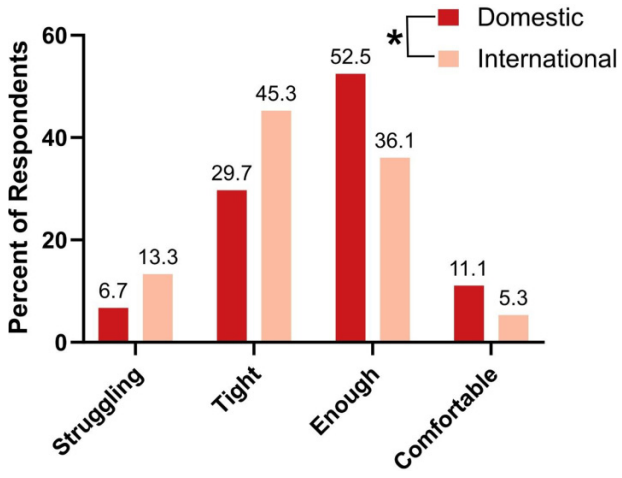


Fig. 53. Financial situation of domestic and international students. The % of respondents who are struggling financially and often do not have enough to make ends meet (struggling); every month is tight and often making sacrifices to pay for necessities (tight); have enough and are able to afford to provide for themselves (enough); or very comfortable and can spend as they like (comfortable), separated by domestic ($n = 892$) and international ($n = 413$) students. $^{*}P < 0.05$, χ^2 test (domestic vs. international).



would also account for an increased stipend need for international students and would compensate if the department provided any tuition waivers for international students. The average cost of rent can be calculated for a one-bedroom apartment within the city where the university is located. We recommend using a resource that regularly publishes these data (such as Zumper: https://www.zumper.com/blog/rental-price-data-canada/) to get the most accurate up-to-date data. Additionally, we recommend an average of $550/month for additional living expenses such as groceries, transportation, medical expenses, and more. The value of this number was calculated in our survey as the average additional monthly expenses seen from students (Fig. 9). We then recommend an additional $500/month for a PhD student as these students have increased financial needs and often have more dependents and responsibilities.

Here, we have provided an example of this equation at work for a domestic (in province, on campus) thesis-based graduate student attending a U15 university in Canada (Table 3). Full details on these numbers and sources can be found in Supplementary files.

3. Expand the eligibility of Tri-Council graduate student scholarships to help provide better funding for international students and underrepresented groups

Current eligibility for Tri-Council graduate student scholarships, namely the CGS and PGS awards (Table 2), excludes international students. While the Vanier scholarship aims to attract and retain international scholars, this award fails to achieve these goals (Canadian Institutes of Health Research 2014). We recommend that the Tri-Council re-evaluate the key priorities of the Vanier scholarship and consider creating separate scholarship allocations for international students as our data indicate that they are less likely to receive these scholarships (Figs. 34 and 38). We further amplify the recommendations of Baskaran et al. (2021), which suggest harmonising the duration eligibility for Tri-Council CGS and PGS awards to increase the time in which a student is eligible to apply for the awards. We also recommend continuing efforts to expand the definition of "excellence" to include diverse forms of work, volunteering, and mentoring. All of these recommendations will assist with removing barriers of entry for foreign scholars and underrepresented groups.

Fig. 54. Financial stresses of domestic and international students. The response for domestic ($n = 892$) and international ($n = 413$) students on how frequently they worry about their (A) ability to pay bills, (B) ability to pay back their student debt, (C) future financial security, (D) savings/ability to pay for emergency expenses, and (E) ability to obtain a future job in their chosen field. Data are shown by % in each category. $^{*}P < 0.05$, χ^2 test (domestic vs. international).

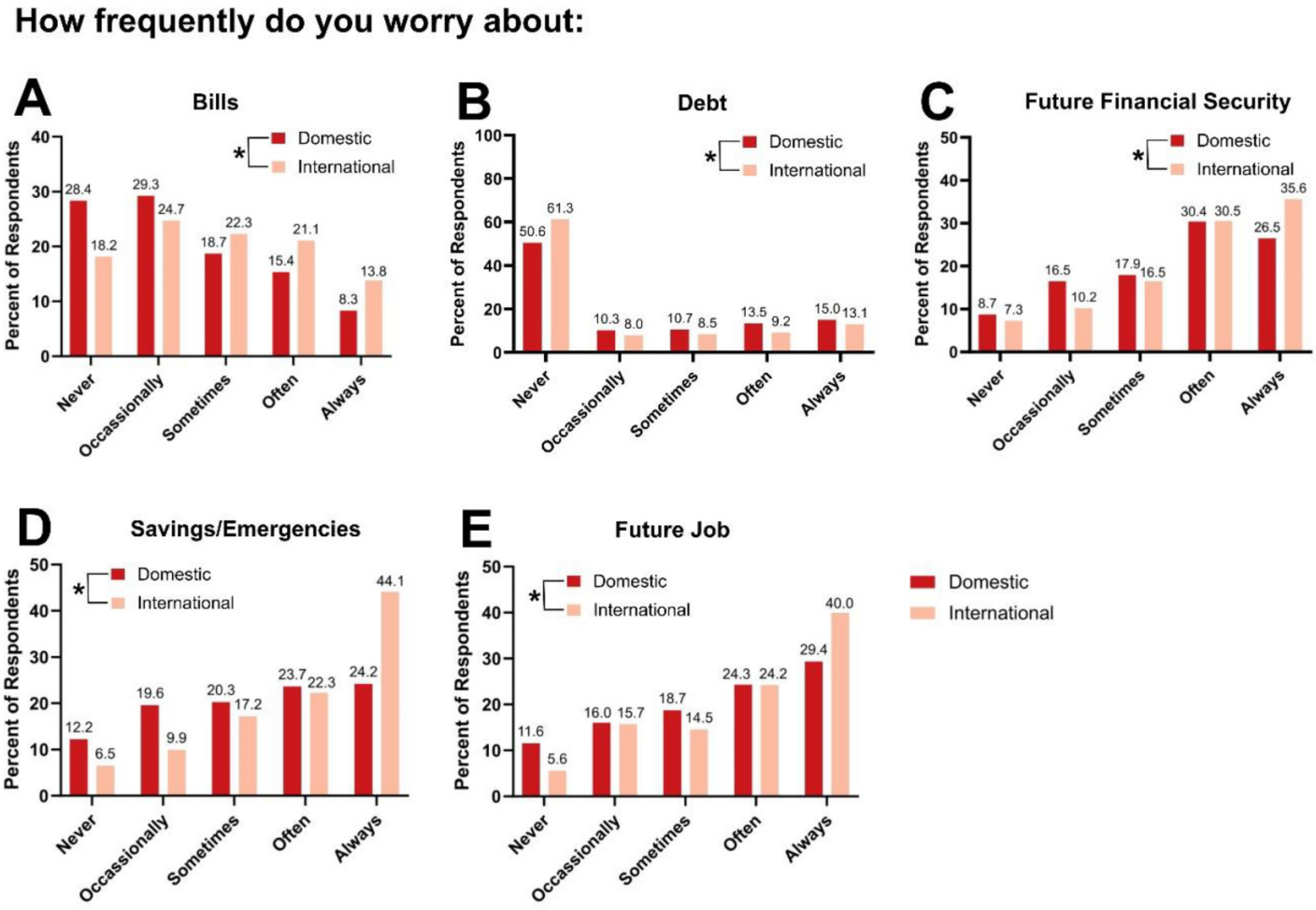


Fig. 55. Savings of domestic and international students. The number of months of living expenses respondents have as savings separated by domestic ($n = 863$) and international ($n = 401$) students. $^{*}P < 0.05$, χ^2 test (domestic vs. international).

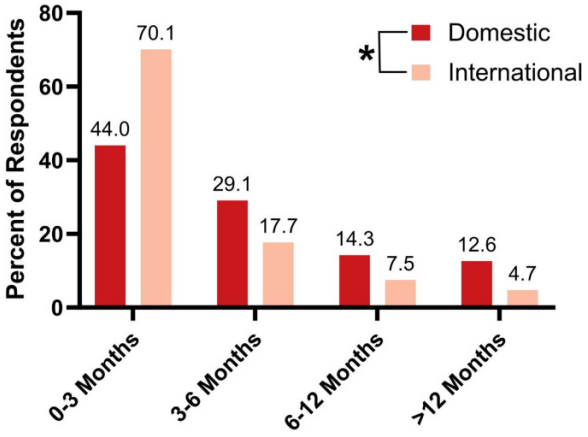


Fig. 56. Housing costs of domestic and international students. The monthly cost of housing of respondents separated by domestic ($n = 879$) and international ($n = 410$) students.

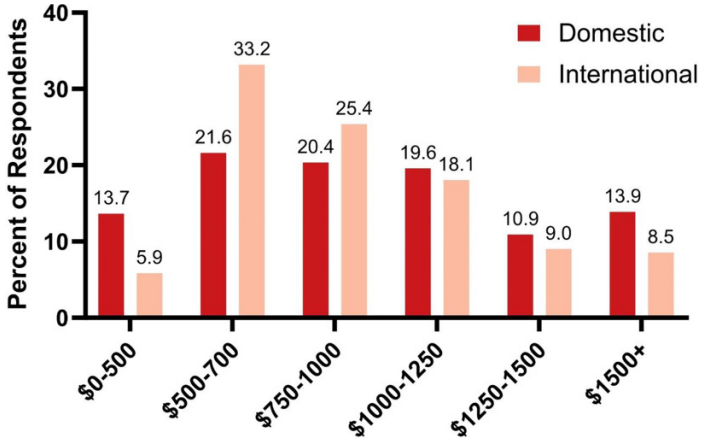


Fig. 57. Government awards and leaving studies. (A) The percentage of respondents who receive a federal or provincial award for domestic ($n = 982$) and international ($n = 413$) students. (B) The percentage of respondents who have considered leaving studies due to concern over finances separated by domestic ($n = 889$) and international ($n = 408$) students.

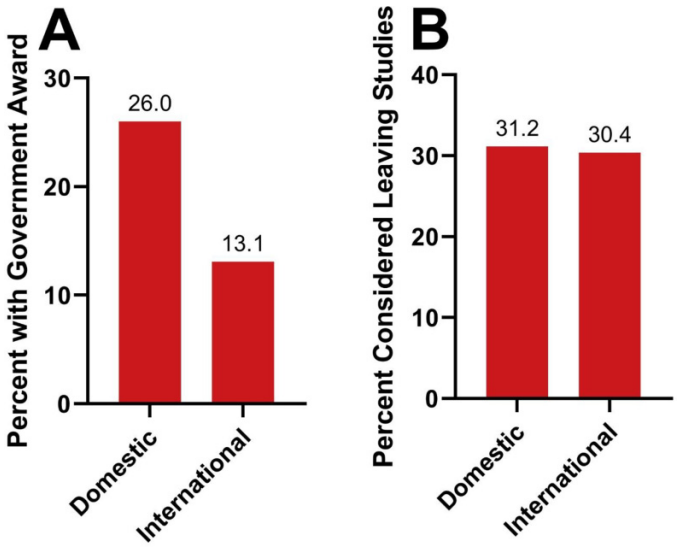


Fig. 58. Hours outside work of domestic and international students. The number of hours worked per week outside of graduate studies separated by domestic ($n = 892$) and international ($n = 413$) students.

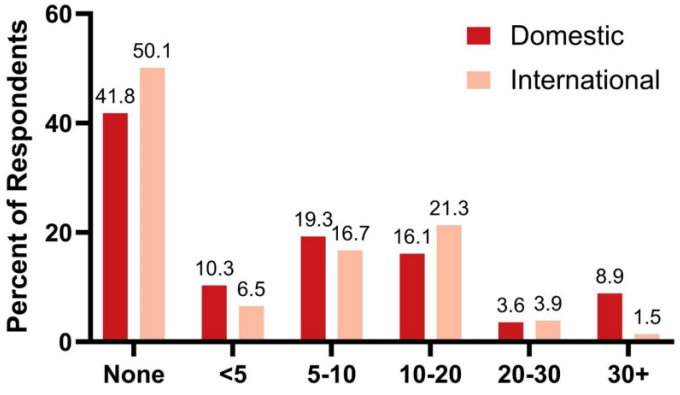
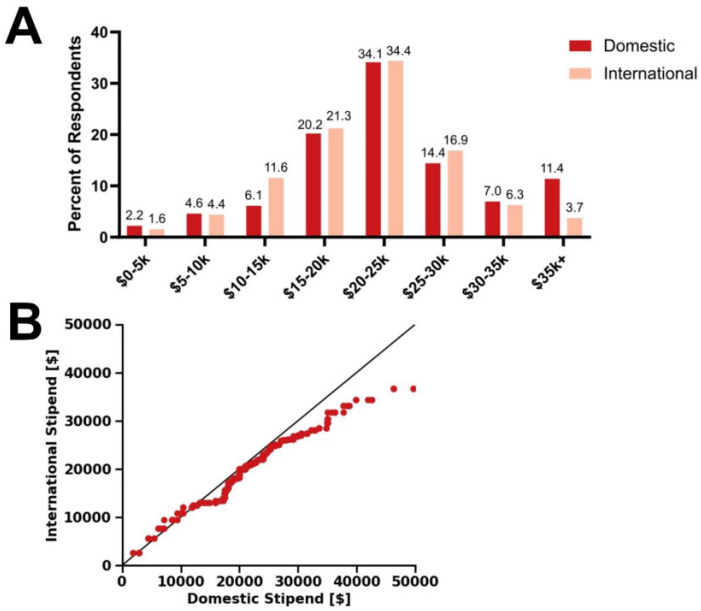


Fig. 59. Stipend levels of domestic and international students. The annual stipend received by domestic ($n = 589$) vs. international ($n = 320$) student respondents. (A) The percentage of respondents in each category who receive a stipend of this amount. (B) A QQ-plot (binned into groups of five to maintain de-identification) showing how the distribution of stipends for domestic and international students differ. A QQ-plot is such that the same quantile for each data set is plotted against each other (e.g., the 5th percentile of both distributions is one point). If the two distributions were the same they would follow the line indicated.



such as that we are experiencing now. The costs of living have continued to increase over time, including the cost of tuition for graduate students, which has increased by 38% since 2006 (Statistics Canada 2022*a*). It is therefore important to recognize the issue that federal awards have not changed in value since 2003, and financial support for graduate students has remained stagnant over the past 20 years.

4. **Index and evaluate graduate student funding on a regular basis to ensure the sustainability of research infrastructure in Canada**

To ensure the long-term sustainability of research in Canada and appropriately retain and attract top students, we recommend indexing the value of stipends and Tri-Council scholarships to the consumer price index (Statistics Canada 2023). This is already done in countries like Australia, which index all graduate student scholarships annually to adjust for inflation (Khoo 2021). This will better ensure in future that we do not reach a financial crisis among graduate students

5. **Remove limits on work outside of studies for graduate students**

We have highlighted the limitations of working outside of full-time graduate studies. We recommend the removal of certain work limitations (e.g., the 10 h rule), which severely impedes graduate students from obtaining needed supplemental income. To be clear, we *do not* suggest removing these limitations as a way of resolving graduate student financial struggle, as this would merely provide a band-aid solution to a much larger problem that is outlined in this report. Instead, this recommendation should be interpreted as a chance for students with increased financial needs to have the option to seek work outside of their studies while still maintaining their commitment to full-time studies.

Table 3. Recommended stipends for Canadian universities.

University	Total tuition	Rent (one-bedroom) per month	Master's minimum stipend	PhD minimum stipend
University of Alberta	$7086.54	$1020.00	$25 926.54	$31 926.54
University of British Columbia	$5777.02	$2500.00	$42 377.02	$48 377.02
University of Calgary	$7895.83	$1610.00	$33 815.83	$39 815.83
Dalhousie University	$11 060.24	$1800.00	$39 260.24	$45 260.24
Université Laval	$3187.44	$1100.00	$22 987.44	$28 987.44
University of Manitoba	$5011.86	$1090.00	$24 691.86	$30 691.86
McGill University	$6389.50	$1500.00	$30 989.50	$36 989.50
McMaster University	$8389.02	$1640.00	$34 669.02	$40 669.02
Universitié de Montreal	$5207.91	$1500.00	$29 807.91	$35 807.91
University of Ottawa	$7850.76	$1720.00	$35 090.76	$41 090.76
Queen's University	$9110.10	$1700.00	$36 110.10	$42 110.10
University of Saskatchewan	$5873.97	$1020.00	$24 713.97	$30 713.97
University of Toronto	$7997.28	$2300.00	$42 197.28	$48 197.28
University of Waterloo	$8414.33	$1800.00	$36 614.33	$42 614.33
University of Western Ontario	$9088.19	$1680.00	$35 848.19	$41 848.19

Note: Recommended values for minimum master's and PhD stipends at 15 Canadian universities, based on tuition fees, average rent prices for a one-bedroom apartment in corresponding cities, plus an additional $550 per month for expenses and additional $500 for PhD students per month. Additional details on calculations, sources, etc. can be found in Supplementary Table 3.

6. **Further investigate the role of EDI factors in financial struggle**

One limitation of our survey is that we did not have sufficient demographic data to provide tangible and targeted EDI-centred recommendations. Future work should investigate the financial status of graduate students who identify as members of historically underrepresented groups, including women, Indigenous peoples (First Nations, Inuit, and Métis), persons with disabilities, members of visible minority/racialized groups, and members of LGBTQ2+ communities This will enable a more diverse understanding of students' needs depending on their demographic background and the subsequent development of effective, equitable, and evidence-based programs and(or) policies to support students from historically underrepresented groups.

Acknowledgements

We would like to acknowledge all of the graduate students across Canada who participated in our survey, as well as the various student associations, organisations, and individuals who helped distribute the survey. We would also like to thank Amy Johnston for assistance with analysis of demographic cross-sections, as well as all those from the Science Policy Exchange and Toronto Science Policy Network providing insight during the initial development of the survey.

Article information

History dates

Received: 27 January 2023
Accepted: 10 March 2023
Accepted manuscript online: 11 April 2023
Version of record online: 11 April 2023

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Data availability

Data generated or analysed during this study are not publicly available due to our stated privacy policy to ensure anonymity of respondent, but anonymized data may be available from the corresponding author on reasonable request.

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Competing interests

The authors declare there are no competing interests.

Funding information

The authors declare no specific funding for this work.

Supplementary material

Supplementary data are available with the article at https://doi.org/10.1139/bcb-2023-0021.

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