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ABSTRACT

A Scientific Approach to Addressing Social Issues Using Administrative Data*

Linked administrative data on education, health, social services, and crime from British Columbia, Canada, are used to document the relationship between measures of secondary educational attainment and indicators of poor outcomes later in life. Poor outcomes are seen to manifest primarily among high school dropouts. Next, we document the ability of characteristics observed in administrative data in grade 4 to predict high school graduation using a very simple model. It is straightforward to identify more than one fifth of future dropouts reasonably accurately. Non-cognitive measures (esp. social and emotional characteristics) are better predictors of educational attainment than cognitive ones. We discuss the implications of these findings for a scientific approach for developing interventions to prevent poor outcomes later in life.

JEL Classification: I24, I24, I38

Keywords: poverty alleviation, high school graduation

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1 Introduction

We make the case for ameliorating social concerns such as poverty, crime, homelessness, and drug and alcohol abuse by means of preventative interventions focusing on helping children identified using rigorous analysis based on administrative data. The paper has four parts. The first describes the data. The second, using cross-tabulations of measures reflecting major social issues by secondary educational status from over one million students in the Canadian province of British Columbia's (BC's) educational system, shows that roughly three quarters of these social issues are manifested in people who had not completed high school. The third part presents a cross-tabulation of observed and predicted educational attainment derived from grade 4 characteristics as reflected in administrative data. It shows that it is straightforward to identify five percent (2,000 children in BC) from each cohort who are at extreme risk of poor educational attainment.

Combining our results with findings from the literature on the costs to government and all of society from non-completion of high school (e.g., Levin and Rouse, 2012) and findings on the effectiveness of some interventions to deflect at-risk children onto better trajectories such as James J. Heckman (2023), leads to the fourth part of the paper. In it, we advocate for a systematic scientific (in the Popperian sense) approach to designing policies and operating programs to address these social concerns and to ameliorate the outcomes of many individuals while reducing costs to taxpayers.

Putting aside the human cost of ignoring the plight of these children, the social problems that will be manifest in them and their children will impose substantial costs on government and society. Cecilia Rouse, current chair of the US Council of Economic Advisors, put the net present value of savings to government from converting a non-graduate to a high school graduate at \$127,000 (Levin and Rouse, 2012). While the use of this single number is misleading both because different savings will be achieved across different margins and because findings in the United States do not necessarily apply in other jurisdictions, other work with our BC data indicates that total savings to government from converting a nongraduate to a graduate is likely of this order of magnitude (Green et al., 2023). This suggests that it would be worthwhile, from the taxpayer's perspective, to spend on the order of magnitude of \$9,000 per student in grade 4 who is near the bottom of the distribution of educational outcomes, for an intervention that increases their high school graduation rate from 30 percent to 40 percent.

At first blush, the solution seems clear: governments should invest in proven interventions early in children's lives and improve both efficiency and equity in our society. But there are challenges. In informal discussions, a BC cabinet member pointed to a deficiency in public trust as one challenge, noting the very long time between investment and payoff, and low levels of public trust in statements made by government officials. On another front, senior civil servants pointed to the problem of "silos" in the very large public sector. For example, information on who needs services is available to the Ministry of Education, but it is not available to the ministries that would provide relevant services such as the Ministry of Children and Family Development, or Health. To that end, the fourth part

of the paper also discusses ways to gain public trust and the data needed to do that. The fourth part additionally, and centrally, discusses the challenges of identifying interventions that work, and includes a brief history of why economists and many others favour random assignment as a trustworthy method of determining whether interventions achieve their objectives. We argue that these considerations lead to a scientific approach to identifying effective interventions like that proposed by the Evidence-Based Policymaking Collaborative (2016).

2 Data

The administrative data was provided to us as part of the work of BC's Basic Income Panel (<https://bcbasicincomepanel.ca/>) and is related to:

- Education;
- Income Assistance;
- Child Protection;
- BC Provincial Corrections;
- Health, including births, deaths and health care usage; and
- Demographics.

The education data came from three sources. First, censuses conducted at least once per year identify every student in the school system, together with their school, grade and indicators for eligibility for additional programming (esp. special needs). Funding provided to the school districts is based on these censuses, so they are subject to audit. Second are the Foundation Skills Assessments (FSA), which are province-wide assessments of numeracy and literacy undertaken each year by students in grades four and seven. The third is the Transcripts and Examinations system, which records progress towards graduation including marks on courses required for graduation and student credentials awarded. The first and third contain information for school years 1991/1992 through 2016/2017. The FSAs began in 1999/2000 and our data includes assessments up to and including 2016/2017.

The Ministry of Social Development and Poverty Reduction provided us with a file identifying each person who received Income Assistance in each month from February 1989 to December 2017. The data allow us to identify which persons were homeless. The number of people identified as homeless in this file (e.g., just over 8,000 people November 2017) is close to homelessness counts for the province in 2017 as reported in a joint report by the Homelessness Services Association of BC, Urban Matters and the BC Non-Profit Housing Association (2018). Our indicator of homelessness takes the value 1 if the individual was homeless in any month in 2017.

The Ministry of Children and Family Development provided us with a file identifying each of the children in care at the end of each month from April 1998 to February 2019.

The Ministry of Public Safety and Solicitor General provided us with a file of adults interacting with BC Provincial Corrections (those sentenced to provincial institutions or probation, and those sentenced in the federal system from a court in BC). This “event” file is for the period 2008 to 2018. This gives us a window into corrections involvement, but, because of the time limits, not a complete picture. The members of our sample born in 1990 turned 18 in 2008, so we can observe them from the onset of their adult corrections involvement, but they were 28 in 2018, when our data ends. So we will miss more than the about 25 percent of cases where lifetime criminality’s onset of criminality is later (Beckley et al. 2016). Among those born after 1990, or 1991 etc., we will miss those whose onset of criminality is after age 27, 26, etc. Among those born earlier, we will miss two groups: 1) those whose most recent offence is at a young age and whose sentence is not sufficiently long for them to be in the corrections system when the data starts; and 2) those who were sentenced to a federal penitentiary before the start 2008 and whose sentence ended after 2018.

The Ministry of Health provided us with four files beginning in the 1980’s and containing data to March 2018. One contains physician billings, which identifies the patient, the physician, the service provided, the date and a three-digit International Classification of Disease Version 9 (ICD-9) diagnosis. The second file, the Discharge Abstract Database, contains records of all in-patient hospital stays, diagnoses, procedures and dates. The third file identifies all individuals registered with BC’s Medical Services Plan. It contains registration date, cancellation date, reason for cancellation and a contract number which would be shared with at least one parent and with siblings. The fourth file, Pharmanet, contained all prescriptions dispensed in BC outside of hospitals from January 1996 until March 2018.

The Vital Statistics Agency provided files of births, deaths, and marriages from January 1985 to December 2017.

2.1 Linkage

Records were linked by Population Data BC (2022). No documentation on linkage was provided, but we did have a few informal meetings regarding linkage and worked with the data. What follows is our understanding of the linkage process. Datasets from different Ministries were linked using both deterministic and probabilistic methods. Medical records in BC, including birth and death records, had a numerical identifier for the years for which we had data. The Medical Services Plan (MSP) number was used initially, but on April 1, 1991, it was replaced by the Personal Health Number. Medical records were, therefore, linked deterministically to each other and to the birth and death records.

The Ministries of Social Development and Poverty Reduction and Children and Family Development were a single Ministry of Social Services and Housing until 1996 and they used a single registry of clients with a single personal identification number which would allow records from those ministries to be linked deterministically. In the early 1990’s the then Ministry of Social Services and Housing began paying MSP premiums for Income Assistance

recipients. To facilitate this, the Personal Health Number was stored, allowing deterministic linkage between those Ministries and health records.

The Ministry of Education created a Personal Education Number for each student, and records with the Ministry of Education were linked using this number.

Education files and Income Assistance files for years prior to 1993 were linked to health files probabilistically using name, birth date and postal code by PopData BC which used Statistics Canada's Generalized Record Linkage Software (GRLS).

PopData reported that some records were unlinkable. We assessed the linkage rate by calculating the percentage of non-matches among expected matches in pairs of files. We found that around five percent of matches were missed (Appendix B). This will attenuate the relationships reported in the remainder of the paper.

3 Social issues and educational attainment

In this section we report the presence of social issues by secondary educational attainment. Our sample comprises the 1,089,330 students who:

- Were born in the years 1976 to 1997,
- Had linkable study identification numbers,
- Were registered with the BC education system, assigned to a grade in at least one year and never listed as non-resident of BC,
- Were between the ages of six and sixteen when they were in grade 8,
- Entered grade 8 before 2013; and
- Were registered with BC's Medical Services Plan continuously while they were 16 and 17 years of age.

We selected birth years 1976 to 1997 because our graduation data runs from 1992 to 2017. The oldest members of this sample could graduate two years early and the youngest could graduate three years late and still be observed. The oldest (1976) cohort will have turned 41 in 2017, the last year for most of the datasets. The youngest cohort (1997) will have turned 20 in 2017. MSP registration is a good proxy for whether an individual is living in the province; we restrict our sample to those registered with MSP while they were 16 and 17 to ensure that all individuals in our sample were highly unlikely to have moved out of province before graduating.

3.1 Groupings of educational attainment

Currently, the Ministry of Education reports a six-year Completion Rate, which is, "an estimate [of] the percentage of BC students who graduate with a BC Certificate of Graduation ('Dogwood') or BC Adult Graduation Diploma ('Adult Dogwood'), within six years from the first time they enroll in Grade 8" (Government of British Columbia 2023). However, some Ministry of Education staff point out that this is very broad, encompassing both those who had a minimum course load, and low but passing marks, and those who took as many

challenging courses as they could fit into their schedule and excelled in all of them. In our analysis, we capture this variation by dividing our sample into seven distinct categories.

1. Those who received a dogwood diploma within 5 years of their entering grade 8, took and passed English 12, and had a Grade Point Average of 3.0 or better,
2. Those who received a dogwood diploma within 5 years of their entering grade 8, took and passed English 12,
3. Those who received a dogwood diploma within 6 years of their entering grade 8, took and passed English 12,
4. Those who received a dogwood diploma within 6 years of their entering grade 8,
5. Those who received an adult dogwood graduation diploma within 6 years of their entering grade 8,
6. Those who entered grade 12, but did not graduate within 6 years of their entering grade 8, and
7. Those who did not enter grade 12 and did not graduate within 6 years of their entering grade 8.

Graduation requirements include successfully completing a course in the grade 12 language arts program: the vast majority of students take either English 12 or the less challenging Communications 12. The median GPA is approximately 3.0, so the first group comprises average or better students. Reflecting the Ministry's measure, we distinguished between those who graduated on time and those who graduated one year late. Recently, the Ministry began to define students who received an Adult Graduation Certificate within 6 years of grade 8 as graduates, so we do the same throughout. Among students who did not graduate, we distinguished between those who made it to grade 12 and those who did not.

Figure 1 shows the distribution of these seven groups in our sample. The largest group graduated on time, took English 12 and received a GPA of 3 or higher. This group is well-positioned to transition to post-secondary. The second largest group also graduated on time, and while they did take English 12 they did not have a high GPA. The third and fourth groups both graduated within six years of their grade 8 graduation; the third group passed English 12, but the fourth group did not. Adult graduation within six years refers to individuals who left school, but subsequently enrolled in adult education classes and received a certificate within six years of their grade 8 year. It is a small group, identified separately from students who graduated. However, when we refer to students who have not graduated in the text, we include this group. The sixth group did not graduate within six years, although 11 percent of them did eventually receive a Dogwood certificate. The seventh group never registered in grade 12. Less than one-half of one percent of them ever received a Dogwood certificate.

Figure 1. Educational attainment of sample

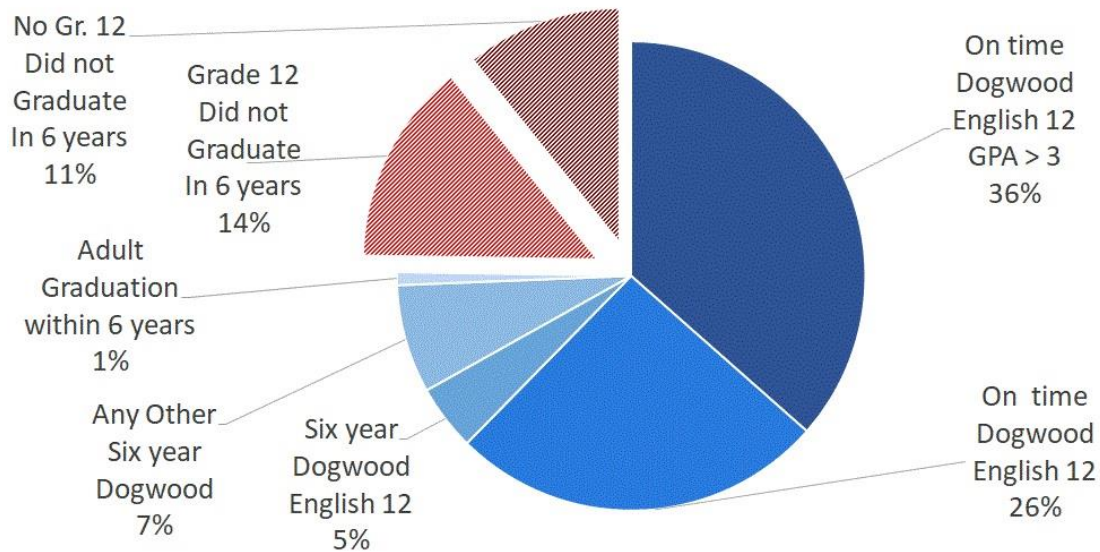
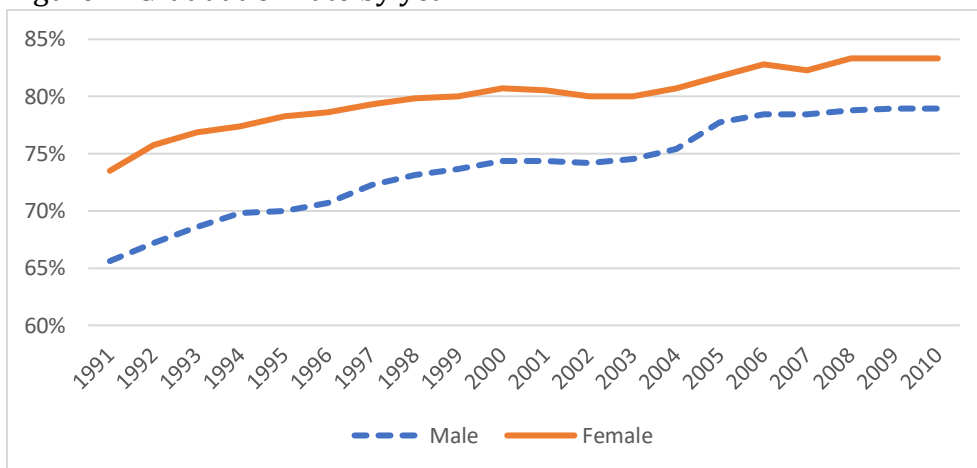


Figure 2 shows the percentage of students who graduated using the 6-year definition, by the year they entered grade 8 starting in 1991. The trend towards higher graduation rates reflects, among other issues, general trends in society towards increased educational attainment, as well as numerous policy changes in the province. For a discussion of the impacts of changes in graduation requirements, see Filiasov and Sweetman (2022). The evolving predictive power of not graduating high school for future outcomes is clearly something that will need to be revisited for future cohorts of graduates. Potentially, as graduation rates rise those who marginally exceed the threshold for graduation may benefit from the early interventions we are advocating nearly as much as those who have not, historically, completed high school.

Figure 2: Graduation rate by year



Finally, the graduation rate averaged six percentage points higher for female students over the entire period, falling from an average of eight percentage points in the first four years to an average of just over four percentage points in the last four.

4 Outcomes by secondary school performance

We consider six distinct outcomes:

1. **Income assistance:** For each child, the numerator is the total number of months of IA received as an adult and the denominator is the number of months that they lived in BC after age 19.
2. **Homelessness:** An indicator for whether they were homeless at any time during 2017,
3. **Corrections:** An indicator for whether they ever interacted with the corrections system between January 2008 and March 2018,
4. **Mortality:**
 - (a) All cause, and
 - (b) Accidental poisoning by and exposure to noxious substances,
5. **Mental Health:**
 - (a) A monthly indicator for MSP billings with a mental health diagnosis,
 - (b) A monthly indicator for MSP billings with a diagnosis related to alcohol or drugs,
 - (c) A monthly indicator for Prescriptions for treatment of alcohol or drug use disorders, and
 - (d) A monthly indicator for Prescriptions for psychotherapeutic drugs, and
6. **Children in Care in the subsequent generation:** For each woman 19 or older, the numerator is the total number of months in which at least one of their children was in care and the denominator is the number of months beyond age 18 that we could have observed a child in care. This ratio will be higher the more children the mothers have, the younger they are when they have these children, and the more likely they are to have a child placed in care.

For each titular outcome and by education group, in Table 1 and subsequent similar tables we report:

- the risk of that outcome by education category,
- the risk, relative to the risk for the highest/largest education category, and
- the percentage of the total population with the relevant outcome that is accounted for by that education category.

4.1 Income Assistance

The percent receiving IA has a strong inverse relationship with educational attainment. While about half of one percent of students who graduated on time with an above-average GPA received IA in an average month, over 20 percent of females and 13 percent of males in column 7 received IA in an average month. The two other categories of those who did not complete high school are also very high. In this sample, 78 percent of IA was paid to students who had not graduated high school. The group with the lowest education (rightmost column) were about 33 times (females) and 26 times (males) more likely to receive IA than the group with the highest educational outcomes.

Table 1: Income Assistance by level of secondary education

High School Graduation		<=5 yrs	<=5 yrs	6 yrs	6 yrs	Adult	No	No Grd 12
Completed English 12		Yes	Yes	Yes	No	NA	NA	NA
GPA		GPA>3	GPA<3	NA	NA	NA	NA	NA
	Gender	1	2	3	4	5	6	7
Risk	F	0.6%	1.8%	3.6%	7.3%	13.4%	15.8%	20.5%
	M	0.5%	1.0%	2.4%	3.2%	6.7%	10.5%	13.1%
Relative risk	F	1	2.9	6.0	12.0	21.9	25.8	33.6
	M	1	2.1	4.8	6.4	13.3	20.7	26.0
Percent of total	F	5%	9%	3%	7%	2%	40%	35%
	M	3%	7%	2%	7%	1%	41%	38%

4.2 Homelessness

The relationship between homelessness and educational attainment is even stronger than the relationship between IA and high school education outcomes as seen in Table 2.

Table 2: Homelessness in 2017 by level of secondary education

High School Graduation		<=5 yrs	<=5 yrs	6 yrs	6 yrs	Adult	No	No Grd 12
Completed English 12		Yes	Yes	Yes	No	NA	NA	NA
GPA		GPA>3	GPA<3	NA	NA	NA	NA	NA
	Gender	1	2	3	4	5	6	7
Risk	F	0.1%	0.2%	0.4%	0.7%	2.3%	1.9%	3.1%
	M	0.1%	0.2%	0.3%	0.5%	2.0%	1.9%	3.3%
Relative risk	F	1.0	4.0	6.8	12.6	43.2	35.0	58.4
	M	1.0	3.5	6.0	9.6	38.8	36.9	64.6
Percent of total	F	4%	9%	3%	5%	3%	36%	41%
	M	2%	6%	2%	6%	2%	35%	47%

Naturally, homelessness is rare in our sample. About one-twentieth of one percent of (both female and male) students who graduated on time with an above-average GPA were homeless in any month in 2017, compared to three percent of females and males who didn't make it to grade 12. Eighty percent (female) and 84 percent (male) of the homeless in our sample were students who had not graduated high school. The group with the lowest education were 58 times (females) and 65 times (males) more likely to be homeless than the group with the highest educational outcomes.

4.3 Criminality

Table 3 shows the percentage of each group that was seen in the BC Provincial Corrections "event" file between 2008 and 2018. Those in the lowest education category were almost 42 times (females) and 38 times (males) more likely to be in this file. Averaging across categories, about three-quarters of the people in the criminality file had not graduated high school.

Table 3: Corrections by level of secondary education

High School Graduation		<=5 yrs	<=5 yrs	6 yrs	6 yrs	Adult	No	No Grd 12
Completed English 12		Yes	Yes	Yes	No	NA	NA	NA
GPA		GPA>3	GPA<3	NA	NA	NA	NA	NA
	Gender	1	2	3	4	5	6	7
Risk	F	0.1%	0.3%	0.3%	0.8%	1.7%	1.8%	2.9%
	M	0.2%	0.9%	1.1%	2.1%	5.4%	5.0%	8.1%
Relative risk	F	1.00	3.62	4.71	11.49	23.59	25.05	41.68
	M	1.00	4.16	5.25	9.95	25.28	23.33	37.57
Percent of total	F	4.7%	10.4%	2.3%	6.3%	2.2%	34.5%	39.5%
	M	2.5%	11.2%	2.2%	9.1%	2.1%	32.9%	40.0%

4.4 Early mortality

All-cause mortality is reported as deaths per million per month. That is, the numerator reflects the total number of people who died, and the denominator is the number of months that our sample was alive and in BC. The overall mortality rate is comparable to that reported by Statistics Canada. The relationship between all-cause mortality and educational attainment is notably less pronounced than the similar relationships for crime and income assistance. However, averaging across the rightmost three categories, 54 percent of people who died prematurely in this sample were students who did not graduate high school.

Deaths due to accidental poisoning by and exposure to noxious substances, the International Classification of Disease (ICD-9 & 10) codes that include fentanyl poisoning,

have a much more pronounced gradient with education. Those with the lowest level of education were 38 (female) and 19 (male) times more likely to die with this cause.

4.5 Mental Health

Like all-cause mortality in Table 4, the education gradient in physician billings with a mental health diagnosis (ICD-9 codes 290 to 319 plus BC code 50B) is flatter than for those for the other outcomes examined here. The relative risk for students who had not graduated high school is just 2.3 times that for the top group. However, when we examine drug and alcohol issues the steeper gradient re-emerges. The bottom panel of the table shows that those with the lowest level of education were 27 (female) and 21 (male) times more likely to be diagnosed with ICD-9 codes 291 (Alcoholic psychoses), 292 (Drug psychoses), 303 (Alcohol dependence syndrome), or 304 (Drug dependence).

This pattern is repeated for prescription medication in the second to bottom panel of Table 5. The education gradient is not as pronounced for psychotropic medicines in general (AHFS codes 28:16). But when we restrict the analysis to drugs used to treat alcohol and opioid use disorder¹, the strong gradient re-emerges.

¹ Methadone, Buprenorphine (Suboxone), Naltrexone, Clonidine, Acamprosate (Campral), and Disulfiram (Antabuse).

Table 4: Mental Health by level of secondary education

High School Graduation		<=5 yrs	<=5 yrs	6 yrs	6 yrs	Adult	No	No Grd 12
Completed English 12		Yes	Yes	Yes	No	NA	NA	NA
GPA		GPA>3	GPA<3	NA	NA	NA	NA	NA
	Gender	1	2	3	4	5	6	7
MSP all MH								
Risk	F	3.1%	4.1%	4.9%	5.3%	7.6%	6.8%	6.7%
	M	1.8%	2.2%	2.9%	2.8%	4.2%	4.2%	4.4%
Relative risk	F	1.0	1.3	1.6	1.7	2.4	2.2	2.1
	M	1.0	1.2	1.6	1.5	2.3	2.4	2.5
Percent of total	F	28%	24%	5%	6%	1%	21%	15%
	M	16%	23%	4%	9%	1%	25%	21%
MSP Alcohol and drug								
Risk	F	0.1%	0.2%	0.3%	0.5%	1.2%	1.0%	1.8%
	M	0.1%	0.3%	0.3%	0.5%	0.8%	1.0%	1.6%
Relative risk	F	1	3.3	5.1	7.4	17.6	15.5	27.1
	M	1	3.4	4.3	6.5	10.6	13.4	20.8
Percent of total	F	6%	13%	3%	6%	2%	31%	40%
	M	4%	14%	3%	9%	1%	31%	39%
Psychotherapeutic Prescriptions								
Risk	F	1.6%	2.1%	2.7%	2.9%	3.6%	3.9%	4.2%
	M	0.8%	1.0%	1.5%	1.4%	1.8%	2.5%	2.8%
Relative risk	F	1.0	1.3	1.7	1.8	2.3	2.4	2.6
	M	1.0	1.2	1.8	1.6	2.2	3.0	3.4
Percent of total	F	27%	24%	5%	6%	1%	22%	15%
	M	14%	20%	4%	9%	1%	28%	24%
Prescriptions related to alcohol and drugs								
Risk	F	0.03%	0.09%	0.17%	0.21%	0.49%	0.54%	1.22%
	M	0.03%	0.09%	0.13%	0.19%	0.24%	0.55%	0.96%
Relative risk	F	1.0	3.3	6.2	7.4	17.3	19.1	43.6
	M	1.0	3.4	5.2	7.3	9.2	21.2	37.1
Percent of total	F	5%	10%	3%	4%	1%	30%	46%
	M	2%	10%	2%	7%	1%	34%	45%

4.6 Next generation: Children in Care

The study identification numbers are attached to the records of children in care (i.e., those in foster care) using birth records. Table 6 shows the percentage of the women in each group who had a child in care in the months between the earlier of their 18th birthday and April 1998 (the first month of children in care data) and the earlier of the month of their death, the last month that they were registered with BC's MSP and December 2017 (the last month of MSP registration data). That is, the numerator is the total number of months in which at least one of their children was in care over this period and the denominator is the number of months beyond age 18 that we could have observed a child in care. This ratio will be higher the more children the mothers have, the younger they are when they have these children, and the more likely they are to have a child placed in care.

The gradient across measures of educational outcomes is the steepest of those addressed in this paper. Women who graduated on time with an average or better GPA almost never have a child in care. In contrast, about 1.8 percent of women who did not make it to grade 12 have a child in care in any given month. Overall, averaging across the last three categories, about ninety percent of months in care are for the children of mothers who did not graduate from high school.

Table 5: Next generation Children in Care by level of secondary education

High School Graduation	<=5 yrs	<=5 yrs	6 yrs	6 yrs	Adult	No	No Grd 12
Completed English 12	Yes	Yes	Yes	No	NA	NA	NA
GPA	GPA>3	GPA<3	NA	NA	NA	NA	NA
	Gender	1	2	3	4	5	6
Risk	F	0.0%	0.0%	0.1%	0.2%	0.4%	0.8%
Relative risk	F	1.0	4.8	10.0	23.1	49.9	98.9
Percent of total	F	1%	4%	1%	3%	1%	37%

5 How well can we predict educational attainment?

How well can the administrative data to which we have access (which, though extensive, is only a subset of that collected by provincial governments) predict at an early age which children will eventually land in each of our educational categories? The answer, we find, is remarkably well. Half of the students who did not graduate are in the bottom 15 percent of predicted educational attainment in grade 4. While 31 percent of children in the bottom five percent of predicted educational attainment in grade 4 graduate, most of those have poor academic records. Only one percent of those in this bottom ventile graduate on time with English 12 and at least an average GPA.

Using data from 1999 to 2005, we estimate the parameters of a very simple ordinary least squares model with high school graduation as the dependent variable using the data for all years except 2002/2003. We then use these parameters to predict educational attainment using the 2002/2003 data and compare to the observed outcomes. The model is estimated using a linear probability model separately for males and females. Undoubtedly the quality of predictions obtained from these data could be improved using a machine learning algorithm, model averaging, or other more advanced techniques. However, we want to show how much can be done with a very simple statistical approach. Our approach represents a lower bound on predictive accuracy given the current state of econometric practice.

Our sample is students in grade 4 from 1999 to 2005 inclusive. We started with 330,313 distinct students, but we then removed the following observations.

- 8,135 students who had a special need indicating severe physical or intellectual barriers to graduation (code in brackets):
 1. Physically Dependent (A)
 2. Deafblind (B)
 3. Moderate to Profound Intellectual Disability (C)
 4. Physical Disability or Chronic Health Impairment (D)
 5. Deaf or Hard of Hearing (F)
 6. Autism Spectrum Disorder (G) 7. Severe Learning Disability (J)
 8. Mild Intellectual Disability (K)
- 723 homeschooled (grade= 'HOME SCHOOLED STUDENT')
- 559 ungraded students (grade = 'ELEMENTARY') who were in the school system the year that they turned 9
- 19,274 students who were not registered with BC's MSP continuously for the 24 month period ending on their 18th birthday (The students remaining in our sample are, therefore, very likely to have completed their secondary schooling in BC.)
- 696 students who were ever classified "Non Resident"
- 34 students who were only ever listed as Home Schooled
- 54,042 students who were not born in BC (So that we have a more complete history of their interaction with the social and health care systems.)
- 41 students who were less than 8 or more than 12 in the reference year
- 84 students who died before their 18th birthday. (On inspection, these may have been data issues—students who were not dropped from the MSP registration file at their death or whose date of death had not been entered correctly.)
- 28 students in federally funded schools

This leaves a sample of 249,261 students.

5.1 The explanatory variables

Our ability to predict later educational achievement from characteristics at age 10 will depend on the extent to which the “die is cast” by age 10 and, assuming that the outcome is not almost entirely random (or primarily a function of post-age 10 measures), whether the measures in our data are good predictors. Of course, specification of the model is also relevant. We construct predictors (the explanatory variables in our model) from records provided by the Ministries of Education, Health (including the Vital Statistics Agency), Social Development and Poverty Reduction, and Children and Family Development, as well as Statistics Canada.

While a large number of predictors makes interpretation difficult, especially when many of the variables are highly correlated, our purpose is to predict later educational attainment rather than to establish causal links. Hence, we employ more than 400 variables that are described in Appendix A and provide the following overview of key variables.

5.1.1 Ministry of Education

Measures of performance on the Foundation Skills Assessments (FSA) in reading, writing and numeracy in grade 4 are very important predictors. For example, an ordinary least squares regression predicting grade 10 English exam marks using only FSA information has an R^2 of 0.21, whereas a model with all explanatory variables has an R^2 of 0.31.

Additional variables derived from the school census identify students funded for special needs and English as a Second Language services. It also identifies students whose language normally spoken at home is neither English nor French.

5.1.2 Ministry of Health

Residents of BC must register with the MSP within three months of moving to BC. Except when the province has responsibility for the child, at least one parent shares an MSP contract number with their children. Sharing a contract number indicates some degree of attachment between adults. In our sample, 77 percent of parents who identified themselves as ‘married’ on birth records share a contract number. Information on contract number sharing and the termination of sharing is included as proxies for family composition and separation. MSP premium subsidies and an indicator for whether an employer paid MSP premiums provide proxies for economic status.

5.1.3 Birth records

Birth records identify mother, child and, in 83 percent of records, the father, together with the parents’ self-declared marital status.

5.1.4 Medical services plan

MSP billings by physicians contain a 3-digit ICD-9 diagnostic code allowing us to construct indicators of disorders for the students and their parents. Hospital discharge abstracts identify all hospitalizations, together with diagnostic codes. Drugs dispensed outside hospitals are identified in the PharmaNet database.

5.1.5 Other

Data from the Ministry of Social Development and Poverty Reduction allowed us to include the number of months of income assistance each student's family received before the student entered grade 4. Data from the Ministry of Children and Family Development identifies children who had been in care or who had a Child and Family Services case file prior to grade 4. Finally, Statistics Canada provided household income decile by postal code. These were attached to students using the grade 4 postal code in their MSP registration file.

5.1.6 Notable missing data

Researchers at the University of Chicago have been working on identifying students who will not graduate high school since the 1990's (Allensworth and Easton 2007; also see Appendix D). In their models, which include standardized test scores, socioeconomic status, and other personal characteristics, school attendance patterns have the highest predictive power by far. They also point to the importance of course marks. Attendance and marks are available in the Ministry of Education's data files but were not available to this project.

Turney and Goodsell (2018) report that parental incarceration is a well-established indicator that children will have problems in school. BC has incarceration data going back to the 1970's but those data were not available to this project.

Attitude towards education by both children and parents is an important factor that would improve our estimates (Foley, Gallipoli and Green, 2014). When predicting high school graduation Borghans et al. (2016, 13354), among others, have pointed to the importance of psychological/non-cognitive measures. They report that "Personality is relatively more important in predicting grades than scores on achievement tests," and "Personality is generally more predictive than IQ of a variety of important life outcomes." These items could be collected by survey, potentially by modifying one of the three different surveys that are administered to school children in BC each year.

Finally, we note that teachers are in a much better position to identify children who are likely to thrive and those who are not. This is because they have access to all marks, and daily, observe the students and each student's interactions with other students, teachers, and the physical environment. Teachers' valuable insights could be collected by survey as is done with the Early Development Indicator.

5.2 Results

Table 7 shows the eventual educational attainment of each student (i.e., the seven categories defined earlier) on the vertical axis, and the ventile of their predicted probability of graduation based on the data available in grade 4 in the horizontal axis. Recall that this is an out-of-sample prediction. The predictions are for students in grade 4 in 2002/2003, but the predictions are from a model whose parameters were estimated using data for other years.

The first column includes those whose predicted outcomes were in the bottom five percent of the cohort, and the second column includes the next five percent, etc. The first column shows that only $[28/(\text{sum of all observations in the first column}) * 100\% =]$ 1.0 percent of children in the bottom five percent in grade 4 will go on to graduate on time with English 12 and a GPA that is at least average. Taking the optimistic view that graduates from adult courses within six years are graduates, then $[(753+616)/(\text{sum of all observations in the first column}) * 100\% =]$ 66 percent of students in the bottom ventile of predictions did not graduate. Moreover, of all those who did not graduate high school within six years (the sum of all observations in the bottom two rows), 22.0 percent were in the lowest ventile. Overall, our very simple approach can reasonably accurately identify those most likely to have difficulties completing high school.

Although Table 7 is a simple cross tabulation, it demonstrates that reasonably accurate predictions of observed future educational outcomes are feasible. Undoubtedly, provincial governments could improve on the quality of these predictions using both more sophisticated models and more expansive data, but such improvements would only make the essential argument of this paper stronger.

Table 7: Secondary educational attainment by selected ventile of grade four achievement

Observed Graduation Group	Grade 4 prediction of end of high school achievement (ventiles 1 - 10 & 20)											Sum (%)
	1	2	3	4	5	6	7	8	9	10	20	
Distribution across ventiles (row %'s)												
On time Dogwood, English 12, GPA > 3	0.7	2.7	4.6	5.4	8.3	8.9	11.9	12.5	15.5	17.5	12.0	100
On time Dogwood, English 12	3.3	5.6	7.8	10.2	10.8	11.5	12.1	12.4	12.4	12.4	1.5	100
Six-year Dogwood, English 12	5.1	7.4	10.4	8.5	12.2	10.7	9.5	9.9	10.2	9.4	6.7	100
Any Other Six-year Dogwood	12.5	13.1	13.1	12.0	12.8	10.0	8.2	7.2	5.6	5.5	*	100
Adult Graduation within 6 years	20.4	18.5	13.1	11.8	12.1	9.9	4.1	5.4	4.8	*	*	100
Grade 12, but not graduate in 6 years	21.8	17.3	13.4	9.8	8.7	7.7	6.7	5.7	4.8	3.7	0.4	100
No Gr. 12, did not graduate in 6 years	33.0	19.3	13.4	9.1	6.3	6.4	3.7	3.7	2.7	2.4	*	100
Characteristics of Ventile												
% of ventile not graduating	69	52	39	29	22	21	16	14	11	8	2	NA
Cumulative % not graduating	22	38	50	59	66	72	77	82	85	88	100	NA

Note: A "Dogwood" is the name of the high school graduation certificate in British Columbia.... NA is not applicable, and * indicates that the result in that cell is too small to be released.

6 A Credible Path Forward

Section 4 of this paper showed that many social problems, including crime, poverty, homelessness, substance abuse and even intergenerational issues proxied by child apprehensions, are highly concentrated among students who have not graduated high school. Section 5 demonstrated that, using existing data sources and simple statistical methodologies, it is possible to identify more than one fifth of students who will not graduate with a better than 70 percent accuracy. In this section, we build on these two observations and discuss approaches to designing and implementing programs to alleviate these poor outcomes in society. Because there are many examples of interventions that have been shown in rigorous studies to be both effective and cost-effective at improving the outcomes of disadvantaged children, the potential to both improve well-being and (in the long run) reduce taxation exists. A key problem is that many interventions have also been shown not to pass a basic cost-benefit test and, even worse, sometimes they do not produce the hoped-for benefits regardless of the cost. Society (and government) need a credible approach to choosing between interventions and we propose a way forward. We also discuss approaches to overcoming barriers to implementing programs and making credible choices among alternatives—such as the structure of government and low levels of public trust—to achieve these improvements.

Concern about public trust is warranted, especially since the required programs have a long gap between costs and the benefits. While the Organisation for Economic Co-operation and Development (OECD 2022), Angus Reid Institute (2019), Edelman (2022) and Pew Research (Funk et al., 2020) all use different measures of public trust, they each document low levels of trust in government. For example, the OECD reports that 45% of respondents in Canada report trusting the federal government compared to 38% who do not; the remainder were neutral or did not know. Fortunately, not all trust has been lost. Edelman reports that while 43% of Canadians trust government, 75% trust scientists. Using a different measure, Pew Research reports that 45% of Canadians trust scientists compared with 14% who trust the federal government. This suggests that one method for getting public buy-in for funding for interventions to improve the well-being of children would be to seek the endorsement of the scientific community. We believe that obtaining the endorsement of the scientific community would be straightforward if interventions were selected using a system in which their impacts were measured in a way that was rigorous, independent, and routine.

Another limitation is the types of studies used to evaluate programs. In the academic and medical communities, randomized control trials (RCTs) are the ‘gold standard’; observational studies are usually less reliable, or even unreliable. When it comes to their health, Canadians, Americans and those in almost all countries in the world rely on RCTs for the evaluation of medicines. Somehow, however, at present we treat the education of our children as requiring less rigorous/less credible evaluations – or even no evaluation whatsoever. As early as the mid-1980s, and based on experiences to that point, it was recommended that going forward, the American Department of Labor “should perform a

selected set of classical experiments” (Stromsdorfer et al., 1985, page III-J-47). Several others pointed to the difficulties of replicating the credible results of randomized trials using observational techniques (LaLonde, 1986; Fraker and Maynard, 1987; and Heckman and Hotz, 1989). Random assignment is the one method for ensuring that estimates of impacts are rigorous.

In the United States, there was some hope that comparisons between experimental and observational estimates of impacts from programs under the Jobs Training Partnership Act (JTPA) might point to a combination of data and techniques that would provide guidelines under which observational studies would be reliable. But, after extensive investigation, Heckman and colleagues, concluded, “We present a rigorous definition of selection bias and find that in our data it is a small component of conventionally measured bias, but it is still substantial when compared with experimentally-estimated program impacts,” (Heckman et al. 1998, 1017).

Of course, random assignment to an intervention is neither a necessary nor a sufficient condition for reliability of a study. It is not sufficient because many factors, such as low response rates in surveys measuring outcomes, can undo the benefits of randomization. The What Works Clearinghouse of the US Institute for Education Sciences, for example, has a one-hundred-page manual detailing the conditions under which a non-observational/experimental study would be considered valid.² Murnane and Willett (2010, page 82) report that in its early days the Clearinghouse rejected 97 percent of studies of the effectiveness of interventions in elementary school mathematics. While in some cases randomization is not necessary because other research designs, such as regression discontinuity designs, will generate consistent estimates of impacts, such designs have limited application. Of course, as research methods develop and data quality improves we may yet discover observational methods that are sufficiently rigorous (Smith and Sweetman, 2016).

Shifting to an environment involving the regular use of random assignment in studies of social policy need not be difficult. In BC, new initiatives under the Academic Detailing program (Jin et al., 2012) and the Portraits program (Klimas et al., 2021) are routinely rolled out with random assignment—and the BC Cancer Agency has enrolled more than 34,000 patients in randomized trials. All that is needed is to apply this existing expertise in other areas.

The shift to rigorous and credible methods for evaluating interventions, such as those proposed to ameliorate the social concerns documented here, require fortitude and wisdom on the part of society and its leaders. First, rigorous methods often yield disappointing results about cherished programs. Some programs do not achieve their targets and this can be upsetting. Second, scientific process is messy, and sometimes involves public debates about the details of studies on the frontier of knowledge. Such debate is commonly observed in clinical trials. In our experience, most people expect evaluations of government programs to confirm that each program is effective (Fiszbein, 2011; Dumas-Mallet et al., 2017). But where interventions have been evaluated rigorously, the opposite is true. Haskins (2018)

² <https://ies.ed.gov/ncee/wwc/> (accessed 15 Feb 2023).

puts the failure rate at 70 to 80 percent for rigorously evaluated social programs. (See also Baron, 2013, 2015; Sawhill and Baron, 2010; and Manzi, 2012).

A well-known example of a large program not attaining a positive impact, in the US context, is *Scared Straight*. It has been a popular intervention intended to reduce re-offending, but rigorous evaluation found that participants were actually, on average, 68 percent more likely to reoffend than the control groups (McCord, 2003; Petrosino et al., 2013). Another example is a randomized trial of Tennessee’s pre-kindergarten. (Durkin et al., 2022, 470) found that the control group outperformed the treatment group; the “children randomly assigned to attend pre-K had lower state achievement test scores in third through sixth grades than control children, with the strongest negative effects in sixth grade. A negative effect was also found for disciplinary infractions, attendance, and receipt of special education services.” (See also Lipsey, Farran and Durkin, 2018.)

Difficulties finding successful interventions extend beyond social programs. Baron reports the following. “In medicine: reviews have found that 50-80% of positive results in initial (“phase II”) clinical studies are overturned in subsequent, more definitive RCTs (“phase III”)” (Baron 2013, 2). In education, of “interventions evaluated in [IES-commissioned] RCTs that our review identified as having no major study limitations (e.g., differential attrition, inadequate statistical power) ... 91% were found to produce weak or no positive effects” (Baron 2013, 1). In business, of 13,000 RCTs of new products/strategies conducted by Google and Microsoft, 80-90% have reportedly found no significant effects (Baron 2013, 2). Failure by an intervention to achieve a positive result is common, and to expect that all programs – even deeply loved programs – successfully achieve their goals is naïve. But, such failure does not mean wasted expenditure. It is important to learn about which interventions are ineffective. Finding and focusing on those programs that are found to be effective, sometimes very effective, is the aim – that is what will help children to have better futures.

Second, as mentioned, science is messy (and sometimes slow). For example, random assignment sometimes yields qualitatively different results for nominally similar intervention in different settings (Gray-Lobe, Pathak and Walters, 2022; Phillips et al., 2017). Impacts can vary substantially depending on circumstances and context, so there is a need for studies to be done in specific regions. In particular, relying on US results to inform Canadian programs can be problematic.

In contrast to the Tennessee pre-kindergarten results mentioned above, the well-known Perry Pre-school project in Ypsilanti Michigan, one of the world’s most famous social experiments, found substantial benefits that lasted well into adulthood (Heckman et al., 2010). Similarly, Gray-Lobe, Pathak and Walters (2022) find that a universal preschool program in Boston increased high school graduation and decreased juvenile incarceration. Instead of a single definitive answer to a question, randomized trials of pre-kindergarten programs yielded puzzles that themselves have to be sorted out (Phillips et al., 2017). Research is trying to understand why programs work in some contexts, but not others. In the near future, if we wish to know if an intervention is making a difference in a particular setting then we must rigorously estimate its impacts in that setting. As we evaluate similar

programs in different contexts, we can start to understand how outcomes are influenced by those contexts. Building a knowledge-base about what works for whom in what context is an ultimate goal.

We must also acknowledge that the task of estimating the impacts of interventions is a human activity and, for this reason, the research/evaluation teams need to be independent. Conflicts of interest can bias even rigorous study designs (e.g., Lundh et al., 2017). In much (but not all) academic publishing, authors must include a conflict-of-interest statement. By contrast, Canada's system of government has ministries report on the effectiveness of their own programs, though external evaluations, such as those by the auditors general and Treasury Boards in some jurisdictions, are sometimes also undertaken. It is unclear whether Canada has the internal/external evaluation mixture "right". The impetus to "do something" seems to sometimes trump efforts to "do the right thing", to the detriment of those being served by ineffective programs. "Doing something" can result in fast interventions and superficially seem like strong leadership, whereas "doing the right thing" takes systematic planning, sustained effort, and actual leadership. The latter is also much more likely to improve the lot of children with poor prospects.

An additional challenge is the siloed structure of government, across the federal, provincial and territorial governments, and within each jurisdiction, that creates not only administrative barriers, but also blunts incentives since few ministries (and, especially, units within ministries) take a "whole of society" perspective. Each ministry has legislation to authorize and a budget to fund a specific set of programs and services.

In BC, even though the Ministry of Education and the Ministry for Social Development and Poverty Reduction would like to see increases in the high school graduation rate, they have no authority to direct the Ministry of Health to provide services to the families of children who are not likely to graduate. Until the development of BC's Data Innovation Program, the Ministry of Education even had to go through a lengthy process to access data on the outcomes of their former students. Sadly, many other provinces are not as advanced as BC on this front.

Given our focus on helping children early in life to provide benefits across their life-times, we argue that cabinets (at all orders of government) need to struggle with how to facilitate developing improved programing, identify success and weed out unsuccessful efforts, and promulgate worthwhile interventions that cross ministry and federal/provincial/territorial boundaries. This is no small task. However, modern approaches to data collection and analysis, taking needs for privacy and confidentiality into account, provide opportunities that are not currently being pursued.

7 Conclusion

We presented cross-tabulations from existing administrative data across the British Columbia (BC) government that can be accessed at low cost. These data sources illustrate that social issues including poverty, crime, homelessness and drug and alcohol abuse primarily manifest among those who do not complete high school. We also showed that it is

straightforward to identify children who are at extreme risk of not completing high school with quite high accuracy. We point to the extensive literature identifying interventions that have been effective at deflecting at-risk children onto healthier trajectories. We also point to interventions that were thought to be successful based on casual/superficial observations, but when rigorously studied were determined not to improve outcomes. This highlights the need for rigorous evaluations to distinguish between programs that provide a (net) benefit to participants, and those that do not. Each child enrolled in a program that does not work is being prevented from enrolling in a program that does provide benefits – to their long-term detriment! We propose the following nine strategies for effective interventions to address social issues and guide children onto better trajectories.

1. Pilot a range of promising interventions.
2. Allocate spaces in these pilot interventions in a transparent, objective, ethical manner. For at least some of the interventions allocate services among those eligible by means of a lottery (random assignment) and use rigorous approaches to credibly evaluate performance.
3. List the elements of each intervention and have an independent expert visit each site, describe the implementation and report on the fidelity of implementation. This provides information on the context and increases the probability that successful implementations can be replicated in different sites.
4. Develop short term indicators of success by documenting the relationship between prospective measures and high school graduation. Collect information on these measures for both treatment and control groups and report differences. Feed this information back to the service providers.
5. Expand interventions that have the biggest impacts. Collect information on the elements of these interventions and the characteristics of the children for whom they were effective. Reform or shut down interventions that have poor, and especially negative, impacts.
6. Keep following the progress of the children served by all interventions and measure a wide variety of inputs and outcomes. Recall that the Perry preschool project hoped to increase IQ. It failed according to that measure but succeeded wonderfully in improving the lives of participants on other dimensions.
7. Establish government-wide administrative data centres that facilitate cross-ministry analysis and allow the cross-ministry outcomes to be observed. BC's Data Innovation Program and Health Data Platform are efforts in this direction since they allow data to be shared across ministries.
8. Use up-to-date administrative data on a wide variety of measures involving youth including school attendance, discipline, and academic performance, together with health care system information to produce province-wide indicators of the well-being of children to capture spillovers (i.e., general equilibrium effects).

9. Appoint an independent science officer, not affiliated with the government, to oversee the allocation of services to children, to select measures for success and to identify interventions that did not achieve their objectives and those that did.

At their foundation, our proposals rely on modern data collection and analysis capabilities that support advances not feasible in previous decades. Canadian society has the option to pursue new ways forward that can improve the life trajectories of those most at risk of poor outcomes.

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