UPSKILL Health and Mental Health Outcomes Study: Conceptual Model Testing

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SRDC SRSA

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Abstract

Background

The UPSKILL Health and Mental Health Outcomes study (UPSKILL Health) is a sub-study of the original UPSKILL project, which SRDC designed and implemented with support from the Office of Literacy and Essential Skills (OLES) at Employment and Social Development Canada (ESDC, formerly HRSDC). UPSKILL's purpose was to evaluate workplace Literacy and Essential Skills (LES) training using the most rigorous evaluation methods. This large-scale randomized control trial began in February 2010 and ran until February 2014.

UPSKILL Health is funded by the Public Health Agency of Canada. The purpose of UPSKILL Health is to explore the relationship of literacy and essential skills to health (physical and mental), using data from the original UPSKILL project. This report concerns the first phase of analysis of the quantitative UPSKILL data related to health.

Objectives

The first stage of work for UPSKILL Health aimed to better understand the theoretical relationship between literacy and essential skills and health, and to conduct preliminary testing of this theory using baseline UPSKILL data.

Methods

The research literature on learning and health was extensively reviewed, with a particular focus on the workplace and workers' health. Based on the literature, we developed a conceptual model to illustrate the relationships among a variety of personal and workplace factors and their relationship to health and mental health, in terms of both individual and business outcomes, in order to understand how an intervention such as workplace LES training might produce effects. Next, we tested this model empirically, using baseline data from UPSKILL to identify variables with proven strength and relevance. We used correlations to identify what relationships might exist between specific variables and health outcomes, and refined the model according to the strength of these relationships. Regressions were conducted to explore the *nature* of these relationships i.e., how they worked.

Results

Overall, we found the UPSKILL data fit the conceptual model quite well, although some areas need more research to understand the relationships more fully. We found that health literacy appears to have a direct effect on mental health, as well as indirect effects, influenced by an individual's sense of self-efficacy and self-esteem. Workplace characteristics did not appear to affect mental health directly, but did affect work stress, which is closely related. Links among essential skills, working safely, and physical health were not clear.

Application

This first stage of the UPSKILL Health study has produced a comprehensive model of worker health. The model advances understanding of factors that affect the health of workers, and the mechanisms through which this influence operates. In addition to the LES workplace training intervention implemented in the UPSKILL trial, the conceptual model could potentially be applied to other types of interventions designed to improve worker health, particularly mental health. Once further analyses are completed, findings of this study will be of interest to policy makers, researchers, literacy practitioners, providers of health programs, as well as the business community (e.g., sector councils, employers).

Executive summary

This document is the second deliverable for the UPSKILL Health and Mental Health Outcomes Study, whose purpose is to explore the relationship of literacy and essential skills with health and mental health, using data from the original UPSKILL project. As described in detail in the document, the UPSKILL project was a large demonstration project that tested the effectiveness of workplace-based literacy and essential skills training for employees in the tourism accommodations sector. The Social Research and Demonstration Corporation (SRDC) is the Canadian non-profit research organization that developed and managed UPSKILL, which ran from 2010 until 2014.

The Public Health Agency of Canada (PHAC) recently contracted with SRDC to undertake a two-phased sub-study to build on the existing UPSKILL demonstration project. The first phase involves an analysis of health-related data already collected through UPSKILL. The second phase is a qualitative inquiry involving key informant interviews and focus groups with a sample of UPSKILL participants.

This report describes the development and empirical testing of a conceptual model of the relationships between literacy and essential skills and health in the workplace. The first section presents a review of the relevant literature in literacy, health, and employment, while the second section presents the project's overall methodology and the proposed conceptual model. The third section provides results from the analyses that have been conducted to date on UPSKILL baseline data sets.

Our analytical strategy consisted of first establishing bivariate associations between a variety of relevant variables and health outcomes, and with other outcomes as defined in the conceptual model. Then, we examined the strength of the relationships among variables to refine this model and guide the multivariate analysis. On the basis of this analysis, three sets of relationships were identified that warranted further investigation:

- *Health literacy and mental health*: Does health literacy affect mental health directly or does its effect pass through channels such as psychosocial variables (i.e., motivation and engagement, self-efficacy, attitudes to learning, resilience and self-esteem)?
- *Workplace characteristics and mental health*: What are the relative influences of workplace characteristics, work stress, and work satisfaction on mental health?
- *Essential skills, safety at work and physical health*: Do numeracy, literacy, and health literacy skills influence job performance, specifically in terms of regarding working safely? Does working safely have any effect on physical health?

Regressions were conducted to provide more information on these three areas of investigation. The first series of regression models showed that health literacy appeared to have a direct effect on mental health, with the implication that any interventions that could enhance health literacy could potentially improve mental health. However, we also observed that many psychosocial variables appeared to be significant intermediary variables in the relationship between health literacy and mental health, of which self-efficacy and self-esteem were the most important mediators.

The second series of models showed that workplace characteristics (such as control over work, satisfaction with home-work balance, firm size, presence of a union, etc.) did not appear to have any

substantial impacts on mental health but did appear to have some impacts on work stress, which in turn, affects mental health. Work satisfaction did not appear to be a mediator between workplace characteristics and mental health.

Finally, evidence of links among essential skills, safety at work and physical health was inconclusive. While numeracy seemed to be related to working safely (conferring a potential role for essential skills training to improve job performance), working safely was not related to any dimension of physical health. However, this finding may be related to the smaller sample size available for these models due to sparser data on job performance. It may also be due to the lack of health–related variables at the individual level, or to work-related injuries. For example, data on work injuries and workers' chronic health conditions could have more easily described the link between safety practices at work and work injuries. Even in the absence of such data, however, we can conclude that overall, the data fit the conceptual model quite well; the connection between working safely and physical health, however, requires further investigation.

1. Introduction

There is a large and growing academic literature that identifies education and literacy as important social determinants of health and the potential for non-health interventions such as training and adult learning to have substantial impacts on individual and population health. While several theories exist as to the mechanisms by which education and health are related (e.g., income, health literacy, access to health resources, learned health behaviours, etc.), these theories are rarely examined empirically in a comprehensive manner.

Building on the original UPSKILL Literacy and Essential Skills in the Workplace project (UPSKILL trial), the UPSKILL Health and Mental Health Outcomes Study (UPSKILL Health) presents a rare opportunity to interrogate a comprehensive dataset on workplaces and their workers to identify how various personal and workplace factors – including workplace literacy training – influence workers' physical health and mental health (for a full list of measures, see Appendix B). UPSKILL trial data also provide us with the opportunity to learn how worker health can influence job performance and business outcomes, and which sub-groups of workers may benefit most from workplace interventions, such as literacy and essential skills training.

This report is the second deliverable for the UPSKILL Health study. Its contents describe the development and empirical testing of a conceptual model of the relationships between literacy and essential skills and health in the workplace. The first section of the report presents a review of the relevant literature in literacy, health, and employment, while the second section presents the project's overall methodology and the proposed conceptual model. The third section provides results from the initial analyses conducted on UPSKILL baseline data sets.

These results – while still preliminary – show that the empirical model is capable of identifying mediating factors in the relationship between employment characteristics/workplace factors and health. The report concludes with a discussion of the opportunities for subsequent analysis of the effects of mental and physical health on job performance, which will be the subject of the next deliverable.

2. Background

2.1 The UPSKILL Literacy and Essential Skills in the Workplace project (UPSKILL Trial)

With support from the Office of Literacy and Essential Skills (OLES) at Employment and Social Development Canada (ESDC, formerly HRSDC), SRDC designed and implemented the Literacy and Essential Skills in the Workplace project. This large-scale demonstration project began in February 2010 and ran until February 2014, and operated in eight provinces (all except Quebec and Prince Edward Island). The purpose of the UPSKILL trial was to evaluate workplace Literacy and Essential Skills (LES) training using the most rigorous evaluation methods. Its research strategy included three main components: 1) an experimental evaluation of impacts; 2) implementation research to explore delivery lessons and best practices; and 3) a cost-benefit analysis to estimate the returns from investments in LES training by firms and government.

The objectives of the UPSKILL trial were to:

- measure the impacts of LES training on workers and workplaces;
- understand the pattern of impacts on different types of workers and firms;
- establish a clear business case for LES training by measuring the returns to workers and firms; and
- describe the conditions in which LES training can be most successfully and strategically implemented.

The UPSKILL trial focused on the tourism accommodations sector, since this was found to have the required conditions for successful implementation of the study (e.g., partnership with a strong national sector council, existing standards and certification) and for generalizing results to other service and retail sectors. Within this sector, the project focused on a range of occupations, from those such as housekeeping that require lower levels of LES, to those requiring higher LES levels, such as front-desk agents. The LES training intervention was based on industry certification and occupational standards for these positions, and was customized to the skills and business needs of participating employers using organizational needs assessments.

To design and implement the project, SRDC worked closely with a number of partner organizations, including the Canadian Tourism Human Resource Council (CTHRC), and several provincial tourism human resource organizations. Several provincial government training departments were also closely involved, along with non-profit organizations (e.g., the Training Group at Douglas College) and a private training developer (SkillPlan).

Recruitment of firms was the responsibility of local partners, who usually began with their established hotel contacts but went farther afield with referrals or “cold calls” as necessary to meet their recruitment targets. Hotels that responded positively to the UPSKILL offer and were interested in joining the study signed an UPSKILL employer agreement to officially begin their participation. In total, 110 firms (hotels) with 1,438 workers were recruited from the eight provinces in which UPSKILL

operated. Nearly one third of the recruited firms were from BC, 18 per cent were from Ontario, and approximately 25 per cent were from of the prairies and another quarter from the Atlantic region. Of the 110 recruited hotels, 22 dropped out during the initial baseline research and needs assessment phase, resulting in 88 hotels that were eligible for random assignment.

Once the employer-level baseline research was completed at a given hotel, employees were invited to attend an on-site information session to learn more about the UPSKILL trial. In some hotels these sessions were a hotel-wide initiative with management ensuring all staff knew about the project and had the opportunity to sign up, though in all cases sign-up was voluntary. In other hotels UPSKILL was more of a "niche" project with only a small percentage of staff invited to attend an information session. Employees were provided with the opportunity to ask questions, review the informed consent form one-on-one with an UPSKILL representative, and sign the form if they wished to participate (or take the forms away to reflect on). All employees received assurances that their participation was voluntary and not tied to any condition of their employment, and that their personal information would be kept confidential.

Once consent was received, half the participating firms were randomly assigned to the program group, and the other to a control group that received no intervention during the study period. The control group had 651 workers while the program group had 787 workers. Training activities were recorded in a program management information database system, along with the progress of both program and control group participants through various measurements, described below.

The workplace LES training was delivered to program group firms within a few months of the random assignment, and lasted an average of three months. Workers at hotels in the program group received roughly 20 hours of training. Employees' uptake of the intervention was high: n=562 workers in total received the training. UPSKILL's large sample size provided sufficient statistical power to detect even fairly modest impacts of five to seven percentage points, equal to about a 10-point change on the International Adult Literacy Scale (IALS)[1] or a 5 per cent increase on a performance measure.

UPSKILL used a clustered random assignment design to provide the most reliable measures of impacts of workplace LES training at two levels: for *individual workers* – on skills, confidence, career advancement, wage growth, health, etc.; and for *firms* – on job performance and business outcomes such as productivity, cost control, worker retention, customer satisfaction, etc.

SRDC developed a variety of employee and employer level data collection instruments for the UPSKILL trial. There were three main components to the employee-related data collection:

- a survey to obtain data on topics such as demographics, psychosocial variables, literacy practices and health variables;
- a literacy and essential skills assessment; and
- a job performance assessment.

[1] IALS scores range on a scale from 0 to 500 points for each domain of literacy, numeracy and document use. Each of the scales are split into five different levels from level 1 for the lowest literacy proficiency to level 5 for the strongest level of literacy proficiency. After level 1 (2-225 points), each level has a 50-point range, so the ability to detect a 10-point change represents a fairly high degree of precision.

These instruments were administered at least twice during the project to obtain pre- and post-intervention assessments. Together, these measurement activities generated repeated measurements of literacy, skills, performance, health, workplace factors and various psychosocial measurements of participants for impact evaluation.

Likewise, the employer data collection had three primary components:

- a baseline survey of key workplace characteristics;
- baseline organizational needs assessment; and
- an employer follow-up survey to measure changes in employee performance and key business outcomes during the study period.

The results of the UPSKILL trial are available on the SRDC website at www.srdc.org/news/new-study-shows-net-benefits-of-essential-skills-training-in-the-workplace.aspx.

2.2 The UPSKILL Health and Mental Health Outcomes Study (UPSKILL Health)

Physical and mental health were included in the conceptual model for the UPSKILL trial – particularly in terms of occupational health and safety – but they were of interest as one of many potential business outcomes arising from the LES training intervention. Exploring physical and mental health outcomes at the worker level, the relationship of these variables with LES levels, and the mechanisms by which improvements in one area might affect the others, were not the primary focus of the original study.

However, there is a large and growing academic literature that identifies education and literacy as social determinants of health and the potential for non-health interventions such as training and adult learning to have substantial impacts on individual and population health. While several theories exist as to the mechanisms by which education and health are related (e.g., income, health literacy, access to health resources, learned health behaviours, etc.), these are rarely examined empirically in a comprehensive manner in the literature.

Fortunately, data collection for the UPSKILL trial included a robust set of health measures, including employees' perceived physical and mental health status, well-being, and worker health behaviours, as well as workplace-level measures such as occupational health and safety. SRDC also developed questions about health literacy and coping behaviours that supplemented questions on perceived stress and other aspects of quality of work life.[2] For the UPSKILL health study, these comprehensive data enable SRDC to build a model of worker health, and to assess the potential of LES (and possibly other interventions) to improve worker and workplace health.

The objectives of UPSKILL Health are:

- to enhance conceptual understanding of how literacy skills and other factors can influence workers' physical and mental health;

[2] A matrix presenting the various LES, psychosocial and health measures used in the UPSKILL trial is provided in Appendix B.

- to measure the effect of workplace literacy and essential skills (LES) training, personal traits of workers, and characteristics of the workplace on worker health;
- to measure the influence of worker health on job and organizational performance;
- to examine differences/inequities in health and performance outcomes experienced by selected subgroups of workers such as those with low literacy, low income earners, immigrants, etc. (data permitting).

The empirical work for UPSKILL Health is divided into two phases: (1) a secondary analysis of UPSKILL trial data, focusing specifically on health; and (2) gathering new qualitative data from selected individuals to explore their lived experiences. In phase One, SRDC will examine the relationships among worker and workplace factors, health literacy, health, mental health, in terms of both individual and business outcomes. Specifically, this includes:

- developing a conceptual and empirical model that describes the relationships among health, mental health, and other mediating and moderating factors;
- applying the model to the workplace to assess worker-level outcomes; and
- analyzing workers' health and mental health in relation to job performance and business outcomes.

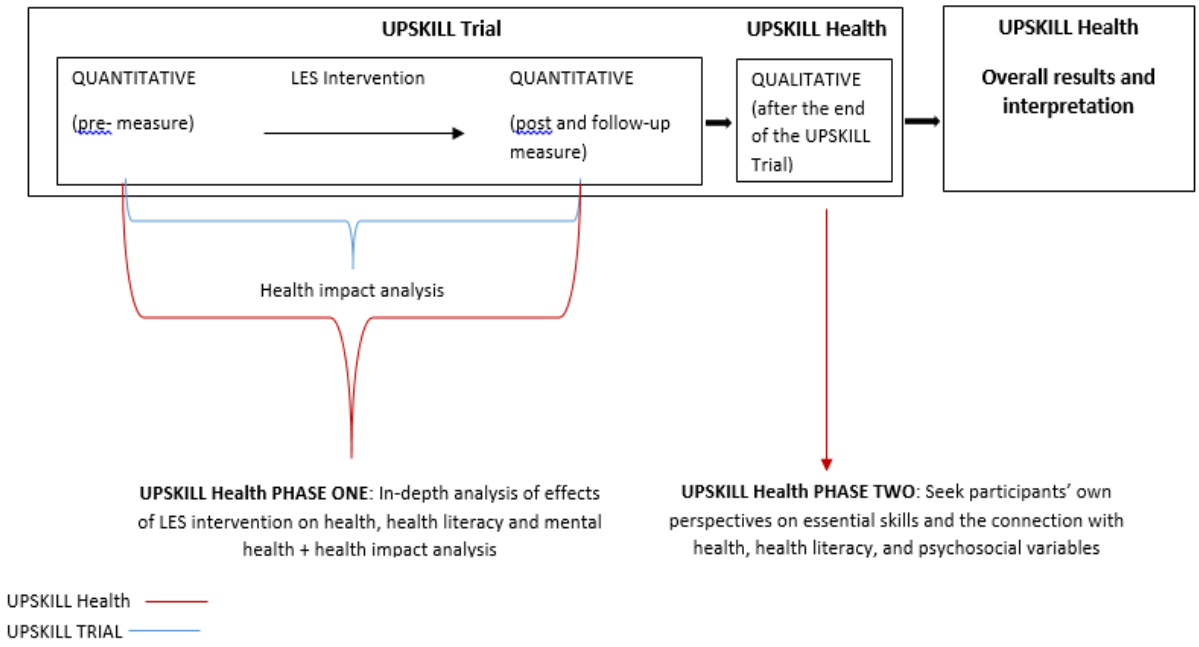
Phase Two will explore the experiences of a sub-group of UPSKILL trial participants to identify how they coped with low levels of LES, how this may have affected their mental health, and whether/how their experiences may have changed to the extent their literacy may have improved. This second phase will involve thematic analysis of new data derived from interviews with experts in literacy and health as well as focus groups with workers from the UPSKILL program group.

UPSKILL Health will extend the analysis undertaken in the UPSKILL trial by examining the mechanisms by which literacy and essential skills affect workers health, by looking at a variety of personal and workplace factors and their relationship to health and mental health, and by measuring the contribution of worker health to performance. More specifically, UPSKILL health will:

- unpack the role LES training plays in worker health, via changes in healthy behaviours, health literacy, and psychosocial capital (in the UPSKILL trial, the impact of LES training on health was measured but not the intermediate mechanisms by which this occurred);
- identify the contribution of, and the paths by which, various personal and workplace characteristics influence health for workers and workplaces, as measured by perceived health status, health and safety, job-related stress and satisfaction, and other measures (in the UPSKILL trial, many of these variables were controlled for in the training impact estimates, but their contribution to health at baseline and to the impact of the training was not identified); and
- measure the contribution of worker health and workplace health to job and organizational performance (in the UPSKILL trial, this was not considered at all).

Figure 1 below illustrates the ways in which UPSKILL Health extends and builds upon the impact analyses of the original UPSKILL trial.

Figure 1 Links between the UPSKILL Trial and UPSKILL Health



Overall, UPSKILL Health will considerably expand upon work already conducted in the area of health and learning by exploring the potential design of, and business case for, interventions that can contribute to worker and workplace health. While literacy training is one possible intervention (as explored in the original UPSKILL trial), the current study considers a number of other factors that could be modified at the workplace level as a means to improving worker health. The results of this study will thus prove useful for policy makers, literacy and health practitioners, and employers interested in improving worker health through LES training and other interventions, and knowing what workplace factors and practices can be modified to contribute to greater worker health and improved job and business performance.

2.3 Sample profile of firms and workers participating in UPSKILL

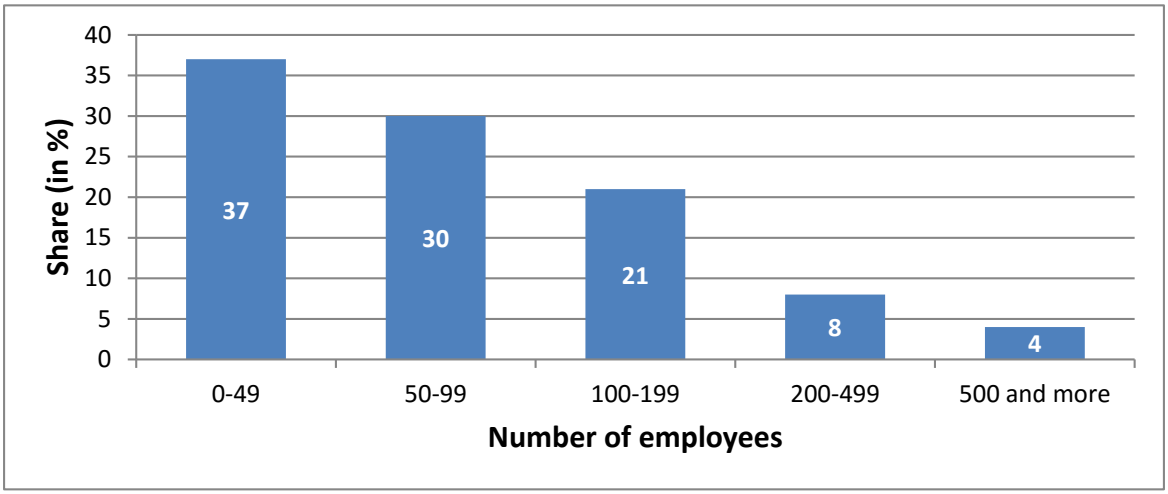
Before presenting the results of the first phase conceptual model testing, we provide an overview of the sample of firms and workers participating in the UPSKILL trial to provide context to the subsequent analyses conducted for UPSKILL Health.

Profile of firms participating in the UPSKILL trial

Almost all firms enrolled in the project are hotels — approximately 89.1 per cent of the sample; the remainder are primarily resorts. While there is little variability by type of firm, there is variation by size of firm (as shown in Figure 1). Not shown is the fact that participating hotels from Ontario tended to be larger, with just 20 per cent having less than 50 employees. The number of guest rooms at each hotel

ranges from less than 50 to over 400 with the largest category (46 per cent) being between 75 and 149 rooms.

Figure 2 Number of employees – % distribution of firms by no. of participating employees



Source: Calculations by SRDC based on Establishment Profile data.

Profile of workers participating in the UPSKILL trial

This section provides a baseline profile of participants who chose to join the UPSKILL trial, including socio-demographic and lifecycle characteristics, health and psychosocial traits, and essential skills and performance levels, all measured at baseline. Results are based on three main lines of evidence:

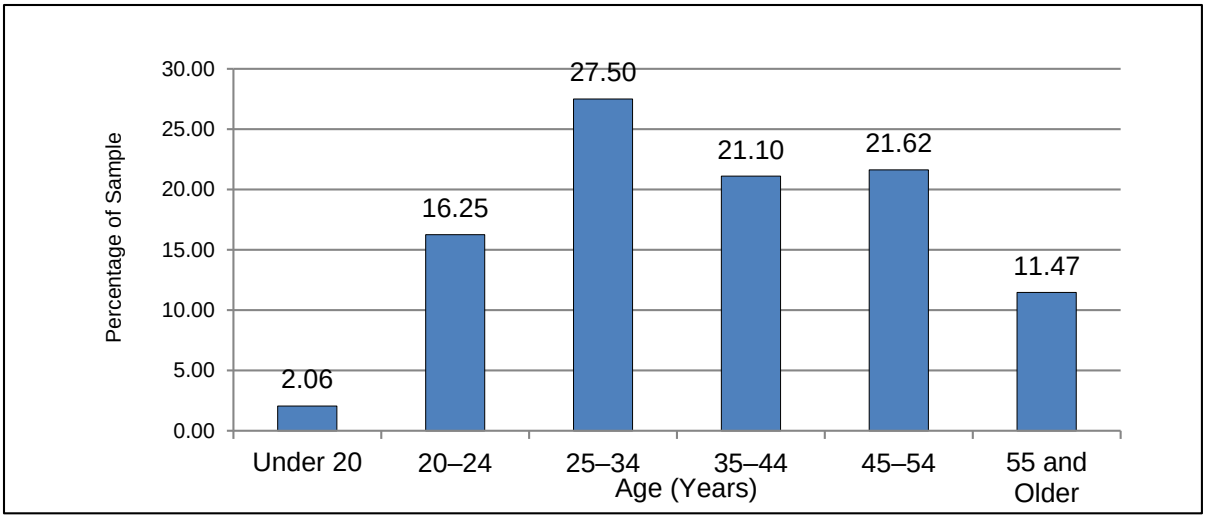
- a baseline survey administered with employees in-person in a group setting by a project representative, to capture socio-demographic and psychosocial characteristics;
- a Skills Snapshot administered in-person in a group setting by a certified TOWES instructor, to capture essential skills level; and
- a performance assessment, administered one-on-one with employees by a Canadian Tourism Human Resource Council (CTHRC)certified assessor.

A majority of the sample members are female (72.3 per cent), owing largely to the large number of housekeeping room attendants in the project, who are predominantly female. On average, sample members are about 38 years of age. Figure 2 indicates that two-thirds (67 per cent) of the sample is under 45 years of age, which is somewhat higher than the proportion for total employment, as per the Labour Force Survey (57 per cent[3]). Very few are under 20 years of age.

3 http://www5.statcan.gc.ca/cansim/a05?searchTypeByValue=1&lang=eng&id=2820002&pattern=2820002

Most participants attained at least a high school diploma (84.6 per cent), and many reported also completing some form of post-secondary education certification. A college diploma was attained by 36.3 per cent of the sample, 28.9 per cent completed a trade or vocational certificate, 7.2 per cent have an apprenticeship diploma, and 17 per cent have a university degree.

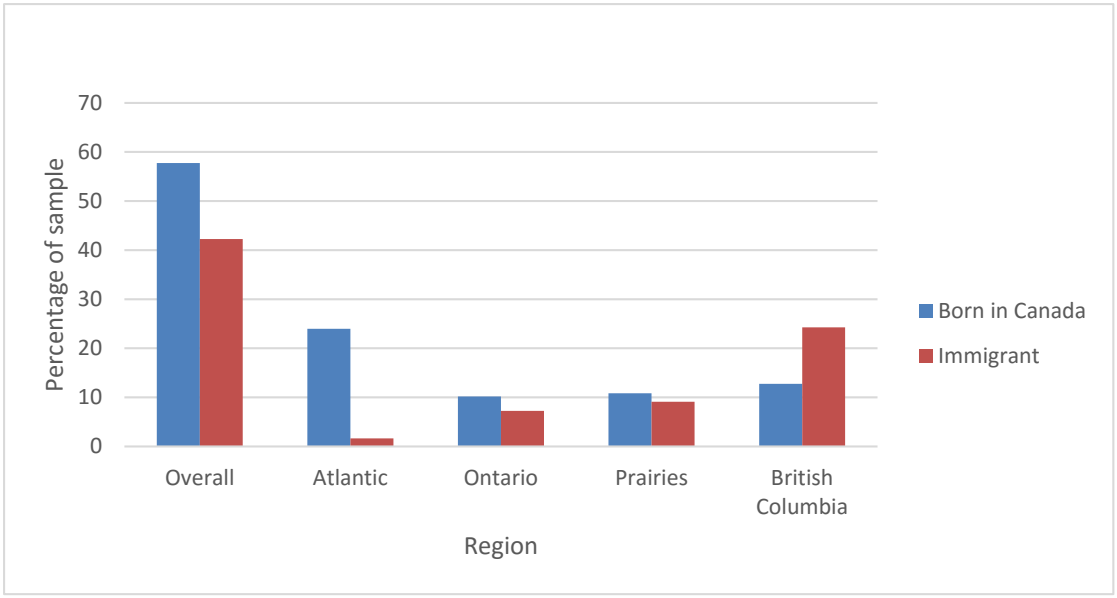
Figure 3 Age composition of UPSKILL trial participants – % distribution



Source: SRDC calculations using information from the UPSKILL Baseline Survey.

The research sample is made up of a large proportion of immigrants (42.3 per cent). Figure 3 indicates that in British Columbia, immigrants out-number non-immigrants by about 2 to 1 in the sample and represent by far the largest proportion of immigrants across the regions. The most prevalent home language — i.e., the language spoken most often at home — is English, which is spoken by 69.5 per cent of the sample. About one-fifth speak a language other than English or French at home. The remainder speak English or French in combination with another language.

Figure 4 Immigration status of UPSKILL trial participants – % distribution, by region



Source: SRDC calculations using information from the UPSKILL Baseline survey.

About half of the sample is living with a spouse or partner – 36.9 per cent are married and 13.8 per cent are living in common law relationships. 39 per cent identified as single, never married. The vast majority of sample members live in households composed of two or more persons. Only 17.8 per cent reported living alone, and about half (51.1 per cent) live in adult-only households.

The distribution of household income, before taxes and deductions, shows that about 22.5 per cent of sample members live in households with an annual income level of less than $20,000 23.3 per cent made between $20,000 and $30,000, and 20.7 per cent between $30,000-$40,000, and just over one-third made $40,000 or more. The majority of households have two or more people contributing to the household income. By contrast, the median household income in Canada in 2012 was $74, 540 (Statistics Canada, 2014a).

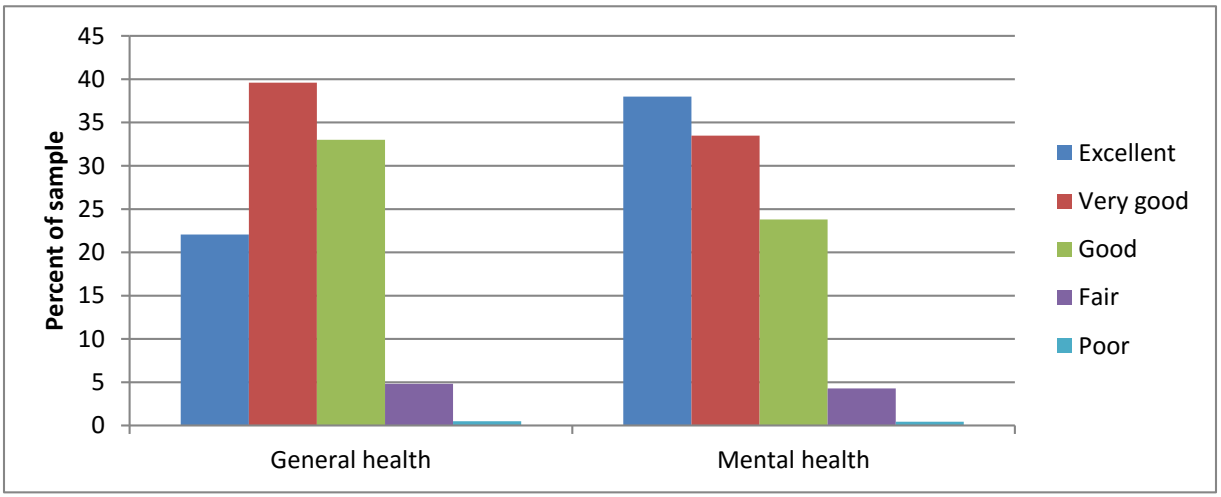
Most research participants (90 per cent) are longer-term, permanent employees who on average have worked 5.6 years at the hotel. The average number of hours worked per week is 37.2, which is slightly less than the average in the overall Canadian workforce (38.5[4]). This contrasts with the overall workforce at these hotels where a third of the employees work on a part-time basis. The average hourly wage after taxes and deductions for participants is $11.69.

[4] Source: Labour Force Survey: http://www5.statcan.gc.ca/access_acces/alternative_alternatif.action?l=eng&keng=2.341&kfra=2.341&teng=Download%20file%20from%20CANSIM&tfra=Fichier%20extrait%20de%20CANSIM&loc=http://www5.statcan.gc.ca/cansim/results/cansim-2820028-eng-5807786483156677156.csv

By occupation, the largest proportion of sample members (43 per cent) work as housekeeping room attendants in the accommodations industry. The next largest group is front desk agents (25 per cent), followed by food and beverage servers (21 per cent), and kitchen staff (11 per cent). This pattern holds for all regions.

In general, the self-reported baseline health and mental health (as measured by two items on the SF-12[5]) of participants is quite good — few reported being in poor health. As shown in Figure 2.5, an overwhelming majority of the sample reported good, very good or excellent general health (about 95 per cent), and good, very good or excellent mental health (also about 95 per cent). This is not surprising, since high proportions of the general population tend to report very good or excellent health (59.4 per cent in 2013; Statistics Canada, 2014b) and mental health (71.1 per cent; Statistics Canada, 2014c), and working populations tend to have even better health status than the general population (for example, see Last, 1995 regarding the 'Healthy Worker Effect'). As well, when UPSKILL participants were asked about absenteeism due to health-related issues, they reported on average about three days or fewer missed at work due to emotional or physical illness in the four weeks prior to the survey.

Figure 5 Health and mental health status of UPSKILL trial participants – % distribution



Source: SRDC calculations using information from the UPSKILL Baseline Survey.

Sub-group analyses

The UPSKILL trial intervention was aimed at helping vulnerable workers to gain essential skills in order to reduce inequalities in accessing opportunities and to increase job performance. UPSKILL

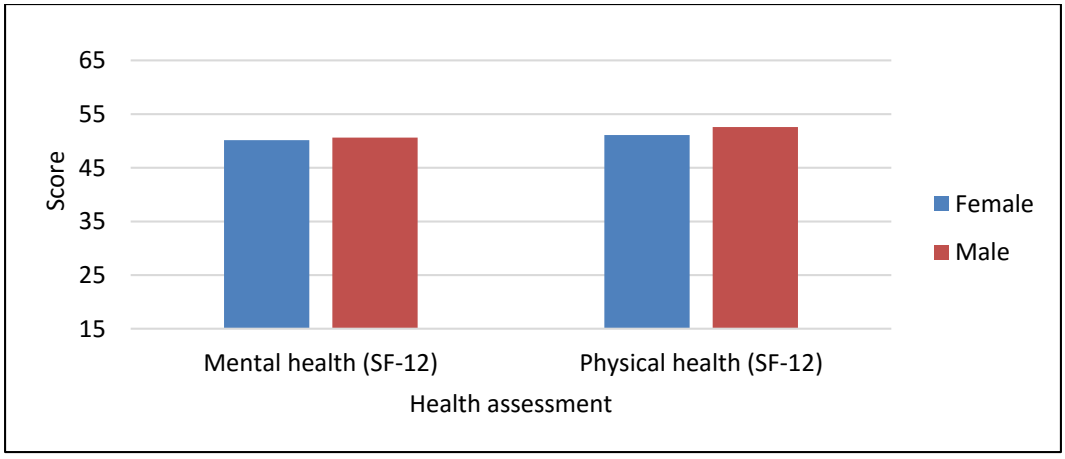
[5] The SF-12 is the measure used in the UPSKILL trial to assess health and mental health. A definition of the measure is presented in Appendix B.

Health is concerned not only about the impact of essential skills on health, but also reducing health inequalities through learning and skills acquisition. Differences in mental health and physical health (as assessed by the SF-12 scale and using composite scores) and health literacy[6] at baseline were examined in order to measure their amplitude. Gender and immigration status were the two variables retained for analysis at this stage because as key social determinants of health, these are two potential program moderators. Also, we theorized that health literacy might be largely determined by the first language learned or spoken at home, which might differ according to immigration status. However, in other stages of the analysis, other sub-group analyses will be conducted to identify for which groups workplace essential skills interventions should have more impacts on health and job performance.

Gender

There were no differences between men and women at baseline regarding mental health, physical health or health literacy. Figure 5 shows the distribution of scores for the two components (Mental Health Component Score (MCS) and Physical health Component Score (PSC)). We observe that health scores (using the SF-12) corroborate the previous results on self-assessed health. Scores on both components are high for men (MCS=50.62, PCS= 52.59) and women (MCS=50.16, PCS= 50.63). Health literacy scores for both groups were high also (men=20.78 and women=20.53 on possible score of 25).

Figure 6 Mental and physical health assessments (SF-12), by gender



Source: SRDC calculations using information from the UPSKILL Baseline Survey.

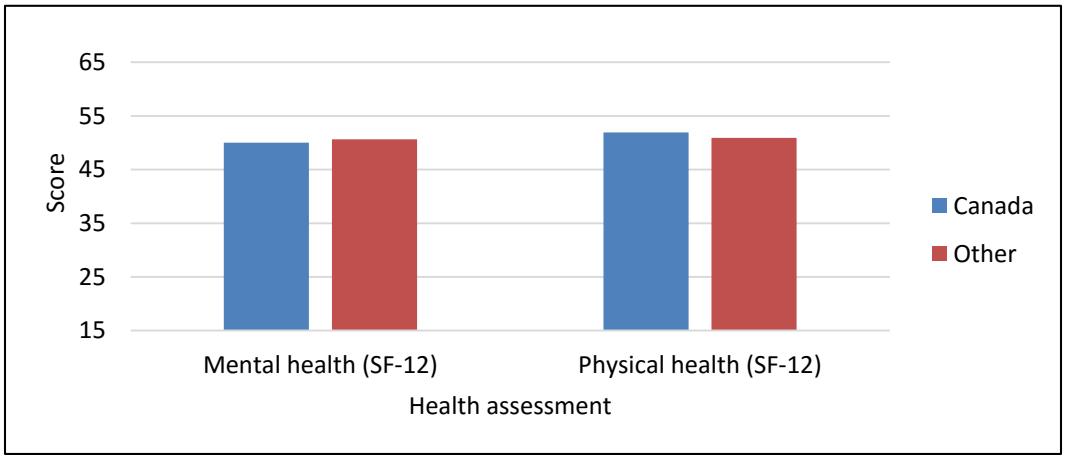
Immigration Status

Aside from the MCS score where no differences between groups are observed, there was a small, but significant difference of almost two points on the PCS score between participants who were born in Canada as opposed to another country. The same result can be found for health literacy: a difference of

6 This is a scale created by SRDC and is presented in Appendix B.

almost one point (0.93) on the health literacy scale is observed (Canada=20.96 vs. other=20.03), and this difference is highly significant (p <.0001). Since about one-fifth of the sample speaks a language other than English or French at home, this last result is expected, due to the fact that language skills are foundational to health literacy.

Figure 7 Mental and physical health assessments (SF-12), by immigration status



Source: SRDC calculations using information from the UPSKILL Baseline Survey.

3. Literature review

To address the research objectives of this project and flesh out its research framework and analytical plan, a comprehensive review of two broad areas of the research literature was conducted. These consisted of (1) the adult learning literature, particularly that which focuses on workplace literacy training in relation to health and safety; and (2) the healthy workplace literature, which focuses on the factors contributing to worker health and the role of worker health in job and organizational performance.

3.1 Learning and health

For this part of the review, we turned to sources focused on the effects of learning and on the role of learning in occupational health and literacy. Specifically, we consulted the Centre for Research on the Wider Benefits of Learning, the Agency for Healthcare Research and Quality, the Health Literacy Portal of the Canadian Public Health Association, the Health Literacy page of the PHAC website, the Health Literacy Special Collection of World Education, Canadian organizations promoting literacy, and the Conference Board of Canada.

Education is commonly acknowledged to be a powerful social determinant of health (e.g., the World Health Organization, 2003; the Public Health Agency of Canada, 2009, 1999). PHAC's 1999 review of the research found that Canadians with higher levels of education have better access to healthy physical environments, exhibit healthier behaviours (smoke less, more physically active, consume healthier foods) and have greater self-reported health status. In their comprehensive evidence review, Feinstein, Sabates, Anderson, Sorhaindo, and Hammond (2006) found that education is strongly linked to health and to other determinants of health such as health behaviours, risky contexts, and preventative service use; in many cases education was shown to be the source of changes in the determinants.

Further trying to untangle the nature of the relationship, Feinstein et al.'s (2006) review found evidence of the mechanisms by which education affects health: economic factors such as higher earnings and access to healthcare; healthy behaviours owing to increased self-efficacy and resilience, enabling one to cope more effectively with stress; and intermediate social capital outcomes such as increased sense of community, social interaction and trust. Wolfe and Haverman (2001) found that, in addition to education being positively associated with health, it was negatively associated with incidence of mental illness, possibly due to increased skills in obtaining and understanding health-related information.

UPSKILL Health looks specifically at one type of education – workplace literacy training – and explores how the mechanisms by which it can influence health. Moreover, this study also aims to determine to what extent people who are motivated to participate in workplace training are already more likely to have positive health trajectories, and why, and to what degree, taking courses actually contributes to this process.

We begin with a review of studies examining the link between health and adult education/learning in general, with few focused specifically on the workplace. We then explore one type of learning and its

effects on health, namely workplace literacy training, such as that delivered in the UPSKILL trial. We have identified health mediators and outcomes in bold for ease of identification.

Adult learning and health

There are a number of examples of research linking adult learning and health, much of which conducted by the UK's Centre for Research on the Wider Benefits of Learning (http://www.ioe.ac.uk). For example, Feinstein (2002) found that increasing one's vocational and academic qualifications through adult education had positive mental health benefits; specifically, it significantly reduced the risk of depression. Studies of learners in community-based education with a history of mental health difficulties also reported that participation in learning had positive effects upon mental health (McGivney, 1997). However, Feinstein et al. (2003) did not find evidence that participation in adult learning protects against the onset or progression of depression; in some cases it may even have triggered or reinforced it.

In many cases, the impacts of adult learning on health are theorized to have occurred, implicitly or explicitly, via changes in **health behaviours**. Feinstein and Hammond (2004) used the UK National Child Development Study data to investigate the relationship between participation in adult learning and health/wellbeing. They used six measures of physical and mental health, and both behaviours and outcomes: smoking, drinking, exercise, life satisfaction, entering depression, and leaving depression. They also examined six measures of social cohesion: racial tolerance, political cynicism, support for authority, political interest, number of group memberships, and voting. The authors found that participating in adult learning was associated with improved outcomes for 9 of the 12 health and cohesion indicators.

Participation in adult learning was found by Feinstein, Hammond, Woods, Preston, and Bynner (2003) to contribute positively towards giving up smoking and exercising more, leading to improvements in health outcomes such as general wellbeing. Sabates and Feinstein (2004) associated adult learning with the uptake of cervical screening. De Coulon, Meschi, and Yates (2010) showed that basic skills and education significantly affect the probability of being a heavy/binge drinker, a smoker and obese, while controlling for personal characteristics such as sex, living with a partner, socio-economic background (i.e., type of occupations; whether full-time employed; availability of newspapers and magazines at home), and measures of life satisfaction. Interestingly, general education was found to be a good proxy for the actual basic skills acquired by individuals; the measure of basic skills did not capture health-improving skills beyond the ones measured by education levels.

Another way in which learning has been thought to affect health is via improved **health literacy** leading to changes in health behaviours. Zarcadoolas, Pleasant, and Greer (2006) define health literacy as the ability to understand, evaluate, and act on health information in spoken, written, and visual formats. Baker (2006) and Campbell (2010) contend that high levels of health literacy lead to healthy behaviours and good physical health via two main channels: (1) reading/document use – strengthened ability to interpret and apply workplace health and safety regulations; and (2) greater awareness of and advocacy for workplace safety rights and/or communication with health and safety officials. Outside the workplace, literacy training could enable individuals to better read and comprehend instructions for taking medicine, to understand the inclusions and exclusions of a health plan, and to

decide on a course of action when public health warnings and emergency bulletins are issued (Zarcadoolas et al., 2006).

There is considerable evidence of health literacy being associated with better health outcomes. For example, an Agency for Healthcare Research and Quality (AHRQ) systematic literature review of studies of literacy and health by Berkman, Dewalt, Pignone, Sheridan, Lohr, Lux, Sutton, Swinson, and Bonito (2004) found a statistically significant association between higher literacy level and knowledge of matters relating to health services use and physical health issues; no definitive relationship could be found with depression, however. In a review of three Canadian random control trials involving literacy training focused on health, Rootman and Ronson (2005) found that the training positively affected health indicators. Lefebvre et al. (2006) reported that the 26 adult literacy learners they interviewed reported, among other benefits of literacy training, health literacy outcomes such as a better understanding of health issues and more effective interactions with the health system as well as healthier lifestyle choices and health benefits such as feeling less stressed.

More recently, an updated AHRQ systematic review of health literacy interventions and outcomes found that lower health literacy levels, as indicated by poor ability to interpret labels and health messages, were consistently associated with negative health behaviours such as lower use of mammography, lower receipt of influenza vaccine, and poorer ability to demonstrate taking medications appropriately. Lower heath literacy was also associated with, sub-optimal health outcomes such as, increased hospitalizations, greater emergency care use, and poorer overall health status including mortality (among seniors).

Researchers have theorized that health outcomes can be associated with **psychological factors** such self-esteem and resilience, but the link to adult learning in particular has not been empirically demonstrated. For example, Hammond (2003) posited that learning influences health through intermediate psychological outcomes such as self-efficacy and self-esteem, which inspire one to better look after one's health, and resilience, which enables one to better cope with stress. She views these effects as being influenced by economic factors such as higher earnings and occupational status that in turn, enable better access to health care services and greater knowledge and understanding of the causes of ailments and their treatment. Vaishnavia, Connor, and Davidson (2007) share Hammond's view on resilience. In demonstrating the validity of their resilience scale (which was employed in the UPSKILL project) they theorized that individuals who are more resilient may experience lower levels of chronic stress in response to a given stressor or life event. They reasoned this would incline such individuals to adopt healthier practices to effectively cope with stressors, in contrast to those who rely on nicotine, alcohol, drugs or other unhealthy coping behaviours. Again, however, much of this is conjecture. In fact, we found no empirical evidence of the psychological factors linking adult learning to health outcomes – a gap the current project aims to address.

Social capital, which includes such concepts as trust and participation, has also been linked to improved health as an intermediary variable. A comprehensive literature review of adult learning uncovered a number of pieces of research that identified social capital effects of adult learning (Centre for Literacy of Quebec, 2010). The research established links between participation in adult learning/literacy programs and social capital in behavioural terms — increased social activity and social networking (Tett & Maclachlan, 2007; Raferty, 2002; Preston & Hammond, 2002).

For example, Balatti, Black, and Falk (2006) found that adult learning positively affected attachments to social networks, which had positive effects on employment and social environments as well as on quality of work life, an indicator of worker health. Two studies have found that adult learners became better parents, and by engaging more with their children, becoming involved in their education at home and in the community, and serving as role model learners, they actively nurtured their children's literacy behaviours and educational achievement, contributing to greater general wellbeing (Brassett-Grundy, 2004; and Macdonald Scollay, 2009).

Workplace literacy training and health

There has been a fair amount of empirical work demonstrating the link between workplace literacy skills and health. For example, Long (1997) conducted a survey of Canadian workplaces with basic skills training programs for ABC Canada Literacy Foundation (now called ABC Life Literacy Canada), completing interviews with 86 representatives of 53 workplaces. The results of the survey indicated that 82 per cent of respondents attributed improved health and safety to the basic skills training: large proportions also thought the training had improved essentials skills (reading, writing, oral communication, problem-solving, and teamwork), reduced errors, and increased productivity and retention.

The Conference Board of Canada also probed the link between literacy skills and health literacy and health in the workplace. Representing that organization, Bloom et al. (1997) surveyed 40 employers and asked respondents to identify the benefits of literacy skills from a list. About a third of the 20 employers who answered this question identified a better health and safety record for their organization as a key benefit (other concrete organizational benefits identified included reducing the amount of time required to complete tasks and process information, reducing the number of errors in completed jobs, and increasing product quality). Employers indicated that employees with higher literacy skills followed instructions more closely and were easier to train, and were more likely to understand, accept and conform to health and safety directives in the workplace and their implications. At the same time, these employees were seen to have a greater ability to process information, be more confident in their ability to communicate, and be more likely to question new or existing procedures, leading to the development of better health and safety practices.

Perrin (1998) also identified intermediate health literacy and psychosocial outcomes of training in the workplace. His findings were based on a review of health data and empirical research, analysis of data collected in a survey of health and literacy organizations, and case studies. Regarding literacy, Perrin found that workers with limited literacy skills have a higher than average incidence of occupational injuries, for a number reasons. First, these workers typically occupy jobs in the primary resource and construction industries where the risk of physical injury tends to be higher. Second, since much occupational health and safety information is in written form, workers with low levels of reading and document use skills are less likely to understand this information and be aware of dangers in the workplace. Third, workers with low literacy skills are less likely to be aware of and/or assert their rights under health and safety legislation and thus continue to work in unsafe work environments.

Regarding psychosocial mediators, Perrin (1998) further noted that workers with low levels of LES typically have limited self-confidence and feel vulnerable. He cites evidence from an Ontario Public

Health Association research study (Perrin, 1990) indicating that, for low literacy workers, trying to cope with the literacy demands of the workplace and society causes stress, which is a major factor in mental health problems such as depression and anxiety. Moreover, many conditions associated with low literacy can be highly stressful, including under-employment, unemployment, poverty, coping with unsafe and insecure working and living conditions, and dealing with uncertainly and lack of control over one's work life. As well, people with low levels of LES typically lack social and financial resources to help them cope with stressful situations.

In terms of occupational health and safety, Kuji-Shikatani and Zori (2007) conducted a review of the literature on LES training in small and medium-sized businesses. Among other positive outcomes of the training, they found fewer workplace accidents and lower absenteeism, suggesting improved health. More recently, a two-year project of Canadian Manufacturers and Exporters, called Creation of Essential Skills through Safety and Health (ESSH),[7] found that having essential skills embedded into Occupational Health and Safety training improved health and safety at 35 participating manufacturing and retail workplaces (ABC 2010).

A more recent Conference Board of Canada study (Campbell, 2010) also identified improved self-reported health and safety from literacy skills training, but support for this notion among employers was modest. Results from a national online survey (n=319, of whom 136 were employers and 126 were learners) indicated that 57 per cent of employers felt that workplace literacy skills development led to improved ability to use documents, specifically, safety instruction and assembly directions/map (the third most frequently observed skill gain from the training); 58 per cent said it affected health and safety practices (the third most frequently indicated performance factor affected by the training). However, employers were much more likely than other groups surveyed (employees and providers of services to immigrant and Aboriginal persons) to be confident in workers' understanding of health and safety policies (64 per cent) and less likely to feel literacy skills would improve health and literacy understanding (20 per cent).

Campbell (2010) concluded that the relatively low value that employers placed on literacy skills was disturbing in light of the high number of Workers' Compensation injury claims and the associated cost to employers in terms of lost time, recruitment efforts, and the apparent complexity of the health and safety manuals and procedures workers are asked to read and understand. The author suggests that if workers with low literacy or weak language skills were assisted in raising their skills through training, they would be better able to react to workplace situations in accordance with approved health and safety measures.

Most recently, the UPSKILL project (SRDC, forthcoming) identified a number of health outcomes of literacy and essential skills training delivered in 40 hotels to some 700 workers in total. Some of these findings included:

- **Bodily pain**: While there were no impacts on overall perceived physical health, program participants reported higher levels of bodily pain. This may relate to the increased incidence of employment (e.g., hours worked)observed among program participants and/or increased

[7] Funded by the Office of Literacy and Essential Skills (OLES).

awareness of their own physical health issues (related to improved health literacy) and willingness to report such issues;

- **Stress**: UPSKILL training has led to large reductions in perceived levels of stress on the job (which the literature has shown can lead to physical and mental ailments). Program group members were nearly 25 percentage points more likely than control group members to report stress reduction following the training;
- **Absenteeism/Presenteeism**: While there was a significant increase in absenteeism (a possible indicator of poor physical and mental health) among program group members compared to control group members, this was offset by a reduction in the incidence of presenteeism (working while unwell). Though the net impact on absenteeism was an average of 0.6 more work days missed among program group members, when days missed and days worked while unwell were combined, the difference between program and control group members (the impact estimate) was no longer significant; and
- **Well-being**: Overall well-being, an indicator of life satisfaction, showed a rising trend among program group members, and a falling one for control group members, with the difference between the two groups just failing to attain statistical significance.

UPSKILL also found a positive impact on a number of outcomes that, as suggested above, are likely *precursors* to improved health, and which will be explored as such in the UPSKILL Health and Mental Health Outcomes Study:

- **Psychosocial outcomes**: UPSKILL training was shown to have had a positive impact on a number of psychosocial outcomes such as self-efficacy, motivation, engagement, future orientation, trust and networks.
- **Health literacy**: UPSKILL led to higher levels of confidence utilizing health information. This was accompanied by an increased willingness to ask for help, along with higher levels of comfort with utilizing supports to understand and use health information when needed.
- **Health behaviours**: In terms of workplace performance outcomes, UPSKILL found improvements in health and safety were achieved through the application of safe working practices: after the UPSKILL training, participants were 12 percentage points more likely than the control group to surpass industry standards for working safely. The results also indicated that low-income earners profited more than high income earners in terms of gains of health and safety performance.

Canada is not alone in seeing the potential benefits of literacy training on health in the workplace. A case study of a workplace literacy program by the New Zealand Department of Labour (2006) found that training improved skills and worker motivation, which contributed to meeting more stringent health and safety regulations. The training also led to improved overall company performance in terms of increased sales and profit and fewer rejected products. Also, recent analysis by Mowatt (undated) of the effects of workplace literacy training in New Zealand showed that health and safety can be dramatically improved through incorporating literacy training into workplace practices. In addition, initial needs analyses conducted by Workbase at two New Zealand manufacturing companies found that that many staff did not understand the terminology used in health and safety procedures or how to

recognize hazards. When a literacy program was introduced, it led to a decline in lost time due to injuries by 69 per cent at one company, and 41 per cent at the other, as well as lower absenteeism and greater understanding of workplace safety.

Another study in New Zealand also identified the potential benefits of addressing a health literacy gap in workplaces through literacy training (Workbase 2013). Over three in five employees (63 per cent) surveyed in the total sample of 466 employees in 23 New Zealand companies had limited knowledge and understanding of their company's health and safety documents. Only 20 per cent of employees were able to accurately complete a hazard report form, a fifth were unable to complete it or provide all the vital information, and about a half were able to convey essential ideas but with some limitations, such as missing information and lack of detail. The primary conclusion drawn was that there was need for increased essential skills training.

Finally, in the United Kingdom, a case study of the implementation of workplace literacy, numeracy, and information technology skills training found the training led to improved health and safety, enhanced communication skills and career progression for employees. The rate of return on the training investment was 140 per cent (ROI Institute, 2007).

In summary, there has been much work exploring the role of literacy skills and training in health. While it has been established that there is a positive correlation between literacy and health, the mechanisms by which these influence each other have generally been theorized, not empirically established. For the most part, the beneficial effect of literacy training on health has been seen as operating through improved document use and reading skills, enabling better understanding of health information, leading to healthier behaviours and practices and ultimately, to improved health. Another way this is thought to occur is via greater communication skills that empower the individual to better interact with healthcare professionals and express their concerns and symptoms. There has also been some consideration of the role of psychosocial factors, whereby literacy training enhances resilience, confidence and social capital, which in turn are positively associated with health. However, these mechanisms have not been well demonstrated in the empirical literature. The goal of the analysis in this project is to address these knowledge gaps.

3.2 Factors contributing to worker health

This section reviews the literature on many factors contributing to worker health, including healthy workplaces and social determinants of health. Among the sources consulted for this review were the World Health Organization (WHO), the US National Institute for Occupational Safety and Health (NIOSH), the UK Centre for the Wider Benefits of Learning at the UK Institute of Education, the Canadian Centre for Occupational Safety and Health (CCOSH), the Cochrane Collaboration, the Institute for Work and Health, the Canadian Public Health Association (including the *Canadian Journal of Public Health*), the Public Health Agency of Canada, Statistics Canada (including *Perspectives* and *Health Reports*), the UK National Institute for Health and Care Excellence (NICE), and the US National Center for Biotechnology Information (PubMed.gov or Medline).

The results of this review are presented in three parts: first, overview pieces of the factors contributing worker health, then analytical studies of worker health determinants, and finally, those measuring and describing the effects of worker health on performance in the workplace.

Overview of factors contributing to worker health

Several organizations and groups have produced overview studies on the factors contributing to worker health, including NIOSH (1999), CCOSH (2012), Jackson (2009), Smith and Polanyi (2009), Burton (2010), Marchand and Durand (2011), and Marmot, Siegrist, and Theorell (2006). In general, there is consensus as to the factors affecting worker health as measured by a wide range of indicators.

A number of **workplace psychological factors** have been found to affect worker health, including high demand combined with lack of control/autonomy (job strain); high effort combined with low/unjust reward; too much work compared to hours available; work-family imbalance and work-family culture; poor job fit; authoritarian leadership; low involvement in decision making; job/employment insecurity; low psychological support; unclear expectations; lack of support for advancement and development; and lack of recognition and low wages. Note that many of these factors are based on the degree of alignment between two aspects of the workplace (demand and control, effort and reward, work and time available, family and work, skills and the job) and are modifiable through workplace policies and practices.

Additional psychological factors have been identified. For example psychological support includes employees feeling able to ask questions, seek feedback, report mistakes and problems, or propose a new idea without fearing negative consequences. Job fit speaks to the alignment between (1) employees' interpersonal and emotional competencies and their job skills and (2) the position held and work expectations and responsibilities (CCOSH, 2012). Marchand and Durand (2011) introduced a number of other psychological factors in the workplace relevant to worker health, including the presence of harassment/aggression, industrial relations climate, risk tolerance, organizational learning climate, and organizational changes.

Another type of factor affecting worker health, both physical and mental, is the **physical conditions of the workplace**. These include factors relating to ergonomics, air quality, sound, and vision. CCOSH (2012) also mentions exposure to toxins and trauma as factors affecting health while Feinstein, Sabates, Anderson, Sorhaindo, and Hammond (2006) find that a lack of control over hazardous workplace conditions can diminish workplace health and safety. In this regard, Marchand and Duran (2011) have identified that occupational health and safety structures and resources play a role in workers' physical health. Work pace/intensity (Mikkonen and Raphael, 2010), workload (NIOSH, 1999 and CCOSH, 2012), and work scheduling (Marchand and Durand, 2011) are additional factors of importance, some of which overlap with demand-effort imbalance.

There is also a set of **workplace social capital** factors that can affect worker health. Chief among these is the availability of social supports from colleagues and managers. CCOSH (2012) also mentions social factors (some of which might overlap with psychological factors), including: civility and respect (positive interactions with co-workers, managers, and clients); social engagement/inclusiveness (feeling connected to work); and organizational culture (trust, honesty, and fairness).

Finally, **individual, workplace, and external factors** are identified in the literature as affecting/moderating worker health. Relevant individual factors include gender, lifecycle status, education and skills level, and psychological traits in regard to self-efficacy and resilience as well as coping skills. Individual factors directly related to health include lifestyle and health behaviours (e.g.,

smoking, exercise, substance use) and past and current mental conditions. External individual factors include socioeconomic status (household income), marital and parental role strain, and the availability of advice or social support, financial assistance and childcare. For example, NIOSH (1999) states that individual and situational factors can strengthen or weaken the influence of workplace psychological factors in worker health, while CCOSH (2012) indicates that health behaviours and personal and life circumstances influence health. As for workplace factors generally agreed upon as affecting worker health, these include occupation, unionization, firm size, economic sector as well as market instability, as suggested by Marchand and Durand (2011).

A wide range of **health outcome** measures have been utilized in the above studies to capture worker health. On the physical side, these include hearing loss, lung disorders, back strain and musculoskeletal disorders, accidents and injuries. Mental health outcomes include mental distress and stress, demoralization, anxiety, burnout, job dissatisfaction, low morale, and depression. **Stress** itself has been shown to be a kind of intermediary or precursor, leading to a number of negative health outcomes. Indeed, stress is one of the most prevalent sources of work and occupational health risk (Feinstein, Sabates, Anderson, Sorhaindo, and Hammond, 2006), and is linked to workplace safety indirectly via unhealthy behaviours and poor mental health, leading to errors in judgment, reduced eye-hand coordination, and compromised physical states (Health Canada, 2000). In another overview piece, Mikkonen and Raphael (2010) showed that stress can lead to bodily pain, sleep deprivation, a high risk of injury, high blood pressure, cardiovascular diseases, and depression and anxiety, among other health problems. Moreover, CCOSH (2012) notes that job stress can lead to demoralization, depressed mood, anxiety, and burnout as well as the likelihood of developing or worsening a mental disorder and suffering an injury on the job.

We include three other studies in this section for the additional information they bring to bear on the subject of worker health. A systematic review of studies of **flexible work arrangements** by Joyce, Pabayo, Critchley, and Bamara (2010) confirmed that demanding jobs with little decision-making authority (high-demand, low-control) are stressful, which in turn can increase a person's risk of heart disease or mental health disorders, as well as work absence due to sickness. However, the review found that flexible working **interventions that increase worker control and choice** (such as self-scheduling or gradual/partial retirement) are likely to have a positive effect on health outcomes.

In contrast, interventions that were motivated or **dictated by organisational interests**, such as fixed-term contracts and involuntary part-time employment, had equivocal or negative health effects. The authors found that few studies conducted subgroup analyses (by occupation or socio-economic groups, for example), suggesting a need for future research to determine how flexible working conditions may affect health inequalities for specific sub-groups.[8]

Perceived Quality of Working Life (QWL) is considered to be a proxy for worker health (e.g., de Lange, Taris, Kompier, Houtman, and Bongers, 2005), and therefore a useful measurement tool. Work design theories have been influential with regard to conceptualizing? QWL. For example, the motivation-hygiene theory, also known as two-factor theory, encompasses: (1) the primary **intrinsic determinants** of workplace gratification such as motivators that are inherent to an individual's work

[8] This will be addressed in the UPSKILL Health and Mental Health Outcomes Study.

(e.g., recognition, responsibility), the presence of which produces positive job satisfaction; combined with (2) the **extrinsic determinants** of workplace health such as company policies, supervisory practices, salaries and job security, the absence of which results in dissatisfaction (Herzberg, 1966). Hackman and Oldman's (1976) theory of job design focused more on specific job structures believed to augment an individual's intrinsic motivation to work, perceived job satisfaction and work place functioning (e.g., skill variety).

Finally, the role of **social capital**, i.e., trust and social engagement and inclusion, has attracted less research attention than psychological factors in terms of workers' health, apart from some studies considering the attenuating effects of social support from colleagues on demand-control imbalance. A useful overview of social capital effects was recently conducted by Murayama, Fujiwara, and Kawachi (2012), who reviewed longitudinal and cohort studies considering the direct contextual association between social capital and health, including healthy behaviours, depression, and self-rated health. They found that both individual social capital and workplace social capital had positive effects on health outcomes, regardless of type of health outcome, including healthy behaviours, depression, and self-rated health.

Individual studies of factors contributing to worker health

In this section, our attention turns to smaller analytical studies. To a large extent, they confirm the variables affecting worker health as identified above. Note that the factors contributing to worker health are similarly bolded in these sections, for ease of identification and completion of the research framework for this project.

A number of researchers in Canada have taken advantage of Statistics Canada's National Population Health Survey to explore the role played by various work and non-work factors in worker health. For example:

- Wilkins and Beaudet (1998) found that job strain, caused by **imbalance between demands and control,** was associated with migraine and psychological distress among men, and with work injury among women. **Job insecurity** was associated with migraines among women. **High physical demands** were related to work injury in both sexes. **Low co-worker support** was linked to migraines among men, and to work injury and psychological distress among women.
- Cole et al. (2002) applied structural equations to the NPHS data and determined that work stressors (**high psychological demands, low decision latitude, low work social support** and **job insecurity**) had consistently positive total effects on psychological distress across gender-occupation strata, with all of these effects being mediated through **reduced self-esteem** and **mastery**. However, **life stressors** (chronic stressors and recent life events) had larger positive total effects on psychological distress; the majority of these were determined to be direct effects.
- Marchand, Demers, and Durand (2005) used the NPHS data to show that an individual's occupation plays a limited role in psychological distress when the structures of daily life and personal characteristics are accounted for. In the workplace, **job insecurity** and **lack of social supports** significantly increased the risk of psychological distress, but **greater decision authority** also

increased it. Workplace effects, however, were not moderated either by family factors or by the individual's demographic, health, psychological traits.

- Smith, Mustard, and Bondy (2008) used path analysis to show that **low job control**, **high environmental stress** and **low household income** have a cumulative effect on both physical activity and health status, even accounting for personal stress levels.
- Marchand and Blanc (2010) showed that occupation did not play a significant role in psychological distress at work, whereas the presence of **social support at work** decreased the risk. Substantial effects for non-work and individual factors were found, including **neighborhood, social support outside the workplace, demographics, physical health, personality traits,** and **life habits**.
- Smith and Bilecky (2012) found that, over a two-year period, changes in **psychological demands** of the job had a stronger influence on the onset of depression than changes in job control, controlling for age, gender, marital status, presence of children, level of education, and physical and mental health status.

Other researchers in Canada have exploited other datasets to explore the role of workplace factors on worker health. For example, Smith, Mustard, Lu, and Glazier (2013) used data from Statistics Canada's Canadian Community Health Survey linked to the Ontario Health Information Plan and Canadian Institute for Health Information databases to show that **low job control** was associated with an increased risk of hypertension among men, but not among women, with healthy behaviours not playing much of a role. Marshall and Tompa (2011) analyzed the Survey of Labour Income Dynamics data to demonstrate that those doing part-time or contract work did not report poorer health in subsequent years, while those in **precarious forms of employment** (characterized by irregular schedule, substantial unpaid overtime, no union coverage, low earnings, no annual pay increase, no pension coverage, no supervisory responsibilities, manual work) reported poorer general health or functional limitations in subsequent years.

Franche, Williams, Ibrahim, Grace, Mustard, Minore, and Steward (2006) analysed data gathered from female health care providers in Ontario and associated the presence of clinical depression with **high worker effort with low reward**; a high level of **negative spillover from work to family**; and **having children under the age of 18** at home. Low **support from work** also played a role as did **low education**. The conclusions were that the association between working conditions and depression is mediated by increased negative work-to-family spillover, and the impact of having young children is mediated by decreased positive family-to-work spillover.

Finally, Gilbert-Ouimet, Brisson, Vézina, Trudel, Bourbonnais, Masse, et al. (2011) implemented and evaluated a workplace intervention to improve health among white collar workers in a single organization providing insurance services to the general population. The intervention involved multiple changes in the workplace that affected psychological demands, decision latitude and social supports, including: employee consultations, employee-manager meetings, promotion of career/skills development, and slower implementation of projects in order to reduce workload, and organizing of work teams to promote synergy.

The results of the Gilbert-Ouimet et al. (2011) study showed that that three psychosocial work factors significantly improved after the intervention: **psychological demands** (excessive workload,

difficult/fast work, etc.), **social support** (cooperation from supervisors and workers), and **reward** (income), as shown by respect and esteem. As well, the prevalence of low back or neck and shoulder symptoms and of high psychological distress both diminished, suggesting a link between health and psychological factors. Short-term beneficial effects observed at six months were maintained at 30 months for both health indicators, and they were intensified for psychological distress. These results suggest that interventions aimed at improving psychosocial work factors may lead to sizeable improvements in health indicators.

Outside Canada, there has been considerable work conducted on the subject of workplace factors and health. For the most part, these studies have come to the same conclusion as the Canadian studies and the overviews in the previous section regarding the negative influence on worker mental health of imbalance between demand and control, and between effort and reward.

In the UK, the results of analysis of the 2007 Adult Psychiatric Morbidity Survey data (Clark et al., 2012) indicated that **job stress** (as measured by **effort-reward or demand-control imbalances**) together with **lower levels of work social support** and **non-work stressors** (such as recent stressful life events, caring responsibilities, lower levels of non-work social support) were independently associated with common medical disorders such as anxiety and depression. Non-work stressors did not appear to make people more susceptible to work stressors, suggesting that addressing work stressors alone would help to reduce employees' stress.

In their prospective/longitudinal epidemiologic study of 386 workers in the US, Gerr, Fethke, Anton, Merlino, Rosecrance, Marcus, and Jones (2014) observed strong associations between psychosocial risk factors (**demand-control**) and work organizational factors (**weekly stress** and **job change**) on the one hand, and physical health as indicated by musculoskeletal outcomes on the other hand. Moreover, these associations were in the hypothesized direction; for example, high-demand/low-control and frequent job changes were associated with high incidence of poor musculoskeletal outcomes. This suggests that prevention of occupational musculoskeletal disorders may require attention to **psychosocial organizational factors** in addition to **physical** factors.

Finally, in an analysis of cross-sectional data in Norway, Torp, Grimsmo, Hagen, Duran, and Gudbersson (2013) found that, high **psychological job demands** combined with high **control** and **social support** correlated significantly with high **work engagement**, defined as being dedicated as absorbed and motivated in one's job. Conversely, high demands combined with low control and social support correlated significantly with high levels of depression. However, engagement can mediate the effects of control and social support on the level of depression. Encouraging enterprises to improve worker engagement in addition to focusing on preventing diseases may be worthwhile in workplace health promotion because engagement is contagious and closely related to good work performance.

Effects of worker health on performance

In this final section of the review, we present the results of research linking worker health to job performance, effectively making the business case for improving worker health. In some cases the connection to organizational performance is made as well. As noted earlier, this literature is sparser than that examining the factors contributing to worker health.

First, NIOSH's (1999) review of the research found that stressful working conditions were linked to increased absenteeism, tardiness, and intention to quit, all of which had a negative effect on the company's bottom line in terms reduced productivity and higher costs. In their review of studies of so-called healthy organizations – defined as those with low rates of illness, injury and disability in its workforce – these authors found that such companies tend to be competitive in the market place, suggesting that policies to enhance worker health could benefit the bottom line.

Lowe (2006) analysed the results of an EKOS survey of 2,000 workers in Canada and focused on worker stress and its causes and effects. He found that those working over 50 hours a week were considerably more likely to experience stress, and about half of respondents said stress had caused them physical and mental problems. As for the productivity effects, at least half of workers reported that stress had frequently or moderately led to lower quality of family life, lower quality of work, lower quantity of work, and a greater tendency to leave a workplace.

Park (2007) used data from the 2002 Canadian Community Health Survey (CCHS) and several cycles of the National Population Health Survey (NPHS) to show that various workplace stress factors had differing significant cross-sectional and longitudinal associations with job performance. For example, high job strain (demand-control imbalance) and active jobs (high demands and control) were associated with reduced work activities and taking disability days. Physically demanding work was related to absence from work in the past week and reduced activities two years later. Perceived job insecurity was associated with subsequent non-employment. Social support and positive coping mechanisms were found to be protective factors for workers, mitigating the influence of many work stress indicators on job performance. On the other hand, negative coping behaviours were likely to increase work impairments.

Gilmour and Patten (2007) also used CCHS and NPHS data to demonstrate an association among depression, work impairment and absences, and lost productivity. The analysis also revealed that the association of depression with work impairment persisted when taking into account the effects of workers' occupations, health conditions and sociodemographic characteristics. Still, being in white-collar occupations or having night/evening shift work schedules accentuated the link between depression and work impairment. On the other hand, coping by trying to "look on the bright side," and the availability of co-worker support buffered the impact of depression on job performance. There was also evidence that the effects of depression on job performance can be long lasting.

Burton (2010), in her review of the international literature and research on worker health for the World Health Organization, identified a number of outcomes of poor worker health at the enterprise or firm level. Economic costs related to poor physical health (as indicated by injuries on the job) included the time needed to write up the incident and investigate it, interruption to production, higher insurance costs, recruitment and training costs if replacement employees were needed, the lower quality and productivity of replacement workers, and reduced productivity due to absenteeism and presenteeism of injured workers. Poor mental health of workers – indicated by symptoms of depression, anxiety disorders and burnout – was also found to have costs to the enterprise, particularly in the form of lost productivity due to fatigue, difficulty concentrating and making decisions, lost interest in work, withdrawal from colleagues, difficulty managing daily tasks, and difficulty coming to work, all of which contribute to poor job performance.

CCOSH (2012) similarly identified the outcomes of a mentally unhealthy workplace as increased conflict and strain, headaches, burnout and anxiety and a higher incidence of accidents, errors, incidents, injuries, and absenteeism/presenteeism, all of which led to increased withdrawal behaviours and turnover, reduced productivity and increased costs**.** Addressing psychosocial stressors, therefore, can lead to greater job commitment, attachment and retention, resulting in increased profitability, customer satisfaction, task performance, morale and motivation.

Burton (2010) identified a number of costs of poor worker physical and mental health for the workplace in terms of lost productivity and higher costs for the employer. Burton cited evidence to indicate that mental health problems cost Canadian businesses $33 billion Canadian dollars per year in 2002, if non-clinical diagnoses were included such as burnout and subclinical depression (The Scientific Advisory Committee to The Global Business and Economic Roundtable on Addiction and Mental Health, 2002). More recently, the Mental Health Commission of Canada (2013) indicated that the potential impact of mental illness on productivity in the workplace in terms of absenteeism, presenteeism and exits amounted to about $6.4 billion in 2011. At the level of both society and community, Burton identified the potential outcomes (costs) of poor worker health in terms of poor family life, lower income and spending power, uncompetitive enterprises and lower economic prosperity, and lower social wellbeing and wealth.

The UK National Institute for Health and Clinical Excellence (NICE) (2009) produced estimates of the costs of mental ill health to UK employers and the costs saved by promoting good workplace mental health. NICE estimates that poor workplace mental health cost a UK employer with 1,000 employees £835,355 ($1.4M) in 2006 due to increased absenteeism, presenteeism, and turnover. In the same size workplace, improving the management of workplace mental health by means of prevention, early action to combat stress and early identification of problems could decrease losses to productivity by up to 30 per cent and result in annual savings of £250,607 ($397,713). NICE also mentions the potential benefits of improved mental health for the employer in the form of increased productivity, potentially enhanced reputation of the organization and increased morale. According to NICE, increased worker health can also result in benefits at the societal level due to improved wellbeing and reduced health inequalities (owing to income and unemployment).

3.3 Conclusions from the literature review

Three main conclusions can be drawn from this review. First, while there has been a fair amount of research into the effects of literacy training on worker health, the evidence is more limited as to the mechanisms by which this occurs. Specifically, it is not well understood how training influences health – is it by increasing workers' health literacy and/or their psychosocial capital (confidence, resilience, social resources), which in turn leads to healthier behaviours? What is the role played by personal and workplace factors in this relationship? These are questions the UPSKILL Health will attempt to address.

Second, psychosocial factors related particularly to demand, control and reward/recognition, social supports, and the interplay among these play a significant role in workers' mental and physical health. The link between these psychosocial workplace factors and worker health is sometimes shown to operate through the intermediary variable of job stress, and to be compounded by other workplace and employment characteristics (e.g., firm size, clarity of goals, job security), workers' sociodemographic

and lifecycle traits (such as having young children, and household income) and psychosocial traits (such as resilience, motivation, motivation, trust and strong social networks). There has been general consensus on these factors in the literature, in some instances based on Canadian data. However in only a few cases were the factors *comprehensively* included and analysed, as they will be in this project.

Though individual socioeconomic, lifecycle and employment factors are often introduced into the analyses as control or moderating variables, they are rarely the primary focus of the analyses, nor are differential results by sub-groups presented. In the UPSKILL Health and Mental Outcomes Study, the issue of health inequities for specific sub-groups will be thoroughly explored.

Finally, there has been less done in previous research with respect to the contribution of worker health to job and organizational performance, which if demonstrated in a more robust manner, could make the business case for intervening to improve worker health. Associating job and workplace performance with worker health will be carried out in the UPSKILL Health Study to produce considerable evidence on the economic importance of enhancing worker health.

With the UPSKILL trial dataset, we have most of the variables that have been considered in the literature as contributors to worker health, most of the measures used to measure worker health outcomes, plus comprehensive measures of job and organizational performance. These all will be presented in the methodological description in the next sections.

4. Developing and testing a conceptual model of worker and workplace health

4.1 UPSKILL Health conceptual model

The literature review indicates that various individual and workplace factors can *directly* affect a worker's physical and mental health. Moreover, it suggests that interventions such as LES training have the potential to affect health *indirectly* through various factors, such as LES skills, health literacy, and psychosocial capital. As a result, LES training – together with various mediating factors and worker's health – may affect job and firm performance.

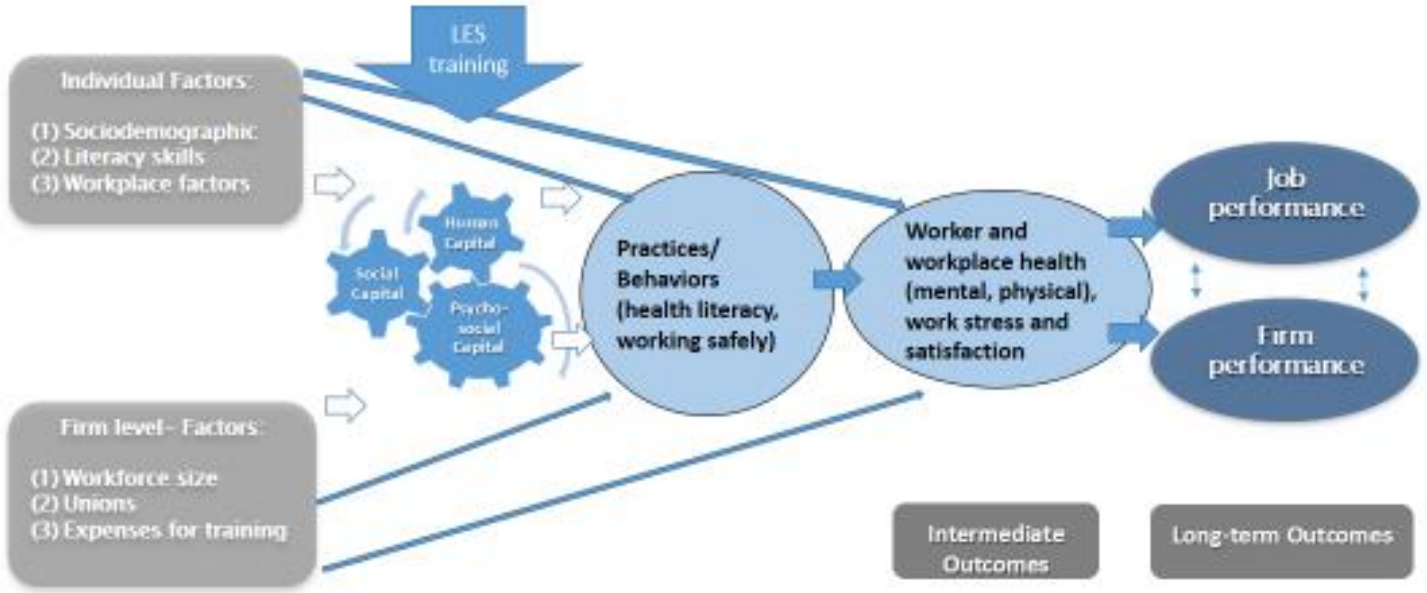
The UPSKILL Health study represents a practical and rigorous approach to identifying the role played by LES and other factors in the health of workers and of the workplace. The first step was to develop a conceptual model of literacy and essential skills, physical and mental health, and job performance, in order to guide the subsequent research and analysis for this project.

The far left hand side of the model includes various worker and workplace factors identified in the research literature as affecting worker health. These health determinants comprise the various baseline sociodemographic, lifecycle, human capital (including LES), psychosocial, contextual and employment characteristics of the individual, along with characteristics of the firm such as its size and working conditions, that could potentially affect workers' mental and physical health.

The middle part of the model specifies the main channels by which changes in workplace health and workplace mental health are thought to occur, particularly through the influence of health literacy and behaviours related to safety at work. The right hand side of the model illustrates how worker and workplace health can enhance job performance and the performance of the organization, that is, its business outcomes.

The model presents a high level summary of the types of variables to be included in the analysis. The LES training intervention (the arrow at the top of the diagram) is understood to achieve its impacts primarily by enhancing human capital (i.e., literacy and essential skills, including health literacy), but also by building psychological and social capital (confidence and trust, for example).

Figure 8 Conceptual Model of Literacy and Essential Skills, Health and Performance



4.2 Analytical strategy

The UPSKILL Health study will apply the conceptual model described above to UPSKILL trial data through an in-depth quantitative analysis of individual and workplace determinants of physical and mental health and related outcomes, and the role played by non-health related interventions – such as a workplace LES training program – in shaping these outcomes. In essence, the quantitative analysis is a series of path analyses. The rich information provided by UPSKILL trial participants at baseline supports analysis of the inter-relations among various health determinants and outcomes, based on cross-sectional correlation. Also, by taking advantage of the UPSKILL trial data on the LES intervention and the repeated measurements of the conditions, determinants, and outcomes before and after training delivery, we are hopeful the final analysis will identify the pathways by which health may be influenced.

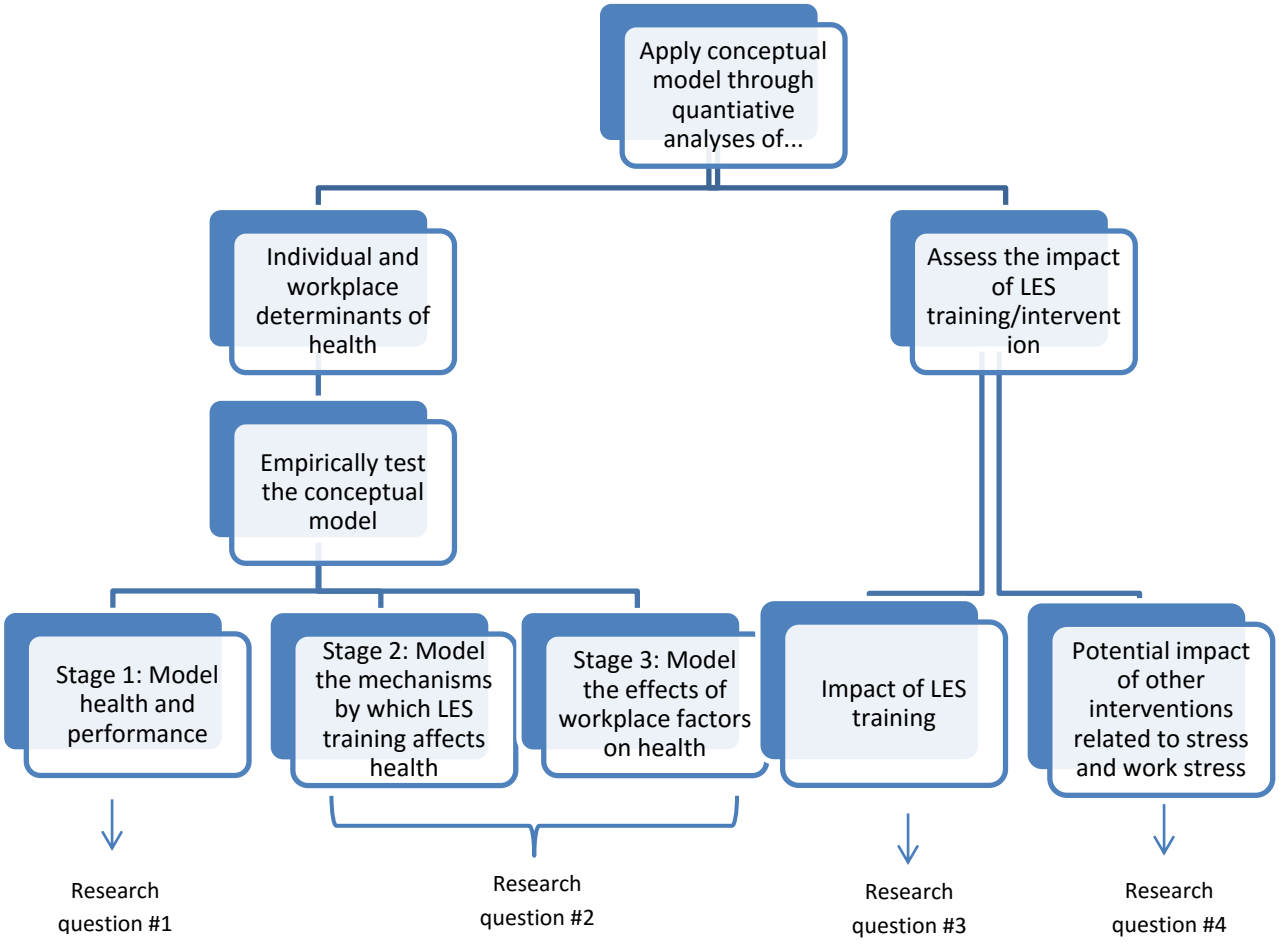
It is important to note that the analysis of worker and firm outcomes is longitudinal only in terms of the LES training intervention used in the UPSKILL trial, since the available data on conditions before and after are specific to this intervention. This permits us to observe the direct and indirect impacts of LES training, but we are unable to observe changes over time resulting from other hypothetical interventions targeted to particular aspects of the workplace. The association we aim to explore between hypothetical changes in workplace factors and health and performance outcomes is necessarily based only on cross-sectional data (at baseline).

After developing and empirically testing the conceptual model using UPSKILL trial data at baseline, we will apply the model to individual-level outcome data from UPSKILL, involving a broad range of variables and focusing particularly on outcomes experienced by participants. Where the data permit (as to sample size), we will consider effects for specific sub-groups by gender, age, income, LES level, immigrant status, etc. We will also focus on outcomes at the workplace level. To carry this out, we will use regression analyses to explore the determinants of physical and mental health, including health-related precursors. In addition, the study will analyze how workers' physical and mental health are related to business and performance outcomes.

Although this study will include a gender-based analysis – conducting quantitative analyses separately for men and women – our strategy is to use a combined sample to first investigate relationships among variables before conducting sub-group analysis by gender. This is primarily due to the small sample of men (27.7 per cent of all participants), which may not provide may not have sufficient statistical power to truly contrast differences between genders. Since no differences were found at baseline between men and women regarding mental health, physical health or health literacy, as presented in last section, using a combined sample may not introduce substantial error as a first exploration.

Figure 9 presents a diagram that sums up the analytical strategy and corresponding research questions for the UPSKILL Health study:

Figure 9 Analytical strategies of UPSKILL Health (quantitative data)



This first report looks at the three left boxes; in section 5, we present results of our efforts to model health and the mechanisms by which LES training and health literacy might improve it (results of modelling *performance* will be presented in a subsequent report). Finally, we explore some of the workplace factors that might influence health and mental health.

4.3 Research questions and variables

Below are more detailed versions of the research questions presented earlier, providing more specificity as to the variables identified in the literature which will be considered, and showing the presumed relationships between outcomes of interest and various other characteristics and factors. This section also expands on these research questions by specifying hypotheses about the variables that will be included in the models. Note that "f (x,x)" signifies "a function of" the variables contained in the brackets.

As reflected in the above diagram, analyses related to Research questions #1 and #2 will test the validity of the conceptual model developed for UPSKILL Health. Research questions #3 and #4 assess the impact of the LES training intervention on health and performance, and what this may tell us about the potential impacts of other workplace interventions.

Research question #1: What personal and business factors affect workers' physical and mental health, and how?

This question explores what baseline personal and business characteristics affect workers' health, including physical health, mental health, job stress, work-home satisfaction, overall well-being and workplace health and safety, as well as the contribution of these factors to worker health, and the pathways by which these effects occur.

Health = f (baseline worker and firm characteristics)

Worker health [as measured by mental health, work stress, perceived job satisfaction, overall wellbeing/life satisfaction, physical health (overall physical health, bodily pain, role physical and physical functioning, presenteeism and absenteeism), and working safely], is explained in terms of:

- worker sociodemographic and lifecycle characteristics (e.g., age, marital status, presence of young children at home, household income, immigration status);
- human capital traits including literacy skills (practice and confidence in using them), education level, education experience, attitudes to learning, health literacy level;
- psychosocial capital (self-efficacy, resilience, future orientation, trust, network density and size);
- employment conditions (hours, wages, benefits, temporary/permanent job, involvement, control);
- business characteristics (e.g., size of business, expenses on training per employee, and union rate).

The *mechanisms* by which literacy and essential skills training affect health include:

- health literacy: ability to read, understand and communicate health information and complete health forms;
- psychological capital: self-efficacy, motivation, resilience, control, confidence, future orientation;
- social capital: supports, networks, trust, participation.

Research question #2: What effect does physical and mental health have on job performance?

This question explores to what degree workers' health (physical health, mental health, job stress, and overall well-being) affects their job performance and business outcomes (e.g., occupational health and safety, overall firm performance), as well as how results vary by sociodemographic group.

Performance = f (health, baseline worker and firm characteristics)

Strong physical, mental health and workplace health of the individual (less stress, higher work satisfaction and overall quality of work life (QWL) are hypothesized to contribute to positive job and

organizational performance outcomes relating to productivity, absenteeism, errors, and costs. These analyses will control for personal sociodemographic, human capital, psychosocial and employment characteristics, as well as firm characteristics.

Research question #3: What is the impact of LES training on physical and mental health and job performance?:

This question explores the mechanisms by which non-health related intervention (such as literacy and essential skills training) affect workers' health and performance through improved health. Differential impacts for specific sub-groups related to sociodemographic variables (e.g., immigrants, women) will be assessed as well other possible moderators of the program for job performance (e.g. working conditions).

i) Health = f (LES training, baseline worker variables s)

LES training can lead to positive health outcomes via two pathways: (1) improved literacy including health literacy (being able to read and understand health information) and safe work practices (including working safely and emergency preparedness and ability to follow safety procedures), or (2) enhanced intermediate psychosocial outcomes such confidence, resilience, self-efficacy and networks (leading to greater mental health and life satisfaction, less stress), controlling for baseline characteristics.

ii) Job performance = f (LES training, health, baseline worker variables controls)

To the extent that LES training generates positive health outcomes, it may directly and indirectly contribute to positive job and organizational performance outcomes relating to productivity, errors, costs, injuries and retention.

Research question #4: How might other health-related workplace interventions influence physical and mental health and job performance?

Data permitting, this question explores the ways in which other types of health related interventions focused on workplace factors (such as reducing work stress or increasing job control or recognition) may potentially affect workers' health and performance through improved health.

i) Health = f (changes in worker variables)

Worker health can be improved by modifying workplace variables, such as reducing hours (less overtime), increasing hours (less part-time), providing more support for skills development, providing flexible hours for family, clarifying goals, etc.

ii) Performance = f (change in health, change in worker variables)

Performance may be improved by modifying workplace variables shown to affect health (indirect influence on performance through less stress and better mental health.

4.4 Data sources

Data sources for employee information include the UPSKILL trial baseline employee survey (n=1,438), the Test of Workplace Essential Skills (TOWES) instrument (n=1,438), and the job performance measurements by the *emerit* assessments of Canadian Tourism Human Resource Council (CTHRC) (n=984).[9]

The baseline survey asked questions about employees' employment, health, education and training, LES levels and literacy practices (i.e., frequency of activities of such as reading, writing, completing forms, making calculations, etc.), attitudes toward themselves and their work situations, as well as social networks and activities. The TOWES instrument used for this project assesses two dimensions of literacy: document use and numeracy. Essential skills such as Communication and Working with Others were measured by items on CTHRC's *emerit* assessments.

Even though all UPSKILL Trial participants responded to the employee survey at baseline and participated in a baseline TOWES assessment, individual missing items in both measures were unavoidable. As a result, the sample that can be used in analysis for any given variable is smaller than the baseline sample of 1,438.

For subsequent analyses, data sources will also include the follow-up employee survey (n=790), CTHRC's *emerit* assessments of job performance following the intervention (n=641), and the TOWES assessment at follow-up (n=796[10]). The response rate of the first job performance assessment was less than 60 per cent, while that of the second assessment was less than 40 per cent. If pre- post- changes of performances are used, the number of observations available would be less than 34 per cent of the overall sample. The smaller sample size at follow-up for workers' essential skills and other measurements in the employee performance measurements might impair the capacity to detect smaller effects of variables in upcoming analyses. However, SRDC will adopt different analytical strategies (see Discussion section) to mitigate against these challenges.

The UPSKILL trial also included pre-and post-training surveys and organizational needs analyses with employers. The above mentioned employee data are linked to these employer data based on anonymous employee identification codes. To ensure confidentiality, all personal/identifying information previously collected was removed from the analysis dataset prior to any secondary analyses being conducted for UPSKILL Health.

4.5 Empirical models

The complex effects and causal relationships between physical and mental health, personal and workplace factors, and performance call for multi-stage empirical analyses to identify the relative importance of various mediating and moderating factors on worker health, and the transmission mechanisms by which this is influenced by LES training. We are using a three-stage design to the analyses, each stage of which is described in more detail in Appendix C:

9 For the four occupations we focused on in this report however, the correct number is n=856.

10 A portion of the sample had two follow-up TOWES assessments.

- **Stage 1**: Identify the *effects* of worker and workplace characteristics on physical and mental health and performance;
- **Stage 2**: Explore the *mechanisms* by which LES training generates health and performance outcomes; and
- **Stage 3**: Examine *moderating* factors and sub-group differences.

This report focuses on the Stage 1 analysis; results from Stages 2 and 3 will be presented in future UPSKILL Health reports.

Stage 1: Effects of worker and workplace characteristics on mental and physical health

For the first stage, we applied a path analysis to individual-level outcome data from the UPSKILL trial (and some of the firm-level data), involving a broad range of variables and focusing particularly on mental and physical health, as well as health literacy. In keeping with the exploratory nature of this study, we first conducted measures of bivariate association (i.e., correlations) on all variables to understand the quality of UPSKILL measurements.

We then identified the most promising areas of investigation to create more precise estimates of different relationships within the conceptual model. Finally, we used regression analyses to explore the relationships among variables and their specific roles in the conceptual model.

From our preliminary data analysis (essentially, measures of bivariate association), many variables were found to have either weak correlations or none that were statistically significant. In some cases, the absence of correlations was expected due to a lack of prior theory. In other cases, the lack of significant correlation is likely due to an insufficient degree of variation in the UPSKILL sample data (e.g., ceiling effects, where most participants rated themselves highly) or to higher levels of missing data (measures at the end of the survey were not completed to the same extent as those at the beginning).

From this first stage of empirical testing, we identified three areas that we felt warranted further investigation, based on other research and the quality of the UPSKILL data. For each area, we considered the effects of these variables in terms of their mediating or moderating roles in the main relationships being examined:[11]

1) **Health literacy and its influence on mental health**: Does health literacy directly affect mental health, or does its effect pass through channels such as psychosocial variables (e.g., motivation and engagement, self-efficacy, attitudes to learning, resilience and self-esteem)? In other words, does health literacy have a direct effect on mental health or are there mediators in that relationship?
2) **The relative effects of different workplace characteristics and conditions on mental health**: What are the relative influences of workplace characteristics, work stress, and work satisfaction on

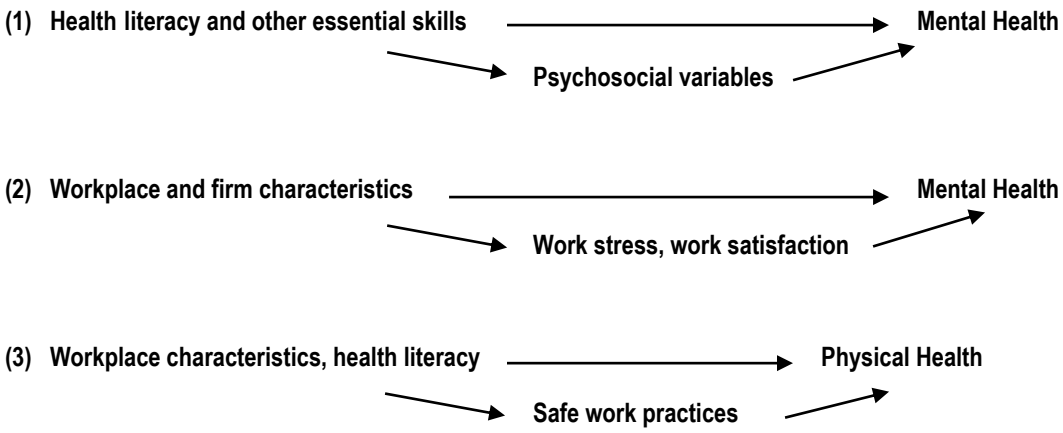
[11] A mediator variable specifies how or why a particular effect or relation occurs. A moderator variable affects the direction or the strength of the relation between a predictor and an outcome. Thus, a moderator variable indicates under what particular condition an effect can be expected.

mental health? To what extent do work stress and work satisfaction act as mediators in the relationship between workplace characteristics and mental health?

3) **The links among essential skills, healthy working practices and physical health**: The UPSKILL trial showed that LES training improved job performance in terms of working safely – participants were about 12 percentage points more likely to surpass industry standards after training compared to the control group. Given this, do numeracy/literacy/health literacy skills help job performance in terms of working safely? Does working safely have an effect on physical health?

Figure 10 indicates the three path analyses conducted.

Figure 10 Path analyses for the conceptual model testing



The following section describes the results of our analyses in these three areas.

5. Results

This section presents what we feel are the most important results of the first stage of empirical testing of the conceptual model described above, in terms of their relevance to the UPSKILL Health research questions presented earlier. Full results of all analyses are available on request.

5.1 Associations among variables

First, correlations and other measures of association were conducted to identify variables to be included in the models (See Appendices D and E for detailed tables). The following are the main findings from this analysis; all associations are statistically significant at a level of probability of less than 10 per cent.

- Health literacy (a scale created by SRDC) and safe work practices (a performance assessment measure) were both associated with a number of sociodemographic variables, essential skills, psychological capital, social capital and workplace factors. Specifically, health literacy was strongly associated with self-efficacy (0.25), resilience (0.29) and motivation and engagement (0.24), whereas the variable safe work practices was more associated with attitudes to learning (0.20);
- While small associations were found between safe work practices (a combination of working safely and knowing emergency procedures) and sociodemographic variables (e.g., education), larger associations were found for specific variables related to psychological and social capital (e.g., motivation and engagement) and literacy skills;
- Numeracy was associated with health literacy (0.28) and safe work practices (0.25). Document use was associated with both of these variables as well (0.14 and 0.18 respectively);
- Safe work practices were positively associated with two firm-level factors: workforce size (0.12) and the proportion of employees enrolled in a union (0.13). Other firm-level factors presented limited associations with outcomes. Only expenditures on training per capita was associated with higher work stress (0.12).

Mental health

- Mental health, life satisfaction, reduced work stress and quality of work life presented important associations (>0.20), particularly with workplace characteristics such as work control, working conditions and work-home satisfaction;
- Mental health was associated with health literacy (0.23). Mechanisms to explain this association are unclear at this point. Attitudes to learning, motivation and engagement and self-efficacy are pathways to explore;
- Mental health was highly associated with reduced work stress (0.40) and quality of work life (0.28) but negatively associated with physical health (-0.19). This latter finding was not expected; the possibility of this being a statistical artifact (i.e., spurious finding) will be explored further.

Physical health

- Physical health was associated with health literacy (0.12), literacy (0.10) and confidence in one's literacy (0.13). One possible pathway for this relationship is the influence of health literacy and literacy on occupational health. The association between safe work practices and physical health was small (0.09) but significant;
- Physical health was not strongly associated with workplace factors (e.g., working conditions) but presented some correlation with network size (0.17) and age (-0.14).

Together, these results identify variables that demonstrate strong relationships or associations with health and mental health. In particular, they confer a potential role for essential skills training to improve mental and physical health. They also confirm health literacy as an important component of the model, whose precise role needs to be further explored. This first step of analysis also allowed us to exclude from the conceptual model variables which did not show moderate or important strength of association. Average expenditures on training per employee, social inclusion and having children under 12 years of age at home are all examples of variables excluded from further analyses for the time being.

The next step of our analytical strategy was to identify which variables were strong *predictors* of workers' health and mental health. As outlined in the next three sections, we used regression models to estimate the relationships outlined as the three most promising areas of investigation in Figure 10, above. For this next step of analysis, each regression was estimated as a generalized linear model using Statistical Analysis System (SAS) software, taking into account potential intra-cluster correlations within a given firm (n=88 firms). Variables have been standardized to facilitate interpretation of coefficients before estimation (unstandardized results can be found in Appendices I, J and K).

It should be noted that these regression model estimates were based on cross-sectional (i.e., baseline) data, so results do not suggest trends over time. In addition, the sample size for some model estimates varied; while the overall sample size was of 1,419 observations for this study, most results included a maximum of 800 observations due to missing items in the variables used for estimation. Given the extensive analyses involved at this stage, we have chosen to present only the most important results in the body of the document; more detail is presented in the Appendices, and full analyses are available upon request.

5.2 Health literacy and mental health

The first series of regression models looked at the relationship between health literacy and mental health,[12] both directly and indirectly, as influenced by a set of psycho-social variables such as general self-efficacy, resilience, motivation and engagement, attitudes to learning, and self-esteem. We started by examining the direct effect of health literacy alone (the "base model"), controlling for relevant variables such as workers' socio-demographic characteristics. We included numeracy and document use in the base regression model to control for the effects of these two literacy skills, and isolate the effect of health literacy.

12 As assessed by an SRDC-created measure and the SF-12, respectively.

Table 1 Effects of health literacy on mental health (base model)

	Estimate β	Empirical Standard	Pr > |Z|
Intercept	0,1686	0,181	0,3516
Health Literacy score	**0,3146**	**0,0356**	**<.0001**
Numeracy score	**-0,1055**	**0,0483**	**0,0291**
Document Use Score	-0,0503	0,0405	0,2143
Age	0,0534	0,049	0,2752
Social network (size)	**0,088**	**0,0378**	**0,0197**
Gender (ref. female)	0,0922	0,1662	0,6457
Highest level of education (ref. Less than high school diploma)			
University degree	-0,0698	0,1403	0,6187
College	-0,0376	0,1407	0,7891
Trade/Vocational/other	0,0039	0,1408	0,9777
Apprentice	-0,2011	0,3624	0,5788
High School diploma	0,1427	0,1177	0,2253
Marital Status (ref. Single, was married)			
Partner/married	-0,0112	0,1215	0,9268
Single, never married	-0,2105	0,149	0,1577
Born in Canada (ref. No, outside Canada)	-0,103	0,0851	0,2263
Number of observations=789			

As we can see from Table 1, health literacy had a positive and highly significant predictive effect on mental health (β=0.3146, p <.0001), indicating that those workers with higher levels of health literacy also reported better mental health. This result suggests an important role for health literacy in the design of potential interventions to improve workplace mental health.

Although our main purpose was to identify the predictive effect of health literacy, we also observe that numeracy – along with social network size – had a predictive effect on mental health, although not nearly to the same degree as health literacy. Interestingly, document use was not found to have a statistically significant effect. Together, these results suggest that literacy in general may be less important to mental health on its own than as a means of improving health literacy, which is clearly the more important factor.

Our next step was to re-estimate the model by including each of the five psychosocial variables identified above to explore their individual and collective effects on mental health. The results of these regressions can be seen in Appendix F, but in summary, each variable had a statistically significant predictive effect on mental health, with the exception of attitudes to learning.

Third, we looked at the mediating role of psychosocial variables in the relationship between health literacy and mental health, that is, the extent to which these variables act as "channels of influence". To

do this, we examined the change of the estimated coefficient of health literacy from that presented in the base model (Table 1), when the psychosocial variables were added to the regression model. Table 2 presents the estimated coefficients for health literacy in the standardized regression when each of the psychosocial variables was included.

Table 2 Coefficients and standard error (SE) for health literacy when adding psychosocial variables

	Coefficients standardized regression of health literacy (SE)
(Table 1 – Base model)	**0.3146 (0.04)**
Self-efficacy	**0.25 (0.03)**
Resilience	**0.27 (0.05)**
Motivation and engagement	**0.28 (0.04)**
Attitudes to learning	**0.32 (0.04)**
Self-esteem	**0.26 (0.04)**
ALL	**0.24 (0.04)**

Note: All coefficients are significant at p<.0001.

We observe that with the exception of attitudes to learning, all coefficients decreased compared to the base model, suggesting that these variables appear to be important intermediary variables in the relationship between health literacy and mental health, particularly self-efficacy and self-esteem. However, even when all five psychosocial variables are included in the regression, the coefficient of health literacy only decreases from 0.31 to 0.24. Taken together with the results from the base model, this suggests that despite the influence of these psycho-social variables, health literacy has a strong, direct predictive effect on the mental health of workers in the UPSKILL trial.

Overall, these results suggest that health literacy can have a direct effect on mental health. Interventions that could improve health literacy could also potentially improve mental health. We can also state that self-efficacy and self-esteem play mediating roles in this relationship.

5.3 Workplace characteristics and mental health

The second area identified for further investigation concerned the direct effects of workplace and firm-level characteristics on mental health, and the possibility of a mediating role for work stress and satisfaction at work (see the second element of Figure 10).

To determine this, we first estimated a base model regression with a series of relevant workplace and firm-level characteristics such as firm size and unionization. Since we learned from the previous model that health literacy was a significant predictor for mental health, we kept it in the model for this

analysis, as well as the psycho-social variables previously used. We also controlled for the same sociodemographic variables as in the other areas of investigation, in order to be able to compare the strength of predictive effects. The results of the base model regression for workplace characteristics and mental health are presented in Table 3.

Table 3 Effects of workplace characteristics on mental health (base model)

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0262	0,1994	0,8956
Control at work	-0,0441	0,0386	0,2528
Home-work satisfaction	**0,0918**	**0,0438**	**0,036**
Intra-firm relations	**0,07**	**0,0307**	**0,0228**
Work conditions	0,0768	0,0509	0,1311
Firm size (ref. large (=>200))			
Small (<50)	0,1306	0,1838	0,4773
Medium (=>50 and <200)	-0,04	0,1742	0,8186
Union rate	0,0242	0,047	0,6065
Health literacy score	**0,1778**	**0,0396**	**<.0001**
Self-esteem	**0,1988**	**0,0477**	**<.0001**
Self-efficacy	**0,1919**	**0,0571**	**0,0008**
Age	0,0981	0,0453	0,0304
Social network (size)	0,0167	0,0345	0,6282
Gender (ref. female)	0,0758	0,0611	0,2147
Highest level of education (ref. Less than high school diploma)			
University degree	-0,2463	0,1405	0,0796
College	-0,12	0,131	0,3596
Trade/Vocational/other	-0,1608	0,1345	0,2318
Apprentice	0,3852	0,739	0,6022
High School diploma	0,0614	0,1247	0,6223
Marital Status (ref. Single, was married)			
Partner/married	0,0208	0,103	0,8396
Single, never married	-0,0944	0,1276	0,4597
Born in Canada (ref. No, outside Canada)	-0,0045	0,0908	0,9605
Number of observations=733			

From this base model regression, we observe that workplace and firm-level characteristics did not appear to play a major role in affecting employees' mental health scores, particularly when compared to the influence of self-esteem, health literacy, and self-efficacy. Neither firm size nor the percentage of staff enrolled in a union had any effect on mental health, for example. Only work-home satisfaction and

the quality of (intra-firm) staff relations had a statistically significant effect on mental health, albeit to a much lesser degree than health literacy, self-esteem, and self-efficacy.

We then modelled two potential mediators of workplace characteristics – work stress and satisfaction at work – to identify their relationship with mental health, both separately and together. Not surprisingly, w*ork stress* was found to be a strong predictor of mental health (β =0.30, p<0.0001; see Appendix G, Table 11). As validation, we looked at factors that might influence work stress, and found that health literacy reduced work stress (β=0.14, p<0.0012), as did work-home balance, intra-firm relationships and especially, working conditions (results available on request).

Satisfaction at work also significantly predicted mental health (β=0.12, p<0.0175; see Appendix G, Table 12), albeit not to the same degree as work stress. Again as validation, we explored the predictors of *satisfaction at work*, and found only self-efficacy was a strong predictor of satisfaction at work (results available on request).

As indicated in the second sequence in Figure 10, our goal was also to explore if either work stress or satisfaction at work (or both) played a mediating role in the relationship between workplace characteristics and mental health. Table 4 summarizes how the workplace and firm-level coefficients changed from the base model (in Table 3) when work stress and satisfaction at work were introduced to observe their mediating effects.

Table 4 Coefficients and standard error (SE) for workplace characteristics when adding work-related mental health variables

	Work control	Work/home satisfaction	Intra-firm relations	Work conditions	Firm size	Union rate
Base model	-0.04 (0.04)	0.09 (0.04)	0.07 (0.03)	0.08 (0.05)	Small=0.13 (0.18) Med=-0.04 (0.17)	0.02 (0.05)
Work stress	-0.02 (0.04)	0.06 (0.05)	0.04 (0.03)	0.03 (0.05)	Small=0.05 (0.17) Med=--0.08 (0.17)	0.02 (0.04)
Satisfaction at work	-0.08 (0.04)	0.07 (0.05)	0.06 (0.03)	0.03 (0.06)	Small=0.12 (0.18) Med=--0.05 (0.17)	0.03 (0.05)
Both work stress and satisfaction at work	-0.05 (0.04)	0.04 (0.05)	0.03 (0.03)	-0.02 (0.06)	Small=0.04 (0.17) Med=--0.08 (0.17)	0.02 (0.04)

As Table 4 illustrates, the coefficients of workplace characteristics (variables along the first row) did not change much from one row to another when we added work stress and satisfaction at work, both individually and together. In other words, these variables did not play an important explanatory role in our model of mental health, based on the UPSKILL trial data.

We know from the literature, however, that workplace characteristics such as working conditions and control over one's work are important factors in mental health. We can infer, then, that their influence

in our analyses was likely felt through interaction with other variables, and was possibly captured by satisfaction at work or work stress. For example, it is possible that lack of control at work or dissatisfaction with work-home balance might have been captured by the measurement of work stress.

The final model we used to investigate the relationship between workplace characteristics and mental health included all these variables together. Here, we found work stress was still the strongest predictor of mental health (β =0.29, $p<0.0001$; see Appendix G, Table 13); satisfaction at work was also a predictor, albeit to a much lesser degree (β =0.11, $p<0.03$). While this finding is consistent with the literature, the absence of direct effects on mental health of other relevant workplace characteristics was unexpected, since variables such as work control are typically associated with depression and anxiety (Clark et al., 2012).

We also found the predictive power of self-efficacy on mental health was reduced when work stress and career satisfaction were included. This finding is consistent with social cognition theory, that self-efficacy is affected by both the environment (in this case, in the workplace) and satisfaction with one's achievement (Bandura, 1989).

Together, these results highlight that work stress and satisfaction at work have important mediating effects on mental health. They support the notion that workplace characteristics in and of themselves are less important to workers' mental health than in how they may influence work stress and satisfaction at work. We can also extrapolate that interventions to help workers cope with stress at work may positively influence mental health, particularly if they involve means to enhance workers' health literacy and sense of self-efficacy.

5.4 Safe work practices and physical health

The final set of regression models examined the third element of the conceptual model identified in Figure 10, the relationship between safe work practices and physical health.

Safe work practices in the context of the UPSKILL trial is a variable derived from the *emerit* performance assessment. It combines observation of employees' ability to work safely (e.g., following guidelines for proper lifting techniques or use of personal protective gear such as gloves) and demonstrated knowledge of emergency procedures. Due to the fact that not all UPSKILL participants undertook a performance assessment, the total sample size to test the third aspect of the conceptual model is much smaller than for other areas (n=837 participants had a result for the working safely assessment). The resulting reduction in statistical power limits our ability to detect small effects of this variable on physical health, only moderate or large effects, which we suspect are unlikely.

As it happens, none of the variables of interest in the first regression model for this area of investigation had any effect on safe work practices (see Appendix H, Table 14). Although numeracy had a significant effect on safe work practices, it was very small, and document use had no significant predictive effect. Health literacy on the other hand, was found to play a small but significant role. As a result, we cannot conclude that essential skills had a predominant role in explaining why participants failed or passed the performance assessment as a result of unsafe work practices.

The same result can be observed for the subsequent models conducted on the relationship between safe work practices and physical health; safe work practices did not have any effect on physical health

composite score of the SF-12 or on any of the physical health subscales. In addition to the potential lack of statistical power, the lack of effect might be explained by the fact that the SF-12 does not specifically measure work-related injuries. All results from the four models related to safe work practices and physical health can be found in Appendix H (standardized results) and Appendix K (non-standardized results).

6. Discussion

6.1 Implications for further quantitative analyses

The results of these analyses point to potential opportunities and issues for subsequent analysis of the effects of mental and physical health on job performance. First, it is clear that health literacy appears to have a direct effect on mental health, and that literacy and numeracy appear to affect mental health partly through their correlation with health literacy. Since literacy and numeracy are also expected to affect performance directly, our investigation of the effects of health on performance must control for these essential skill variables.

Second, the role of employment characteristics and workplace factors in explaining variations in health was mainly found to be through the mediators of work stress and satisfaction at work, rather than through direct effects. However, employment characteristics and workplace factors may themselves have direct effects on job performance. Our subsequent investigation of the relationship between performance and employment characteristics/workplace factors will determine if similar mediating effects apply.

Third, the evidence from UPSKILL performance assessments suggests that safe work practices have no significant correlation with physical health, at least in this study. It also suggests that the issue of endogeneity between health and business performance may not be substantial. In other words, health has an impact on job performance, and job performance impacts health, but the effects in either direction are not strong.

That said, there was much less performance assessment data available for our analysis than data on health and psychosocial factors. As a result, factors found in our early analyses to contribute to health may show different results (usually by becoming insignificant) in the sample of observations with valid job performance data. If we determine we have sufficient longitudinal data to conduct detailed job performance analyses, a sensitivity analysis will be conducted to understand whether sample selection is an issue. In other words, our analysis will use the best available evidence (with the highest statistical power) as possible; if the sub-group of workers for whom we have performance data differs substantially from the group for whom we have only survey data, we will qualify our interpretation of the results accordingly.

The conceptual framework specifies that business-related outcomes such as job performance, workplace health and safety, absenteeism could be affected by employee health. The first phase of testing described above shows the empirical model is capable of identifying mediating factors, of which health literacy, self-esteem, self-efficacy and work stress were found to be most important. Therefore, in the second phase of testing, we will estimate how some performance outcomes may vary in relation to these and other health, psychosocial and workplace factors.

The next stages of analysis will also examine how various individual and workplace factors and outcomes may have changed as a result of the UPSKILL training intervention (for particular subgroups) and the effect of health and mental health on job performance. The results presented above provide some guidance on which factors are likely to be of particular importance (e.g., the mediating role of

some psychosocial variables in the relationship between health literacy and mental health). At the same time, these results also show that subsequent analyses regarding business and performance outcomes will have to address issues of statistical power because of the small number of observations available. Our mitigation strategy is to use the baseline data to infer the resulting business and performance outcomes, and confirm these predictions against the impacts found in the UPSKILL trial.

6.2 Implications for qualitative data collection and analysis

The results of the first stage of empirical analysis also inform the qualitative component of UPSKILL Health, which focuses on the experiences of individuals who participated in the training intervention. Specifically, the goal of the qualitative component is to identify how low levels of LES may have affected their physical or mental health, the role of health literacy, and what coping strategies participants used.

The results of the first and second series of model testing will inform the design of the data collection protocols for the focus groups with workers and the interviews with literacy experts. For example, the initial results reported here suggest that health literacy is strongly influenced by essential skills, especially numeracy; this link could be more thoroughly explored through questions about the nature of these connections, and the aspects of health literacy on which participants may have experienced greater improvement (e.g., reading medical information, treatment compliance, etc.). Similarly, the finding that health literacy can have a direct effect on mental health, while conferring a mediator role to self-efficacy and self-esteem, prompts questions about how improved literacy and numeracy might influence these qualities.

Finally, the second series of models provided information on the importance of work stress and, to a lesser extent, satisfaction at work to workers' mental health. These findings suggest two relevant lines of inquiry with respect to workplace LES training: does work stress limit motivation or uptake of the training? Are there enabling factors in the workplace that could positively affect workers' learning of new essential skills? We will aim to explore these factors in our upcoming interviews and focus groups.

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Appendix A: Empirical Models

Stage 1: Identifying Factors of Employee Health and their Potential Effects on Performance/Business Outcomes, through Baseline Exploration

In the first stage, preliminary exploratory analysis will be conducted to identify the factors to be incorporated into the model. Then regression will be used to establish the relative importance of the factors. Specifically, multivariate regressions of the following model are estimated:

$$H_{0i} = \gamma_0 + \mathbf{P}_{0i}\boldsymbol{\gamma}_1 + \mathbf{F}_{0i}\boldsymbol{\gamma}_2 + \mathbf{L}_{0i}\boldsymbol{\gamma}_3 + \mathbf{K}_{0i}\boldsymbol{\gamma_4} + \mathbf{X}_{0i}\boldsymbol{\gamma_5} + \epsilon_{0i}, \qquad (\mathbf{1})$$

where:

$\mathbf{H}_{0i}$	is a measurement of mental or physical health of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits (age, disability, education, skills, employment, confidence, networks, etc.) of worker *i* at period 0 (baseline);
$\mathbf{F}_{0i}$	is a row vector of firm characteristics (size, intra-firm relations, learning culture, policies, etc.) of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of LES skills of worker *i* at period 0 (baseline) of worker *i* at period 0 (baseline);
$\mathbf{K}_{0i}$	is a row vector of psychosocial capital of worker *i* at period 0 (baseline);
$\mathbf{X}_{0i}$	is a row vector of healthy practices of worker *i* at period 0 (baseline);
$\gamma_0, \boldsymbol{\gamma}_1, \boldsymbol{\gamma}_2, \boldsymbol{\gamma}_3, \boldsymbol{\gamma}_4,$ and $\boldsymbol{\gamma}_5$	are the various factors' effects on health to be estimated by the regression coefficients; and
ϵ_{0i}	is the unexplained factor of health of worker i at period 0 (baseline).

Using the baseline measurements, the estimated coefficients can be rescaled to effect sizes such that comparisons across different factors are meaningful. Estimating equation (1) will produce a "map" of the relative importance of various factors that influence health. Since the average impacts of UPSKILL on these factors have already been established, the first set will shed light on how a non-health related intervention such as UPSKILL may affect worker's health indirectly through mediating factors of psychosocial capital, health literacy and healthy practices. For example, if there is an intervention that will change only the level of self-efficacy, by ΔK, then the intervention's average indirect effect on health through self-efficacy can be calculated as $E(\Delta H|intervention) = E(\Delta K \times \gamma_{4K}|intervention)$.

The research framework also specifies that business related outcomes, such as job performance, workplace health and safety, absenteeism, and other non-health business outcomes could be affected by employees' health. Therefore, in the first stage baseline exploration, we will also estimate how some business/performance outcomes vary with employees' health and all other business factors through a model similar to that of equation (1):

$$Y_{0i} = \alpha_0 + \mathbf{P}_{0i}\boldsymbol{\alpha}_1 + \mathbf{F}_{0i}\boldsymbol{\alpha}_2 + \mathbf{L}_{0i}\boldsymbol{\alpha}_3 + \mathbf{K}_{0i}\boldsymbol{\alpha_4} + \mathbf{X}_{0i}\boldsymbol{\alpha_5} + \mathbf{H}_{0i}\boldsymbol{\alpha_6} + v_{0i}, \qquad \mathbf{(2)}$$

where (noting that variables described above are not described below again):

Y_{0i}	is a measurement of business/performance outcomes related to worker i at period 0 (baseline);
$\boldsymbol{H}_{0i}$	is a row vector of worker mental or physical health measures and indicators of worker i at period 0 (baseline);
$\boldsymbol{\alpha_6}$	is a column vector of health's direct effects on the business outcome to be estimated by the regression coefficient;
$\boldsymbol{\alpha_0}, \boldsymbol{\alpha_1}, \boldsymbol{\alpha_2}, \boldsymbol{\alpha}_3, \boldsymbol{\alpha}_4, and\ \boldsymbol{\alpha}_5$	are the factors' effects on health to be estimated by the regression coefficients; and
v_{0i}	is the unexplained factor of business outcome related to worker i at period 0 (baseline).

The estimated values of $\boldsymbol{\alpha_6}$ (effects on health) together with the estimates from equation (1) will help determine how the indirect effects of a non-health related intervention (such as UPSKILL's LES training) could affect business outcomes through improved employee physical and mental health. Using the previous example of an intervention's effect on improved self-efficacy, the average indirect effect of the intervention on business outcome can be calculated as $E(\Delta Y|intervention) = E(\Delta H \times \alpha_{6H}|intervention) = E(\Delta K \times \gamma_{4K} \times \alpha_{6H}|intervention)$.

Stage 2: Examining the Mechanisms by which UPSKILL LES Training Generates Health and Performance/Business Outcomes

The impact analysis of UPSKILL has already identified the impact of workplace LES training on various measures of the variables included in equations (1) and (2). That is, the following equations have already been estimated:

$$Z_{\delta i} = \theta_0 + T_i\theta_Z + u_i, \qquad \mathbf{(3)}$$

where:

$Z_{\delta i}$	is a measure of change – from baseline to post UPSKILL – for all variables in health (health literacy, healthy practices, mental health, physical health, employment, general skills, LES skills, psychosocial capital, job performance, business outcomes, etc.);
T_i	is a 0-1 indicator of worker i belonging to the UPSKILL program (training) group or not;
θ_Z	is the average impact of UPSKILL on measurement Z; and
u_i	is the unexplained change.

However, it is unknown what mechanism and specific channels by which LES training affects employees' health and in turn their performance. The second stage analysis will extend the first stage models to examine the changes due to LES training. Specifically, the effects on health are modelled as:

$$H_{\delta i} = \beta_0 + \mathbf{P}_{\delta i}\boldsymbol{\beta}_1 + \mathbf{F}_{\delta i}\boldsymbol{\beta}_2 + \mathbf{L}_{\delta i}\boldsymbol{\beta}_3 + \mathbf{K}_{\delta i}\boldsymbol{\beta_4} + \mathbf{X}_{\delta i}\boldsymbol{\beta_5} + T_i\beta_H + \varepsilon_i, \qquad (\mathbf{4})$$

where:

$H_{\delta i}$	is the change in mental or physical health of worker *i* between baseline and post LES training;
$\mathbf{P}_{\delta i}$	is a row vector of changes in personal traits (if there is any) of worker *i* since baseline;
$\mathbf{F}_{\delta i}$	is a row vector of changes in firm characteristic (if there is any) of worker *i* since baseline;
$\mathbf{L}_{\delta i}$	is a row vector of LES skill changes of worker *i* since baseline;
$\mathbf{K}_{\delta i}$	is a row vector of psychosocial capital changes of worker *i* since baseline;
$\mathbf{X}_{\delta i}$	is a row vector of the changes in health literacy and practices of worker *i* since baseline;
$\beta_0, \boldsymbol{\beta}_1, \boldsymbol{\beta}_2,$ $\boldsymbol{\beta}_3, \boldsymbol{\beta}_4,$ and $\boldsymbol{\beta}_5$	are the factors' effects on health to be estimated as regression coefficients;
β_H	is the direct effect of LES training on health to be estimated as a regression coefficient; and
ε_i	is the unexplained changes of health of worker *i* since baseline.

The average direct effect of LES training on health will be estimated as the coefficient on the 0-1 indicator of the program, β_H. However, UPSKILL may also affect other health factors as specified in (3). For example, if LES training has an impact on the level of self-efficacy by θ_K, then its average indirect effect on health through self-efficacy can be calculated as $E(H_{\delta i}|indirect\ effect\ of\ LES\ training) = \theta_K \times \beta_{4K}$. If LES training had an impact on health either directly or only through self-efficacy, then its total impact on health can be decomposed into two components – the respective indirect effect and the direct effect:

$$E(H_{\delta i}|total\ impact\ of\ LES\ training) = \theta_K \times \beta_{4K} + \beta_H. \qquad (\mathbf{5})$$

The second stage analysis of the effect of LES training on health can also be extended to examine the direct and indirect impacts (through health) on business/performance outcome, similar to that of (2):

$$Y_{\delta i} = \rho_0 + \mathbf{P}_{\delta i}\boldsymbol{\rho}_1 + \mathbf{F}_{\delta i}\boldsymbol{\rho}_2 + \mathbf{L}_{\delta i}\boldsymbol{\rho}_3 + \mathbf{K}_{\delta i}\boldsymbol{\rho_4} + \mathbf{X}_{\delta i}\boldsymbol{\rho_5} + T_i\rho_T + \mathbf{H}_{\delta \boldsymbol{i}}\boldsymbol{\rho_H} + w_i, \qquad (\mathbf{6})$$

where:

$Y_{\delta i}$	is the change in a business/performance outcome of worker *i* between baseline and post LES training; and

$\boldsymbol{H}_{\delta i}$ is a row vector of the changes in mental or physical health of worker *i* between baseline and post LES training.

Also similar to the estimation of (2), the estimated coefficient of ρ_T represents the impact of LES training on business/performance outcome directly, while its indirect effects on business/performance outcomes through health are calculated as $E(\mathbf{H}_{\delta i}\boldsymbol{\rho}_{\boldsymbol{H}})$, with the rest of coefficients are estimates of the impact of changes in personal traits, firm characteristics, LES skills, psychosocial capital, and health literacy and practices.

Stage 3: Examining Moderating Factors and Subgroup Differences

The literature review indicates workplace factors affecting worker health can be modified to enhance worker health; a performance-based reward scheme would be an example of this. The third stage of analysis, therefore, will aim to identify possible modifiable factors (and their potential effect if they are modified) using subgroup analysis: i.e., by dividing the sample into subgroups for some modifiable workplace factors and then re-estimating equations (1) to (6) above re-estimated for each subgroup using regression techniques.

Substantial differences in the estimates between subgroups defined by workplace factors would reveal those that could be modified in a non-health related intervention to improve workers' health and job performance and organizational performance. For example, if there were large differences in outcomes between workers in workplaces where performance was rewarded and those where performance was not rewarded, then the case could be made for recommending such a measure to improve worker health and performance.

Similarly, differences by subgroups defined by individual characteristics such as age, gender, education, skills, disability and immigrant status would enable identification of particular population subgroups deemed at greater risk for poorer health outcomes and who could therefore benefit from policy or programmatic intervention. Note that this analysis depends on sample size, i.e., whether or not there are sufficient observations within a particular subgroup.

Appendix B: Psychosocial measures, health measures and workplace variable (stage 1)

Concept	Description	Scale, No. of items and example
Skills		
Literacy Practices	Participants' frequency and confidence in reading literacy and numeracy	▪ Literacy questions from the Longitudinal Study of Adult Learning ▪ 11 questions ▪ Participant frequently does, and is confident in doing, math
Document use	Essential Skills level	▪ TOWES assessed #1
Numeracy	Essential Skills level	TOWES assessed #1
Psychosocial Variables		
Self-efficacy	Participant believes in their ability to perform tasks	▪ Generalized Self-efficacy Scale ▪ 10 items ▪ Participant finds it easy to accomplish goals
Self-esteem	Participants' evaluation of their self-worth	▪ Single-item Self-Esteem Scale ▪ 1 item ▪ Participant perceives she/he has high self-esteem
Resilience	Participants' ability to cope with change or difficulty	▪ Abbreviated Connor-Davidson Resilience Scale ▪ 2 items ▪ Participant ability to recover from illness or hardship
Workplace Motivation/ Engagement	Participant has goals and works towards those goals	▪ Motivation and Engagement Scale ▪ 11 items ▪ Participant persists in their job despite challenges or difficulties
Social Inclusion/Capital (network engagement)	Number of contacts participants have and number of organizations participants have participated in	▪ General Social Survey questions ▪ 5 multiple-part questions: 3 network questions and 2 engagement questions ▪ No. of persons participant contact s to get various kinds of support, and no. of different types of organizations participant has participated in.

Concept	Description	Scale, No. of items and example
Health literacy, Health & Life Satisfaction		
Health Literacy	Participants' numeracy and prose literacy in health	▪ SRDC developed health literacy scale ▪ 5 items ▪ Extent to which participant understands various health-related textual and arithmetic content (see below)
Health	Participants' view of own health and how it affects work and non-work activities	▪ SF-12 Health Survey ▪ 12 items ▪ Participant difficulty in physical activities at work because of health ▪ Additional 4 questions selected by SRDC from a variety of sources (see questions below)
Stress	Participants feel that most days are stressful	▪ From SF-12 Health Survey ▪ 1 item
Life Satisfaction	Extent to which participants are satisfied with life	▪ Life Satisfaction question ▪ 1 item ▪ Participant is satisfied with life
Workplace variables		
Qualify of Work Life	Participants' evaluation of their satisfaction and contentment with job, career and training	▪ Work Related Quality of Life Scale ▪ 23 items ▪ Participant is satisfied with job
Work Stress	Participants feel under pressure at work or feel excessive levels of stress at work	▪ Subscale- Work Related Quality of Life Scale ▪ 2 items
Career/Satisfaction at work	Participants have a clear set of goals, opportunity to use abilities at work or encouraged to develop new skills. Employers provides sufficient support, training and opportunities.	▪ Subscale- Work Related Quality of Life Scale ▪ 6 items
Home-Work Satisfaction	Employer provides flexibility for to fit work around family time, satisfaction with working hours, line-manager promotes flexible working patters.	▪ Subscale- Work Related Quality of Life Scale ▪ 3 items

Concept	Description	Scale, No. of items and example
Work Control	Employee is able to voice opinion or is involve with decisions in its area of work.	▪ Subscale- Work Related Quality of Life Scale ▪ 3 items
Work Condition	Overall satisfaction, recognition of the good work and safety of the work environment.	▪ Subscale- Work Related Quality of Life Scale ▪ 3 items
Total Workload	Sum of all hours worked in a week (including second job)	NA
Occupation	Housekeeping room attendant – Group (HRA) Kitchen – Group (KITCHEN) Front desk agent – Group(FDA)' Food and beverage servers – Group (FBS)	NA
Atypical schedule	Variable schedule Usually weekdays Usually week-ends Usually evenings/overnight	NA
Firm-level variables*		
Expense in training	Amount spent on all forms of training, both on and off site (per employee)	NA
Union rate	Percentage of employees in a union	NA
Firm size	Small: less than 50 employees Medium: Between 50 and 199 employees Large: More than 200 employees	NA

***Source**: Establishment Profile.

Health questions used in the UPSKILL surveys

The UPSKILL demonstration project utilized the *SF-12v2 Health Survey*, which measures self-perceived overall health; how a person feels and how well s/he is able to do her/his usual activities (see Gandek, Ware, Aaronson, Apolone, Bjorner, Brazier, Bullinger, Kaasa, Leplege, Prieto, & Sullivan, 1998; Ware, Kosinski, & Keller, 1996).

Additional questions were also developed to focus on the workplace context and to better assess mental health. Additional questions include:

1. In general, would you say your mental health is:

a. Excellent
b. Very Good
c. Good
d. Fair
e. Poor

From GSS, question SRH_Q115; also same as Canadian Community Health Survey (CCHS) question on perceived mental health; somewhat similar to SF-8 Q7; included to show overall mental health status and relationship with literacy, stress and coping/resilience.

2. Thinking of the amount of stress in your life, would you say that most days are:

a. Not at all stressful?
b. Not very stressful?
c. A bit stressful?
d. Quite a bit stressful?
e. Extremely stressful?

From GSS question SRH_Q130; included to show relationships among literacy, stress and coping/resilience.

3. In the past 4 weeks, about how many days have you missed work…

a. illness? _____
b. injury? _____
c. stress? _____
d. some other health condition? _____

4. In the <u>next</u> 4 weeks, about how many days do you <u>expect</u> to miss work because of …

a. illness? _____
b. injury? _____
c. stress? _____
d. some other health condition? _____

Health literacy questions used in the UPSKILL baseline surveys

Both the *Short Test of Functional Health Literacy in Adults (S-TOFHLA)* and the *Rapid Estimate of Adult Literacy in Medicine (REALM-R)* were considered to assess participants' health literacy, but on the advice of several Canadian experts, both were rejected as being inadequate measures and inappropriate for the UPSKILL project.

Instead, SRDC worked with Scott Murray of Data Angel, who has had much research experience in the literacy field, to develop a subset of the IALS literacy questionnaire to assess health literacy more directly. We also used Chew's screening questions (more as a back-up, to correlate with our proxy) and added a few other items to try to unpack the possible impacts of limited and marginal health literacy, and the coping strategies people use to deal with it.

5. **A lot of health information is confusing and unclear – including pamphlets, medical forms, advertisements, and instructions from the doctor or pharmacist. How confident do you feel filling out medical forms by yourself?**

    a. Extremely
    b. Quite a bit
    c. Somewhat
    d. A little bit
    e. Not at all

    From Chew et al. 2004 (see also Wallace et al., 2006); included as a screening question to identify limited and marginal health literacy, to correlate with other HL items.

6. **How often do you have someone help you read medical materials?**

    a. Always
    b. Often
    c. Sometimes
    d. Occasionally
    e. Never

    From Chew et al. 2004 (see also Wallace et al., 2006); screening question used to identify limited and marginal health literacy, as well as coping strategies.

    (If answer a-d above:)

7. **Some people find it stressful to depend on others for help to understand and use health information, such as figuring out how much medication to take, or if you should get a flu shot. How stressful do you find it to rely on others to understand and use health information?**

a. Not at all stressful?
b. Not very stressful?
c. A bit stressful?
d. Quite a bit stressful?
e. Extremely stressful?

8. If you had difficulty understanding and using health information (such as figuring out how much medication to take, or if you should get a flu shot) which of the following best describes what you would do?

a. Do nothing
b. Ask a friend or family member for advice
c. Ask advice from someone in my community
d. Try to find the information out on my own
e. Ask my doctor or another health professional to clarify
f. Make a guess
g. Other _____

Included to identify coping strategies associated with low health literacy.

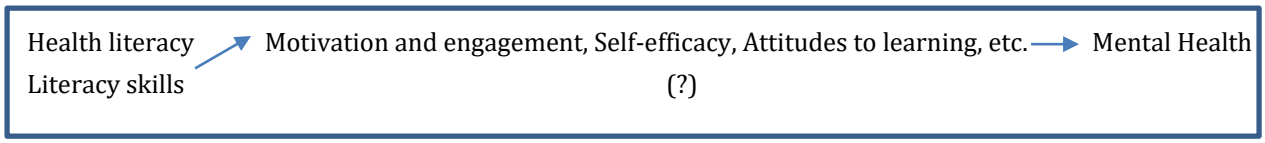
9. In the past 12 months, which of the following happened to you because health information was not clear? (Check all that apply)

a. Missed an appointment?
b. Took the wrong medication, or too much/too little?
c. Couldn't locate or access needed services?
d. Had difficulty managing a medical condition (e.g., diabetes)?
e. Had an accident or injury at work?
f. Had difficulty deciding if a treatment would be good for you?
g. Weren't able to participate in decisions about your health?
h. Didn't get the health care you needed?
i. Had difficulty making changes to improve your health (e.g., quitting smoking)?
j. None of the above

Included to show potential impacts on health/health practices because of low health literacy AND lack of clearly-communicated health information.

Appendix C: Stage 1 – Conceptual model testing

1. Health literacy and mental health



Analytical steps to examine this question are the following:

Model 1: Estimate the impact of health literacy on mental health.

$$Mental\ health_{0i} = \gamma_0 + \mathbf{F}_{0i}\text{Health literacy} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \epsilon_{0i},$$

$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of worker mental health *i* at period 0 (baseline).

Model 2: Estimate impact of psychosocial variables (five equations to be estimated separately) on mental health.

$$Mental\ health_{0i} = \gamma_0 + \mathbf{S}_{0i}\text{Psycho} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \epsilon_{0i},$$

$\mathbf{S}_{0i}$	is a set of psychosocial variables (Self-efficacy, motivation and engagement, attitudes to learning, resilience and self-esteem) of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of mental health of worker *i* at period 0 (baseline).

Model 3: Estimate the impact of health literacy on psychosocial variables (self-efficacy, motivation and engagement, attitudes to learning, resilience and self-esteem).

$Psycho_{0i} = \gamma_0 + \mathbf{F}_{0i}\text{Health literacy} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \epsilon_{0i}$

$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);

Model 4: Estimate the impact of health literacy and psychosocial variables (five equations to be estimated separately) on mental health.

$Mental\ health_{0i} = \gamma_0 + \mathbf{F}_{0i}\text{Health literacy} + \mathbf{S}_{0i}\text{Psycho} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \epsilon_{0i},$

$\boldsymbol{S_{0i}}$	is a set of psychosocial variables (Self-efficacy, motivation and engagement, attitudes to learning, resilience and self-esteem);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);

2. Workplace characteristics and mental health

Work conditions, Work-home satisfaction, Intra-firm relations → Work stress, Work satisfaction (?) → Mental Health

Following the same procedure than above, four models are tested:

Model 1: Estimate impact of workplace characteristics on mental health.

$Mental\ health_{0i} = \gamma_0 + \mathbf{W}_{0i}\text{workplace} + \mathbf{H}_{0i}\text{ Firm} + \mathbf{F}_{0i}\text{Health literacy} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i},$

$\mathbf{W}_{0i}$	is a row vector of workplace characteristics (work control, work-home satisfaction, intra-firm relations, work conditions) of worker *i* at period 0 (baseline);

$\mathbf{H}_{0i}$	is a row vector of firm-level characteristics (firm size and union rate) of worker *i* (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variables (self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of mental health of worker *i* at period 0 (baseline).

Model 2: Estimate impact of workplace mental health (work stress and satisfaction at work, to be estimated separately) on mental health

$$Mental\ health_{0i} = \gamma_0 + \mathbf{M}_{0i}\text{workhealth} + \mathbf{H}_{0i}\text{ Firm} + \mathbf{F}_{0i}\text{Health lit} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i}$$

$\mathbf{M}_{0i}$	is a set of variable related to workplace mental health proxies (work stress and work satisfaction) of worker *i* at period 0 (baseline);
$\mathbf{H}_{0i}$	is a row vector of firm-level characteristics (firm size and union rate) of worker *i* (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, social network size, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variable (self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of mental health of worker i at period 0 (baseline).

Model 3: Estimate the impacts of workplace conditions on workplace mental health (work stress and satisfaction at work, to be estimated separately)

$$Workhealth_{0i} = \gamma_0 + \mathbf{W}_{0i}\text{workplace} + \mathbf{H}_{0i}\text{ Firm} + \mathbf{F}_{0i}\text{Health lit} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i}$$

$\mathbf{W}_{0i}$	is a row vector of workplace characteristics (work control, home-work satisfaction, intra-firm relations, work conditions) of worker *i* at period 0 (baseline);
$\mathbf{H}_{0i}$	is a row vector of firm-level characteristics (firm size, and union rate) of worker *i* (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);

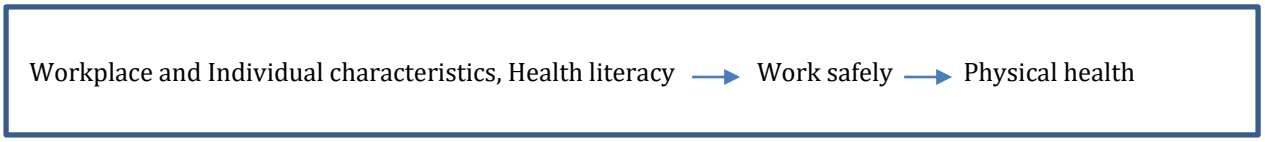
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, social network size, sex, education, marital status, social network size, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variable (self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of workplace mental health of worker i at period 0 (baseline).

Model 4: Estimate the impacts of both workplace characteristics and related workplace health issues on mental health.

$$Mental\ health_{0i} = \gamma_0 + \mathbf{W}_{0i}\text{workplace} + \mathbf{M}_{0i}\text{workhealth} + \mathbf{H}_{0i}\ \text{Firm} + \mathbf{F}_{0i}\text{Health lit} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i}$$

$\mathbf{W}_{0i}$	is a row vector of workplace characteristics (work control, home-work satisfaction, intra-firm relations, work conditions) of worker *i* at period 0 (baseline);
$\mathbf{M}_{0i}$	is a set of variable related to workplace mental health proxies (work stress and work satisfaction) of worker *i* at period 0 (baseline);
$\mathbf{H}_{0i}$	is a row vector of firm-level characteristics (firm size, union rate) of worker *i* at period 0 (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, social network size, sex, education, marital status, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variable (Self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of workplace mental health of worker *i* at period 0 (baseline).

3. Working safely and physical health



Two models will be estimated to answer these questions:

Model 1: Estimate the effects of numeracy/literacy/health literacy skills on working safely.

$$Working\ safely_{0i} = \gamma_0 + \mathbf{W}_{0i}\text{workplace} + \mathbf{H}_{0i}\ \text{Firm} + \mathbf{F}_{0i}\text{Health lit} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i}$$

$\mathbf{W}_{0i}$	is a row vector of workplace characteristics (work conditions, total hours worked atypical schedule) of worker *i* at period 0 (baseline);
H_{0i}	is a firm-level characteristic (rate of union) of worker *i* (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* at period 0 (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, social network size, sex, education, marital status, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variable (self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of the performance assessment of worker i at period 0 (baseline).

Model 2: Estimate the impact of working safely on physical health. Physical health is measured first as a whole construct, and the three subscales of the SF-12 (bodily pain, role physical and physical functioning) will be treated as an outcome.

$$Phy\ health_{0i} = \gamma_0 + \mathbf{T}_{0i}\text{Safe} + \mathbf{W}_{0i}\text{workplace} + \mathbf{H}_{0i}\ \text{Firm} + \mathbf{F}_{0i}\text{Health lit} + \mathbf{L}_{0i}\text{Skills} + \mathbf{P}_{0i}\text{Traits} + \mathbf{S_{0i}}\text{Psycho} + \epsilon_{0i}$$

$\mathbf{T}_{0i}$	is a dummy variable that indicates if the worker *i* has passed the work safety assessment at period 0 (baseline).
$\mathbf{W}_{0i}$	is a row vector of workplace characteristics (work conditions, total hours worked atypical schedule) of worker *i* at period 0 (baseline);
$\mathbf{H}_{0i}$	is a row vector of firm-level characteristics (rate of union) of worker *i* (baseline);
$\mathbf{F}_{0i}$	is the health literacy score of worker *i* at period 0 (baseline);
$\mathbf{L}_{0i}$	is a row vector of essential skills scores (numeracy and document use) of worker *i* (baseline);
$\mathbf{P}_{0i}$	is a row vector of personal traits: age, social network size, sex, education, marital status, and immigration of worker *i* at period 0 (baseline);
$\mathbf{S}_{0i}$	is a row of psychosocial variable (self-efficacy and self-esteem) of worker *i* at period 0 (baseline);
ϵ_{0i}	is the unexplained factor of physical health of worker i at period 0 (baseline).

Appendix D: Working table of associations between worker and workplace determinants and outcomes

	Mental health	Physical health	Health literacy	Stress	Work stress	Life satisfaction	Quality of working life	Career satisfaction	Safe work practices (performance assessment) PASS (all)
Household income	0.04	0.02	0.12	-0.01	-0.01	0.06	-0.03	-0.09	0.189
Education (reverse)	0.04	-0.11	-0.1	-0.04	0.07	0.03	0.07	0.09	-0.031
Age	0.16	-0.14	0.07	0.07	-0.04	0.10	0.10	0.04	-0.04
*Gender ** categorical*	-		-		-				
Immigration **categorical	-				-	-	-		
Children under 12yrs-old	0.01	0.02	-0.04	0.03	-0.02	0.02	0	0.07	-0.1
*Marital status** Cat.*			-		-	-			
Self-efficacy (total)	**0.25**	0.11	**0.25**	-0.16	0.17	**0.33**	**0.20**	**0.24**	0.04
Resilience	**0.20**	0.14	**0.29**	-0.16	**0.21**	**0.28**	0.13	0.16	0.12
Self-esteem	**0.27**	0.07	**0.15**	**-0.22**	0.12	**0.37**	0.19	0.18	-0.018
Social inclusion	0.01	0.005	-0.01	-0.03	0.03	0.03	0.01	-0.03	0.021
Network density	0.07	-0.01	0.08	-0.01	-0.004	0.10	0.05	0.05	0.01
Network size	0.01	0.17	0.14	-0.05	0.06	0.17	0.03	0.05	0.11
Motivation/engagement	0.15	0.10	**0.24**	-0.08	0.12	**0.29**	0.20	0.28	0.08
Attitudes to learning			**0.21**						**0.198**
Document use (TOWES)	-0.12	0.10	0.14	0.03	0.02	-0.05	-0.04	-0.08	**0.18**
Numeracy (TOWES)	-0.11	0.19	**0.28**	0.02	-0.05	-0.06	-0.07	-0.17	**0.25**
Literacy-confidence	0.04	0.13	**0.30**	-0.06	0.005	0.15	0.06	0.10	0.11
Reading favorite activity	0.01	0.11	0.19	-0.05	-0.003	0.07	0.02	0.05	0.04
Read or use information	0.002	0.10	**0.21**	0.03	-0.06	0.04	0.03	0.06	**0.14**
Work control	0.15	0.01	0.11	-0.08	0.09	**0.34**	**0.45**	**0.58**	-0.03
Work-home satisfaction	**0.22**	0.04	0.09	-0.16	**0.20**	**0.42**	**0.45**	**0.51**	-0.005
Working conditions	**0.19**	0.06	0.03	-0.16	**0.25**	**0.43**	**0.54**	**0.64**	0.034

	Mental health	Physical health	Health literacy	Stress	Work stress	Life satisfaction	Quality of working life	Career satisfaction	Safe work practices (performance assessment) PASS (all)
Workload (total hours)	0.05	-0.08	-0.03	-0.05	-0.03	0.07	0.06	0.08	-0.044
Occupation***categorical*									
Atypical schedule***categorical*	-		-				-		
Intra-firm relations	0.11	-0.007	0.05	-0.15	0.15	**0.29**	**0.40**	**0.44**	-0.05
Work force size	-0.04	0.006	0.021	0.05	-0.09	-0.08	-0.06	-0.10	0.12
Union and collective agreement	-0.01	-0.09	-0.03	-0.004	-0.06	-0.04	-0.05	-0.09	0.13
Training expenses (per capita)	-0.007	0.006	-0.02	0.04	0.12	-0.06	-0.02	0.015	0.04

Spearman correlation (pair-wise deletion)

Empty cells = Student, Anova, or Chi-square tests have been conducted on these categorical variables

Shaded cells=associations significant at 10%

Bolded figures = strong associations (>.20)

Appendix E: Correlations between outcomes

	Mental health-SF 12	Physical health-SF 12	Health Literacy (5 items)	Stress	Work stress	General life satisfaction	Overall quality of working life	Career satisfaction	Safe work practices
Mental Health	1.00	-0.19	**0.23**	**-0.43**	**0.40**	**0.37**	**0.28**	**0.25**	-0.04
Physical Health-SF 12	-0.19	1.00	0.15	-0.08	0.05	0.09	0.03	0.01	0.09
Health literacy (5 items)	**0.23**	0.15	1.00	-0.10	0.13	0.11	0.06	0.04	0.15
Stress	**-0.43**	-0.08	-0.10	1.00	**-0.37**	**-0.31**	**-0.21**	-0.18	0.03
Work Stress	**0.40**	0.05	0.13	-0.37	1.00	**0.20**	**0.25**	**0.20**	0.01
General life satisfaction	**0.37**	0.09	0.11	**-0.31**	**0.20**	1.00	0.31	**0.26**	-0.02
Overall quality of working life	**0.28**	0.03	0.06	**-0.21**	**0.25**	**0.31**	1.00	**0.59**	-0.06
Career/satisfaction at work	**0.25**	0.01	0.04	-0.18	**0.20**	**0.26**	**0.59**	1.00	-0.08

Spearman correlation (pair-wise deletion)
Shaded cells=associations significant at 10%
Bolded figures = strong associations (>.20)

Appendix F: Results (standardized) – Model 1

Table 5 Effects of health literacy and Self-efficacy on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,1205	0,1924	0,5313
Health Literacy Score	0,2535	0,0338	<.0001
General self-efficacy	0,3176	0,0511	<.0001
Numeracy score	-0,1182	0,0456	0,0095
Document Use Score	-0,0492	0,0357	0,1684
Age	0,0348	0,0505	0,4904
Social network (size)	0,0508	0,0349	0,1455
Gender (ref. female)	-0,0656	0,1777	0,7574
Highest level of education (ref. Less than high school diploma)			
University degree	-0,1572	0,1548	0,31
College	-0,1019	0,1425	0,4747
Trade/Vocational/other	-0,0545	0,1511	0,718
Apprentice	-0,2628	0,3848	0,4945
High School diploma	0,0928	0,1248	0,4569
Marital Status (ref. Single, was married)			
Partner/married	0,0378	0,1154	0,7434
Single, never married	-0,1607	0,1436	0,2629
Born in Canada (ref. No, outside Canada)	-0,0698	0,0887	0,4314
N =773			

Table 6 Effects of health literacy and resilience on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,3516	0,2278	0,1227
Health Literacy Score	0,2702	0,0525	<.0001
Resilience	0,1785	0,0795	0,0248
Numeracy score	-0,2271	0,0601	0,0002
Document Use Score	0,0798	0,0567	0,1592
Age	0,0694	0,0968	0,4731
Social network (size)	0,0703	0,0753	0,3505
Gender (ref. female)	-0,0093	0,2532	0,154
Highest level of education (ref. Less than high school diploma)			
University degree	-0,2507	0,1909	0,1892
College	-0,2972	0,2294	0,1951
Trade/Vocational/other	-0,0006	0,2138	0,9979
Apprentice	-0,2343	0,1715	0,1719
Marital Status (ref. Single, was married)	0	0	.
Partner/married	0,0948	0,2006	0,6367
Single, never married	-0,2578	0,2017	0,2013
Born in Canada (ref. No, outside Canada)	-0,2191	0,1221	0,0728
N=255			

Table 7 Effects of health literacy and Motivation and Engagement on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0315	0,1681	0,8514
Health literacy Score	0,2819	0,037	<.0001
Motivation and Engagement	0,144	0,0339	<.0001
Numeracy score	-0,1102	0,0483	0,0225
Document Use Score	-0,0543	0,0403	0,1777
Age	0,0438	0,0518	0,3979
Social network (size)	0,074	0,0376	0,0487
Gender (ref. female)	-0,1088	0,1681	0,8514
Highest level of education (ref. Less than high school diploma)			
University degree	-0,0615	0,1448	0,6713
College	-0,0166	0,1423	0,907
Trade/Vocational/other	-0,0149	0,1488	0,9201
Apprentice	-0,1667	0,5234	0,7502
High School diploma	0,1613	0,1223	0,187
Marital Status (ref. Single, was married)			
Partner/married	0,0174	0,1223	0,8867
Single, never married	-0,1807	0,1474	0,2203
Born in Canada (ref. No, outside Canada)	-0,103	0,0847	0,2237
N =760			

Table 8 Effects of health literacy and attitudes to learning on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0479	0,1744	0,7837
Health literacy score	0,3164	0,0345	<.0001
Attitudes to learning	-0,0256	0,0417	0,5387
Numeracy score	-0,1032	0,0492	0,0361
Document Use Score	-0,0482	0,0408	0,2375
Age	0,052	0,0503	0,301
Social network (size)	0,0885	0,0364	0,0152
Gender (ref. female)	-0,081	0,1744	0,7837
Highest level of education (ref. Less than high school diploma)			
University degree	-0,0546	0,1522	0,7199
College	-0,0122	0,15	0,9354
Trade/Vocational/other	0,0228	0,1521	0,8811
Apprentice	-0,1494	0,3542	0,6733
High School diploma	0,164	0,1265	0,1947
Marital Status (ref. Single, was married)			
Partner/married	0,002	0,1225	0,9867
Single, never married	-0,1994	0,1498	0,1832
Born in Canada (ref. No, outside Canada)	-0,0959	0,0858	0,2639
Number of observations=773			

Table 9 Effects of health literacy and self-esteem on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0876	0,1634	0,592
Health literacy score	0,2634	0,0353	<.0001
Self-esteem	0,2729	0,0464	<.0001
Numeracy score	-0,0966	0,0475	0,0422
Document Use Score	-0,0391	0,038	0,3028
Age	0,0348	0,0495	0,4825
Social network (size)	0,0443	0,0371	0,2323
Gender (ref. female)	0,0175	0,1443	0,6268
Highest level of education (ref. Less than high school diploma)			
University degree	-0,1428	0,1367	0,296
College	-0,07	0,1243	0,5732
Trade/Vocational/other	-0,0271	0,1275	0,8315
Apprentice	-0,0747	0,3803	0,8443
High School diploma	0,1265	0,1125	0,2608
Marital Status (ref. Single, was married)			
Partner/married	-0,0088	0,1019	0,9313
Single, never married	-0,1797	0,13	0,1669
Born in Canada (ref. No, outside Canada)	-0,0169	0,0874	0,8462
Number of observations=762			

Table 10 Effects of psychosocial variables on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0518	0,1909	0,7862
Health literacy Score	0,2361	0,0346	<.0001
Attitudes to learning	-0,0914	0,04	0,0224
Motivation and engagement	0,0344	0,041	0,4012
Self-efficacy	0,2238	0,0569	<.0001
Self-esteem	0,2034	0,0464	<.0001
Numeracy score	-0,1013	0,0457	0,0264
Document Use Score	-0,0417	0,0359	0,2454
Age	0,0148	0,0491	0,7631
Social network (size)	0,0342	0,0337	0,31
Gender (ref. female)	0,0077	0,1715	0,797
Highest level of education (ref. Less than high school diploma)			
University degree	-0,1747	0,1552	0,2604
College	-0,088	0,1385	0,525
Trade/Vocational/other	-0,0374	0,1481	0,8008
Apprentice	-0,0292	0,3974	0,9413
High School diploma	0,1267	0,1293	0,3269
Marital Status (ref. Single, was married)			
Partner/married	0,0112	0,1094	0,9184
Single, never married	-0,162	0,136	0,2336
Born in Canada (ref. No, outside Canada)	0,0099	0,0912	0,9136
Number of observations=741			

Appendix G: Results (standardized) – Model 2

Table 11 Effects of work stress on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0255	0,188	0,892
Control at work	-0,0183	0,0363	0,6149
Home-work satisfaction	0,0581	0,0446	0,1929
Intra-firm relations	0,0424	0,0308	0,1683
Work conditions	0,025	0,0494	0,6131
Work stress	0,2945	0,0445	<.0001
Firm size (ref. large (=>200))			
Small (<50)	0,0552	0,1706	0,7464
Medium (=>50 and <200)	-0,0748	0,1727	0,665
% of staff in a union	0,018	0,042	0,6692
Health literacy score	0,1388	0,0401	0,0005
Self-esteem	0,179	0,0485	0,0002
Self-efficacy	0,1695	0,052	0,0011
Age	0,1104	0,0403	0,0062
Social network (size)	0,017	0,0309	0,5825
Gender (ref. female)	0,0311	0,0605	0,6078
Highest level of education (ref. Less than high school diploma)			
University degree	-0,1648	0,141	0,2423
College	-0,0554	0,1279	0,6645
Trade/Vocational/other	-0,0697	0,131	0,5946
Apprentice	0,211	0,3621	0,56
High School diploma	0,0792	0,1259	0,5295
Marital Status (ref. Single, was married)			
Partner/married	0,0379	0,0961	0,6937
Single, never married	-0,0843	0,1185	0,4772
Born in Canada (ref. No, outside Canada)	0,0038	0,0838	0,964
N=733			

Table 12 Effects of work satisfaction on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0174	0,1975	0,9296
Control at work	-0,0801	0,0408	0,0494
Home-work satisfaction	0,0742	0,0448	0,0981
Intra-firm relations	0,0601	0,0311	0,053
Work conditions	0,0314	0,0557	0,5731
Work satisfaction	**0,1196**	**0,0504**	**0,0175**
Firm size (ref. large (=>200))			
Small (<50)	0,1163	0,1811	0,5208
Medium (=>50 and <200)	-0,0455	0,1715	0,7907
% of staff in a union	0,0228	0,0478	0,633
Health literacy score	0,1819	0,0392	<.0001
Self-esteem	0,1988	0,0477	<.0001
Self-efficacy	0,179	0,0578	0,002
Age	0,1025	0,0454	0,0239
Social network (size)	0,0206	0,0344	0,5487
Gender (ref. female)	0,0853	0,0614	0,165
Highest level of education (ref. Less than high school diploma)			
University degree	-0,2133	0,1397	0,1269
College	-0,1128	0,1307	0,3882
Trade/Vocational/other	-0,1613	0,1333	0,2261
Apprentice	0,3043	0,6674	0,6484
High School diploma	0,0615	0,1248	0,6221
Marital Status (ref. Single, was married)			
Partner/married	0,0153	0,1005	0,879
Single, never married	-0,0907	0,1256	0,4701
Born in Canada (ref. No, outside Canada)	-0,0002	0,089	0,9978
N=733			

Table 13 Effects of work satisfaction and work stress on mental health

	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0178	0,1859	0,9239
Control at work	-0,0506	0,0392	0,1974
Home-work satisfaction	0,0426	0,045	0,3435
Intra-firm relations	0,0338	0,0307	0,2723
Work conditions	-0,0151	0,0552	0,7839
Work stress	**0,2926**	**0,0449**	**<.0001**
Work satisfaction	**0,1068**	**0,0485**	**0,0276**
Firm size (ref. large (=>200))			
Small (<50)	0,0428	0,1679	0,7985
Medium (=>50 and <200)	-0,0795	0,1699	0,6399
% of staff in a union	0,0168	0,0429	0,6956
Health literacy score	0,1427	0,0396	0,0003
Self-esteem	0,1792	0,0482	0,0002
Self-efficacy	0,1581	0,0523	0,0025
Age	0,1142	0,0401	0,0044
Social network (size)	0,0204	0,0309	0,5081
Gender (ref. female)	0,0398	0,06	0,507
Highest level of education (ref. Less than high school diploma)			
University degree	-0,1359	0,1411	0,3356
College	-0,0494	0,1275	0,6982
Trade/Vocational/other	-0,0707	0,1296	0,5854
Apprentice	0,14	0,3133	0,655
High School diploma	0,0792	0,1262	0,5305
Marital Status (ref. Single, was married)			
Partner/married	0,0328	0,0945	0,7283
Single, never married	-0,0811	0,1167	0,487
Born in Canada (ref. No, outside Canada)	0,0075	0,0825	0,9273
Number of observations = 733			.

Appendix H: Results (standardized) Model - 3

Table 14 Effects of essential skills on unsafe work practices

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,4261	0,1624	0,0087
Work conditions	-0,0263	0,0231	0,2546
Total hours worked in a week	0,024	0,0249	0,3366
Schedule (ref. It depends)			
Usually weekdays	0,3211	0,1763	0,0685
Usually week-ends	0,4473	0,1886	0,0177
Usually evenings/overnight	0,5479	0,1688	0,0012
Union rate	0,0632	0,0341	0,0635
Health Literacy Score	0,0237	0,0264	0,3697
Numeracy score	0,0996	0,0318	0,0017
Document Use Score	0,0151	0,0268	0,5732
Self-efficacy	-0,0097	0,0275	0,7245
Social network (size)	0,0323	0,0262	0,2172
Age	0,0006	0,0026	0,8235
Gender (ref. female)	0,0022	0,0609	0,9707
Highest level of education (ref. Less than high school diploma			.
University degree	0,1458	0,1174	0,2142
College	0,2499	0,0993	0,0119
Trade/Vocational/other	0,2734	0,1004	0,0065
High school diploma	0,2084	0,0922	0,0237
Marital Status (ref. Single, was married)			.
Partner/married	0,0062	0,08	0,9378
Single, never married	0,0571	0,0957	0,5507
Born in Canada (ref. No, outside Canada)	0,0081	0,0562	0,8849
N=404			

Table 15 Effects of unsafe work practices on physical health (total score)

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,1429	0,3881	0,7127
Work conditions	0,0515	0,0583	0,3765
Total hours worked in a week	-0,1169	0,0458	0,0107
Schedule (ref. It depends)			
Usually weekdays	-0,0342	0,3923	0,9305
Usually week-ends	0,1439	0,4368	0,7419
Usually evenings/overnight	0,0272	0,4285	0,9494
Unsafe work practices	-0,0882	0,1223	0,471
Union rate	-0,1211	0,0598	0,0428
Health Literacy Score	0,0906	0,0459	0,0486
Numeracy score	0,1325	0,0638	0,0379
Document Use Score	0,0548	0,0573	0,3389
Self-efficacy	-0,0234	0,0621	0,7064
Social network (size)	0,0882	0,0507	0,0819
Age	0,0002	0,0062	0,9786
Gender (ref. female)	-0,1051	0,0937	0,262
Highest level of education (ref. Less than high school diploma			
University degree	-0,2026	0,2309	0,3802
College	0,0358	0,1925	0,8525
Trade/Vocational/other	-0,1358	0,23	0,555
High school diploma	-0,2167	0,1726	0,2092
Marital Status (ref. Single, was married)			
Partner/married	-0,0899	0,1587	0,5713
Single, never married	0,0254	0,1897	0,8933
Born in Canada (ref. No, outside Canada)	0,0513	0,12	0,6687
N=374			

Table 16 Effects of unsafe work practices on bodily pain

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,4233	0,3843	0,2708
Work conditions	0,023	0,0491	0,6394
Total hours worked in a week	0,0398	0,0422	0,3462
Schedule (ref. It depends)			
Usually weekdays	0,1729	0,3919	0,659
Usually week-ends	0,3447	0,404	0,3935
Usually evenings/overnight	0,1705	0,4555	0,7081
Unsafe work practices	-0,03	0,0918	0,7434
Union rate	-0,0742	0,0553	0,1796
Health Literacy Score	0,1769	0,0568	0,0018
Numeracy score	0,0382	0,0709	0,5902
Document Use Score	0,0372	0,0546	0,4958
Self-efficacy	0,1363	0,061	0,0255
Social network (size)	0,1044	0,049	0,033
Age	-0,0035	0,0059	0,55
Gender (ref. female)	-0,0978	0,0853	0,2516
Highest level of education (ref. Less than high school diploma			
University degree	-0,3238	0,2225	0,1456
College	-0,0707	0,1741	0,6847
Trade/Vocational/other	-0,1011	0,1792	0,5727
High school diploma	-0,1839	0,1647	0,2642
Marital Status (ref. Single, was married)			
Partner/married	-0,0244	0,1683	0,8846
Single, never married	-0,003	0,1871	0,9871
Born in Canada (ref. No, outside Canada)	-0,165	0,0951	0,0827
N=402			

Table 17 Effects of unsafe work practices on role limitations from physical health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	0,0028	0,3881	0,9942
Work conditions	0,1346	0,0405	0,0009
Total hours worked in a week	-0,0978	0,0549	0,075
Schedule (ref. It depends)			
Usually weekdays	-0,1961	0,3897	0,6148
Usually week-ends	0,3248	0,3697	0,3797
Usually evenings/overnight	-0,0813	0,3756	0,8287
Unsafe work practices	-0,0802	0,1082	0,4586
Union rate	-0,1081	0,0591	0,0671
Health Literacy Score	0,1818	0,0564	0,0013
Numeracy score	0,1631	0,0674	0,0156
Document Use Score	-0,0308	0,0495	0,5339
Self-efficacy	0,0738	0,052	0,156
Social network (size)	0,0497	0,0559	0,3733
Age	0,0029	0,0062	0,6354
Gender (ref. female)	-0,0712	0,0977	0,466
Highest level of education (ref. Less than high school diploma			
University degree	-0,4529	0,2187	0,0384
College	-0,2168	0,2011	0,2809
Trade/Vocational/other	-0,2512	0,238	0,2913
High school diploma	-0,1606	0,1693	0,3429
Marital Status (ref. Single, was married)			
Partner/married	0,0229	0,1365	0,8668
Single, never married	0,1111	0,1691	0,5114
Born in Canada (ref. No, outside Canada)	0,0861	0,1016	0,3968
N=393			

Table 18 Effects of unsafe work practices on physical functioning

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	-0,1658	0,3787	0,6616
Work conditions	0,0387	0,0573	0,4994
Total hours worked in a week	-0,1117	0,052	0,0316
Schedule (ref. It depends)			
Usually weekdays	-0,4179	0,3603	0,2461
Usually week-ends	-0,223	0,3905	0,5679
Usually evenings/overnight	-0,4433	0,3959	0,2628
Unsafe work practices	0,0842	0,1292	0,5145
Union rate	-0,0818	0,052	0,1158
Health Literacy Score	0,1094	0,0552	0,0477
Numeracy score	0,1223	0,072	0,0894
Document Use Score	0,0519	0,0548	0,3437
Self-efficacy	-0,0949	0,0651	0,1445
Social network (size)	0,0735	0,048	0,1256
Age	0,0052	0,006	0,3875
Gender (ref. female)	0,1732	0,1011	0,0868
Highest level of education (ref. Less than high school diploma			
University degree	-0,1168	0,227	0,6069
College	-0,0591	0,2263	0,7941
Trade/Vocational/other	-0,1235	0,2074	0,5514
High school diploma	-0,2809	0,1956	0,1509
Marital Status (ref. Single, was married)			
Partner/married	0,0546	0,1415	0,6995
Single, never married	0,2398	0,178	0,1778
Born in Canada (ref. No, outside Canada)	0,0306	0,1094	0,7796
N=395			

Appendix I: Results (non-standardized) – Model 1

Table 19 Effects of health literacy on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	36,1946	4,0936	<.0001
Health Literacy Score	0,9347	0,1058	<.0001
Numeracy score	-0,0215	0,0098	0,0291
Document Use Score	-0,0124	0,01	0,2143
Age	0,041	0,0376	0,2752
Social network (size)	0,7063	0,303	0,0197
Gender (ref. female)	0,8892	0,5518	0,1071
Highest level of education (ref. Less than high school diploma			
University degree	-0,6736	1,3532	0,6187
College	-0,363	1,357	0,7891
Trade/Vocational/other	0,038	1,3573	0,9777
Apprentice	-1,9397	3,4943	0,5788
High School diploma	1,3764	1,135	0,2253
Marital Status (ref. Single, was married)			
Partner/married	-0,1076	1,1713	0,9268
Single, never married	-2,0301	1,4369	0,1577
Born in Canada (ref. No, outside Canada)	-0,9928	0,8205	0,2263
N=789			

Table 20 Effects of health literacy and self-efficacy on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	23,854	5,047	<.0001
Health Literacy Score	0,753	0,1003	<.0001
Self-efficacy Score	0,5759	0,0928	<.0001
Numeracy score	-0,0241	0,0093	0,0095
Document Use Score	-0,0122	0,0088	0,1684
Age	0,0267	0,0388	0,4904
Social network (size)	0,4075	0,2799	0,1455
Gender (ref. female)	0,6325	0,5617	0,2601
Highest level of education (ref. Less than high school diploma			
University degree	-1,5155	1,4928	0,31
College	-0,9824	1,3743	0,4747
Trade/Vocational/other	-0,526	1,4566	0,718
Apprentice	-2,5346	3,7103	0,4945
High School diploma	0,8952	1,2032	0,4569
Marital Status (ref. Single, was married)			
Partner/married	0,3643	1,1127	0,7434
Single, never married	-1,5497	1,3843	0,2629
Born in Canada (ref. No, outside Canada)	-0,6732	0,8556	0,4314
N=773			

Table 21 Effects of health literacy and resilience on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	32,5296	8,5738	0,0001
Health Literacy Score	0,8028	0,1558	<.0001
Resilience	1,2489	0,5563	0,0248
Numeracy score	-0,0462	0,0122	0,0002
Document Use Score	0,0197	0,014	0,1592
Age	0,0533	0,0743	0,4731
Social network (size)	0,5643	0,6045	0,3505
Gender (ref. female)	0,0898	1,0691	0,9331
Highest level of education (ref. Less than high school diploma			
University degree	-2,4176	1,8412	0,1892
College	-2,8657	2,2118	0,1951
Trade/Vocational/other	-0,0053	2,0613	0,9979
Apprentice	-2,2595	1,6538	0,1719
Marital Status (ref. Single, was married)			
Partner/married	0,9137	1,9344	0,6367
Single, never married	-2,4856	1,9449	0,2013
Born in Canada (ref. No, outside Canada)	-2,1132	1,1778	0,0728
N=255			

Table 22 Effects of health literacy and motivation on mental health

Parameter	Estimate	Z	Pr > |Z|
Intercept	27,7146	5,37	<.0001
Health Literacy Score	0,8374	7,62	<.0001
Motivation and Engagement	2,7439	4,25	<.0001
Numeracy score	-0,0224	-2,28	0,0225
Document Use Score	-0,0134	-1,35	0,1777
Age	0,0336	0,85	0,3979
Social network (size)	0,594	1,97	0,0487
Gender (ref. female)	1,0491	1,77	0,0762
Highest level of education (ref. Less than high school diploma			
University degree	-0,5926	-0,42	0,6713
College	-0,1602	-0,12	0,907
Trade/Vocational/other	-0,1439	-0,1	0,9201
Apprentice	-1,6071	-0,32	0,7502
High School diploma	1,5558	1,32	0,187
Marital Status (ref. Single, was married)			
Partner/married	0,1681	0,14	0,8867
Single, never married	-1,7426	-1,23	0,2203
Born in Canada (ref. No, outside Canada)	-0,9936	-1,22	0,2237
N=760			

Table 23 Effects of health literacy and attitudes to learning on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	37,0567	4,8574	<.0001
Health Literacy Score	0,9399	0,1025	<.0001
Attitudes to learning	-0,1204	0,1959	0,5387
Numeracy score	-0,021	0,01	0,0361
Document Use Score	-0,0119	0,0101	0,2375
Age	0,04	0,0386	0,301
Social network (size)	0,71	0,2923	0,0152
Gender (ref. female)	0,7815	0,5819	0,1792
Highest level of education (ref. Less than high school diploma			
University degree	-0,5266	1,4681	0,7199
College	-0,1172	1,4465	0,9354
Trade/Vocational/other	0,2195	1,467	0,8811
Apprentice	-1,4403	3,416	0,6733
High School diploma	1,5812	1,2194	0,1947
Marital Status (ref. Single, was married)			
Partner/married	0,0197	1,1817	0,9867
Single, never married	-1,9228	1,4447	0,1832
Born in Canada (ref. No, outside Canada)	-0,9243	0,8273	0,2639
N=733			

Table 24 Effects of health literacy and self-esteem on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	29,922	4,3227	<.0001
Health Literacy Score	0,7825	0,1049	<.0001
Self-esteem	2,7595	0,4688	<.0001
Numeracy score	-0,0197	0,0097	0,0422
Document Use Score	-0,0097	0,0094	0,3028
Age	0,0267	0,038	0,4825
Social network (size)	0,3555	0,2976	0,2323
Gender (ref. female)	0,1683	0,5793	0,7714
Highest level of education (ref. Less than high school diploma			
University degree	-1,3773	1,318	0,296
College	-0,6755	1,199	0,5732
Trade/Vocational/other	-0,2616	1,2295	0,8315
Apprentice	-0,7202	3,6671	0,8443
High School diploma	1,2202	1,0852	0,2608
Marital Status (ref. Single, was married)			
Partner/married	-0,0847	0,9828	0,9313
Single, never married	-1,733	1,2539	0,1669
Born in Canada (ref. No, outside Canada)	-0,1634	0,8426	0,8462
N=762			

Appendix J: Results (non-standardized) – Model 2

Table 25 Effects of workplace and firm-level characteristics on mental health

Parameter	Estimate	Z	Pr > |Z|
Intercept	9,2556	1,83	0,0675
Control at work	-0,5261	-1,14	0,2528
Home-work satisfaction	1,0357	2,1	0,036
Intra-firm relations	0,2784	2,28	0,0228
Work conditions	1,0293	1,51	0,1311
Firm size (ref. large (=>200))			
Small (<50)	1,0077	0,92	0,3562
Medium (=>50 and <200)	-0,6375	-0,7	0,4847
Union rate	0,0058	0,52	0,6065
Health Literacy Score	0,5283	4,49	<.0001
Self-esteem	2,0105	4,17	<.0001
Self-efficacy	0,348	3,36	0,0008
Age	0,0754	2,17	0,0304
Social network (size)	0,1341	0,48	0,6282
Gender (ref. female)	0,7312	1,24	0,2147
Highest level of education (ref. Less than high school diploma			.
University degree	-2,3755	-1,75	0,0796
College	-1,1569	-0,92	0,3596
Trade/Vocational/other	-1,551	-1,2	0,2318
Apprentice	3,7142	0,52	0,6022
High School diploma	0,5922	0,49	0,6223
Marital Status (ref. Single, was married)			
Partner/married	0,201	0,2	0,8396
Single, never married	-0,9099	-0,74	0,4597
Born in Canada (ref. No, outside Canada)	-0,0433	-0,05	0,9605
N=733			

Table 26 Effects of work stress on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	8,2008	5,0393	0,1037
Control at work	-0,2181	0,4336	0,6149
Home-work satisfaction	0,6558	0,5036	0,1929
Intra-firm relations	0,1686	0,1224	0,1683
Work conditions	0,3352	0,6629	0,6131
Stress at work	2,9674	0,4486	<.0001
Firm size (ref. large (=>200))			
Small (<50)	0,2859	0,9749	0,7693
Medium (=>50 and <200)	-0,9671	0,8137	0,2346
Union rate	0,0043	0,0101	0,6692
Health Literacy Score	0,4123	0,1191	0,0005
Self-esteem	1,8104	0,4906	0,0002
Self-efficacy	0,3074	0,0942	0,0011
Age	0,0847	0,031	0,0062
Social network (size)	0,1362	0,2478	0,5825
Gender (ref. female)	0,2994	0,5834	0,6078
Highest level of education (ref. Less than high school diploma			
University degree	-1,5896	1,3595	0,2423
College	-0,5347	1,233	0,6645
Trade/Vocational/other	-0,6721	1,2629	0,5946
Apprentice	2,0348	3,4916	0,56
High School diploma	0,7636	1,2144	0,5295
Marital Status (ref. Single, was married)			
Partner/married	0,3651	0,9272	0,6937
Single, never married	-0,8125	1,143	0,4772
Born in Canada (ref. No, outside Canada)	0,0365	0,8078	0,964
N=733	0	0	.

Table 27 Effects of satisfaction at work on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	7,5702	5,1109	0,1386
Control at work	-0,9558	0,4864	0,0494
Home-work satisfaction	0,8367	0,5058	0,0981
Intra-firm relations	0,2392	0,1236	0,053
Work conditions	0,4212	0,7474	0,5731
Firm size (ref. large (=>200))			
Small (<50)	0,9532	1,1018	0,387
Medium (=>50 and <200)	-0,6071	0,9134	0,5063
Union rate	0,0055	0,0115	0,633
Work satisfaction	1,7957	0,7558	0,0175
Health Literacy Score	0,5405	0,1165	<.0001
Self-esteem	2,0106	0,4819	<.0001
Self-efficacy	0,3246	0,1048	0,002
Age	0,0787	0,0348	0,0239
Social network (size)	0,1653	0,2756	0,5487
Gender (ref. female)	0,8227	0,5926	0,165
Highest level of education (ref. Less than high school diploma	0	0	.
University degree	-2,0571	1,3475	0,1269
College	-1,0875	1,2602	0,3882
Trade/Vocational/other	-1,5556	1,2851	0,2261
Apprentice	2,9345	6,4358	0,6484
High School diploma	0,5934	1,2039	0,6221
Marital Status (ref. Single, was married)	0	0	.
Partner/married	0,1476	0,9692	0,879
Single, never married	-0,8751	1,2115	0,4701
Born in Canada (ref. No, outside Canada)	-0,0024	0,8582	0,9978
N=733			

Table 28 Effects of work stress and satisfaction at work on mental health

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	6,7037	5,0949	0,1883
Control at work	-0,6035	0,4682	0,1974
Home-work satisfaction	0,4806	0,5074	0,3435
Intra-firm relations	0,1343	0,1223	0,2723
Work conditions	-0,2031	0,7405	0,7839
Stress at work	2,9486	0,4525	<.0001
Work satisfaction	1,6022	0,7275	0,0276
Firm size (ref. large (=>200))			
Small (<50)	0,2419	0,985	0,806
Medium (=>50 and <200)	-0,9378	0,8154	0,2501
Union rate	0,004	0,0103	0,6956
Health Literacy Score	0,4239	0,1177	0,0003
Self-esteem	1,8118	0,4875	0,0002
Self-efficacy	0,2867	0,0948	0,0025
Age	0,0877	0,0308	0,0044
Social network (size)	0,1641	0,2479	0,5081
Gender (ref. female)	0,3838	0,5784	0,507
Highest level of education (ref. Less than high school diploma	0	0	.
University degree	-1,3104	1,3608	0,3356
College	-0,4767	1,2293	0,6982
Trade/Vocational/other	-0,6818	1,2499	0,5854
Apprentice	1,3498	3,0208	0,655
High School diploma	0,7635	1,2174	0,5305
Marital Status (ref. Single, was married)	0	0	.
Partner/married	0,3164	0,911	0,7283
Single, never married	-0,7821	1,1253	0,487
Born in Canada (ref. No, outside Canada)	0,0725	0,7951	0,9273
N=733			.

Appendix K: Results (non-standardized) – Model 3

Table 29 Effects of essential skills of unsafe work practices

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	4,4078	1,4806	0,0029
Work conditions	0,2211	0,1898	0,244
Total hours worked in a week	-0,0087	0,0097	0,369
Schedule (ref. It depends)			
Usually weekdays	0,4868	0,2925	0,096
Usually week-ends	-0,1511	0,4333	0,7273
Usually evenings/overnight	-1,0047	0,5544	0,07
Union rate	-0,0088	0,0049	0,0714
Health Literacy Score	-0,0384	0,0425	0,3653
Numeracy score	-0,0109	0,0037	0,0031
Document Use Score	-0,0024	0,0038	0,524
Self-efficacy	0,0111	0,026	0,6701
Social network (size)	-0,1461	0,1215	0,2289
Age	-0,004	0,0135	0,7683
Gender (ref. female)	0,0069	0,3519	0,9842
Highest level of education (ref. Less than high school diploma	0	0	.
University degree	-0,5905	0,5791	0,3079
College	-1,133	0,4937	0,0217
Trade/Vocational/other	-1,2848	0,5117	0,012
High school diploma	-0,9076	0,444	0,0409
Marital Status (ref. Single, was married)	0	0	.
Partner/married	-0,0209	0,4416	0,9623
Single, never married	-0,2839	0,5207	0,5856
Born in Canada (ref. No, outside Canada)	-0,0694	0,3047	0,8197
N=404			

Table 30 Effects of unsafe work practices on physical health (total score)

Parameter	Estimate	Z	Pr > |Z|
Intercept	41,0921	8,93	<.0001
Unsafe work practices	-0,6783	-0,74	0,46
Work conditions	0,5382	0,89	0,3759
Total hours worked in a week	-0,0627	-2,56	0,0105
Schedule (ref. It depends)			
Usually weekdays	-1,3381	-1,47	0,1421
Usually week-ends	0,0031	0	0,9982
Usually evenings/overnight	-0,877	-0,62	0,5351
Union rate	-0,0236	-2,11	0,0352
Health Literacy Score	0,208	1,96	0,0502
Numeracy score	0,021	2,08	0,0379
Document Use Score	0,0103	0,94	0,3488
Self-efficacy	-0,0326	-0,37	0,7099
Social network (size)	0,5495	1,74	0,0822
Age	0,0016	0,04	0,9717
Gender (ref. female)	0,7965	1,13	0,2591
Highest level of education (ref. Less than high school diploma			
University degree	-1,5192	-0,88	0,3812
College	0,2691	0,19	0,8525
Trade/Vocational/other	-1,0242	-0,59	0,5533
High school diploma	-1,6238	-1,25	0,2101
Marital Status (ref. Single, was married)			
Partner/married	-0,671	-0,56	0,5732
Single, never married	0,1916	0,13	0,893
Born in Canada (ref. No, outside Canada)	0,3781	0,42	0,6741
N=374			

Table 31 Effects of unsafe work practices on bodily pain

Parameter	Estimate	Z	Pr > |Z|
Intercept	28,6552	2,03	0,042
Unsafe work practices	-0,6841	-0,33	0,7389
Work conditions	0,7229	0,47	0,6363
Total hours worked in a week	0,0637	0,95	0,3447
Schedule (ref. It depends)			
Usually weekdays	-5,6099	-2,2	0,028
Usually week-ends	-1,7729	-0,37	0,7118
Usually evenings/overnight	-5,6662	-1,43	0,1533
Union rate	-0,0417	-1,36	0,1749
Health Literacy Score	1,2175	3,11	0,0019
Numeracy score	0,018	0,54	0,5899
Document Use Score	0,021	0,67	0,5028
Self-efficacy	0,5736	2,23	0,0254
Social network (size)	1,9422	2,13	0,0332
Age	-0,0794	-0,6	0,5484
Gender (ref. female)	2,1896	1,15	0,2513
Highest level of education (ref. Less than high school diploma			
University degree	-7,2234	-1,45	0,1463
College	-1,569	-0,4	0,6869
Trade/Vocational/other	-2,2508	-0,56	0,574
High school diploma	-4,102	-1,11	0,2652
Marital Status (ref. Single, was married)			
Partner/married	-0,5402	-0,14	0,8859
Single, never married	-0,0666	-0,02	0,9873
Born in Canada (ref. No, outside Canada)	-3,6959	-1,74	0,0822
N=402			

Table 32 Effects of unsafe work practices on role limitations from physical health

Parameter	Estimate	Z	Pr > |Z|
Intercept	11,5594	0,67	0,5004
Unsafe work practices	-2,056	-0,75	0,4527
Work conditions	4,7409	3,34	0,0008
Total hours worked in a week	-0,1762	-1,78	0,0745
Schedule (ref. It depends)			
Usually weekdays	-5,0509	-1,66	0,0969
Usually week-ends	8,1185	2,05	0,0401
Usually evenings/overnight	-2,1504	-0,53	0,5944
Union rate	-0,0692	-1,87	0,0609
Health Literacy Score	1,4136	3,22	0,0013
Numeracy score	0,0871	2,42	0,0155
Document Use Score	-0,0205	-0,64	0,5222
Self-efficacy	0,3516	1,42	0,1554
Social network (size)	1,0443	0,89	0,3741
Age	0,0745	0,47	0,6358
Gender (ref. female)	1,8075	0,73	0,4643
Highest level of education (ref. Less than high school diploma			
University degree	-11,4292	-2,07	0,0388
College	-5,4689	-1,07	0,2825
Trade/Vocational/other	-6,3416	-1,05	0,2922
High school diploma	-4,045	-0,94	0,3448
Marital Status (ref. Single, was married)			
Partner/married	0,5891	0,17	0,8645
Single, never married	2,8102	0,66	0,5111
Born in Canada (ref. No, outside Canada)	2,1663	0,84	0,399
N=393			

Table 33 Effects of unsafe work practices on physical functioning

Parameter	Estimate	Empirical Standard	Pr > |Z|
Intercept	49,0013	18,7591	0,009
Unsafe work practices	2,2563	3,5097	0,5203
Work conditions	1,4661	2,1648	0,4983
Total hours worked in a week	-0,2164	0,1004	0,0312
Schedule (ref. It depends)			
Usually weekdays	-6,8627	3,6129	0,0575
Usually week-ends	-1,5639	4,9133	0,7503
Usually evenings/overnight	-7,5547	4,4085	0,0866
Union rate	-0,0569	0,0351	0,1049
Health Literacy Score	0,9122	0,4623	0,0485
Numeracy score	0,0701	0,0412	0,0893
Document Use Score	0,0356	0,0382	0,3513
Self-efficacy	-0,484	0,3323	0,1452
Social network (size)	1,6591	1,084	0,1259
Age	0,142	0,1638	0,3861
Gender (ref. female)	4,7154	2,748	0,0862
Highest level of education (ref. Less than high school diploma			
University degree	-3,1604	6,1668	0,6083
College	-1,5972	6,1456	0,795
Trade/Vocational/other	-3,3547	5,6333	0,5515
High school diploma	-7,618	5,3085	0,1513
Marital Status (ref. Single, was married)			.
Partner/married	1,4905	3,8406	0,6979
Single, never married	6,5128	4,8341	0,1779
Born in Canada (ref. No, outside Canada)	0,8171	2,9697	0,7832
N=395			

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