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THE FISCAL, SOCIAL AND ECONOMIC DIVIDENDS OF FEELING BETTER AND LIVING LONGER

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SUMMARY

While Canada has socialized most of the costs of treating illness, Canada has maintained a reliance on individuals interacting through private markets to invest in upstream health promotion and disease prevention. The failure of the market to provide the efficient level of upstream investment in health is leading to large and avoidable increases in the need for downstream medical treatment. The way to reduce the future deadweight loss of illness and disease is for provincial governments to address the upstream market failures through an expansion of the scope of public payment for health care to include upstream services for health promotion and disease prevention. Perhaps somewhat counterintuitively, spending public health-care dollars across a broader range of health and wellness services can result in spending less in total, because of the efficiency gains that will come from better health in the population.

That is certainly what the evidence from a unique Albertan pilot project leads us to conclude. The Pure North S'Energy Foundation is a philanthropic initiative that pays for and provides preventative health-care services for Albertans drawn from groups that are vulnerable to poor health. This includes homeless people, people suffering from addiction, people with low incomes, people in isolated areas and susceptible seniors. The health improvements observed in those participating in the Pure North program have been significant.

Effective health-promotion and disease-prevention services obviously benefit patients. But there are also substantial benefits to society as well. The annual health-care bill for a Canadian in poor health is estimated to be more than $10,000 higher than for someone in good health, meaning that keeping people in good health can be an important means for controlling public health-care budgets, and can free up scarce acute-care hospital resources. If the Pure North program were scaled-up province-wide to cover the nearly quarter-million Albertans in poor health, the resulting health improvement seen in Pure North participants could translate into a nearly 25-per-cent reduction in hospital days used by Alberta patients every year and a net savings of $500 million on hospital and physician costs. That does not even include the economic benefits of keeping workers in better health and productive, while spending fewer days ill or hospitalized.

To date, Canada's approach to health care has largely left it to patients to choose whether to seek health-promotion and disease-prevention services on their own, suggesting an implicit deference to an individual's rights and responsibilities. But for many low-income, isolated, addicted or aboriginal Canadians, there often is no choice: These services, when delivered privately, are often too expensive or may be otherwise inaccessible. The initial spirit behind Canadian medicare was to correct a health-market failure, so that no patient would face barriers to accessing necessary treatments. That same philosophy also recommends extending universal coverage for health-promotion and disease-prevention to vulnerable Canadians who today face similar barriers to access. If the Alberta government wants to show both foresight and fairness, the benefits from this kind of program, economically and societally, are simply too attractive to disregard.

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INTRODUCTION

Treating illness and disease is expensive. Historically, the decision to use public payment for physician services and hospitalization was made to address pervasive market failures in health-care markets — notably, one-quarter of Canadians lacked private insurance and the ability to pay for costly medical treatment. While Canada has socialized most of the costs of treating illness, the country has maintained a reliance on individuals interacting through private markets to invest in upstream health promotion and disease prevention, even though the problems of incomplete insurance markets and a lack of ability to pay exist in this mostly privately financed part of the health-care system. The failure of the market to provide the efficient level of upstream investment in health is leading to large and avoidable increases in the need for downstream medical treatment. The way to reduce the future deadweight loss of illness and disease is for provincial governments to address the upstream market failures in the markets for illness and disease prevention through an expansion of the scope of public payment for health care to include upstream services for health promotion and disease prevention. Perhaps somewhat counterintuitively, spending public health-care dollars across a broader range of health and wellness services can result in spending less in total because of the efficiency gains that will come from better health in the population.

The Pure North S'Energy Foundation's preventative and integrative health-care program provides a rare opportunity to demonstrate the potential for upstream health promotion and disease prevention to improve the social efficiency of the health-care system. Since 2003, the Pure North program has paid $140 million to provide over 20,000 Alberta participants with personalized, preventative health-care services through access to health-assessment tools, nutritional supplementation, wellness counselling and dental care from a team of physicians, nurse practitioners, nurses, naturopaths and dentists on the same "no out-of-pocket costs" terms as illness treatment under medicare. The Pure North S'Energy Foundation pays for participants' access to services and supports that generate broader societal benefits, including decreased demand for publicly funded acute-care medical treatment, improved labour-force productivity and improved well-being. While it began as a workplace-based program for oilfield workers in northern Alberta, the Pure North program has evolved and expanded, providing access to its health-promotion and disease-prevention services to vulnerable populations in Alberta, including those who are homeless, suffering from addiction, living in isolated areas, susceptible seniors, those with low income, and aboriginals. Historically, these groups have not generally accessed health-promotion and disease-prevention services, as the out-of-pocket costs for these services are a substantial barrier to access.[1]

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[1] Canadian Institute for Health Information, *Exploring the 70/30 Split: How Canada's Health Care System is Financed*, 2005; Nadeem Esmail, "Complementary and Alternative Medicine in Canada: Trends in Use and Public Attitudes, 1997-2006," Fraser Institute, *Public Policy Sources* 87 (2007) http://www.fraserinstitute.org/uploadedFiles/fraser-ca/Content/research-news/research/publications/complementary-alternative-medicine-in-canada-2007.pdf; Susan J. Whiting et al., "Barriers to Healthful Eating and Supplement Use in Lower-Income Adults," *Canadian Journal of Dietetic Practice and Research* 71, 2 (2010): 70-76. In Calgary in 2012, the cost of "private medicine" for services through wellness clinics that are most comparable to the Pure North program charge clients $3,200 to $6,200 per year. It appears that the cost of supplements is in addition to those amounts (*Calgary Herald*, "Options: Your Guide to Private Medicine," Advertising Supplement, February 23, 2013). The full removal of the financial barriers and the preference of the foundation to use its resources for disadvantaged Albertans would seem to be addressing health inequities, as participants are aware that they are in a program that also works with Olympic athletes.

Our interest is in measuring the fiscal, economic and social returns attributable to the Pure North S'Energy Foundation's preventative and integrative health-care program. Pure North program participants receive a health-status assessment based on their responses to a comprehensive lifestyle questionnaire, physiological testing, blood and urine analysis, and interviews with program physicians. The health information collected by Pure North is longitudinal, as it is collected at entry into the program and on an ongoing basis for the purposes of monitoring a participant's health. In the absence of the survey being applied to control cases (patients who are comparable to Pure North participants, but who are not in the Pure North program), the "longitudinal" nature of the survey (repeated surveying and measurement of the participants) allows for analyses exploiting pre- and post- structure of the data around the intervention that can identify health changes attributable to the Pure North program.

We find that 45 per cent of Pure North participants who had initially self-reported fair health or health that needs improvement, had, after at least six months in the program, self-reported having good or better health. As studies show that we should not expect to see much improvement in self-reported health in the absence of an intervention, we attribute these changes in participant health to participation in the program.

We then assess the fiscal impact of the Pure North program arising from the improved health of participants in terms of decreased utilization of hospitals and doctors, better earning and employment outcomes, and the gain in well-being associated with changes in self-reported health. Overall, for persons who are in poor health, participation in the Pure North program represents a high-return use of funds, as each dollar spent on a participant in poor health can be expected to yield thirteen dollars in societal benefits. Even when we only consider the likely impact of the program on society's "direct costs" — represented by spending on the acute-care medical system — when scaled to the population level to cover all Albertans in poor health, the health improvements seen in the program would be associated with a 25-per-cent reduction in hospital utilization which would free up over $1 billion of Alberta Health Services' annual budget. The health improvements seen in program participants are associated with future reductions in the prevalence of chronic diseases and conditions including cardiovascular disease and diabetes. The broader "indirect costs" of poor health of Albertans from lower labour productivity, income and well-being are typically found to be as large, if not substantially larger, than the direct costs.[2]

At a time when it is believed that the social and economic returns to greater spending on illness treatment are zero if not negative, the enormous potential for preventative health care and health promotion, as demonstrated by the health outcomes attributable to the Pure North program, to reduce acute-care medical costs for public payers, improve the quality and quantity of the workforce, improve the broader well-being of the population, and improve general quality of life becomes harder to ignore.[3] Governments are aware of this potential fix for medicare's

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[2] See: Public Health Agency of Canada, "Investing in Prevention: the Economic Perspective: Key Findings from a Survey of the Recent Evidence," May 2009, 2.

[3] See: Public Health Agency of Canada, "Investing in Prevention: the Economic Perspective: Key Findings from a Survey of the Recent Evidence," May 2009; and Greg Finlayson et al., "The Additional Cost of Chronic Disease in Manitoba," Manitoba Centre for Health Policy, April 2010.

sustainability and they have taken some steps to act in this direction. Governments have had success in improving population health with information campaigns to influence diet, lifestyle choices and service-delivery in primary care, through regulation and fortification of foods.[4,5] Governments are increasingly made aware of the need to improve health through influencing social determinants of health like education, housing and income.[6]

Perhaps the biggest conundrum for policy-makers is determining which programs and interventions should be supported to improve the health of a population beyond the government's traditional actions in the domain of public health (i.e., vaccinations, screening for diseases, environmental regulation, and information campaigns). What has prevented policy-makers from reaping these gains is the lack of a piloted concrete approach for intervening to improve health outcomes in the population, along with collection of data that could be used to evaluate the impact of the intervention. The health outcomes from the Pure North program demonstrate the opportunity to "bend the cost curve" through upstream investment in health-promotion and disease-prevention outside of the medicare system to restore the sustainability of Canada's iconic single-payer health-care system. At a time when provincial governments in Canada are struggling to restrain the rise in health-care costs, expanding the scope of public payment for health care may seem a counterintuitive solution to health care's fiscal problem, but it reflects the efficiency gain that arises from addressing the market failures in the non-medicare part of the health-care system. The incomplete market for health-promotion and disease-prevention has created a large negative fiscal externality for the acute-care (medicare) system. The estimated returns to the Pure North program show how large the deadweight loss of poor health has become.

THE PURE NORTH PROGRAM

The Pure North S'Energy Foundation is a service-delivery program that focuses on delivering preventative health-care services to populations that have poor access to health care and lack information on preventative health-care measures. The Pure North program participants include those who are homeless, suffering from addiction, living in isolated areas, susceptible seniors and those with low income, and aboriginals. The goal of the Pure North S'Energy Foundation is to identify health needs, share that information with participants and support them in achieving lifestyle changes that will help them feel better and live longer.

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4 For example, see: M.R. Joffres et al., "Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada," *Canadian Journal of Cardiology* 23, 6 (May 1, 2007): 437-43. Lindsay McLaren, "Policy Options For Reducing Dietary Sodium Intake," University of Calgary, SPP Research Papers 5, 20 (June 2012) http://policyschool.ucalgary.ca/sites/default/files/research/lindsay-mclaren-sodium-revised.pdf.

5 That said, there is also evidence that food fortification, which is an effectively ad hoc approach to setting doses of supplementation, has not met the needs of all of the population. See: J. Sacco and V. Tarasuk, "Health Canada's proposed discretionary fortification policy is misaligned with the nutritional needs of Canadians," *Journal of Nutrition* 139, 10 (October 2009): 1980-1986; and J. Sacco and V. Tarasuk, "Discretionary addition of nutrients to foods: implications for healthy eating," *European Journal of Clinical Nutrition* 1, 8 (March 2011).

6 Don Drummond states: "A broader perspective would consider the cost savings possible through improving various lifestyle patterns that have health implications. For example, education interventions may be more effective in lowering future healthcare costs than investments in hospitals today." Don Drummond, "Benefactor's Lecture, 2011: Therapy or Surgery? A Prescription for Canada's Health System," C.D. Howe Institute, 2011, accessed April 17, 2013, http://www.cdhowe.org/pdf/Benefactors_Lecture_2011.pdf.

Pure North operates out of Calgary, Alberta but has established clinics in several locations in Alberta and British Columbia. These locations include the Thorpe Recovery Centre for recovering addicts in Lloydminster; several homeless shelters in Calgary, such as the Mustard Seed Street Ministry and the Drop Inn Centre; the Alberta Adolescent Recovery Centre in Calgary; a satellite clinic in Fort St. John, B.C.; vulnerable seniors clinics in Calgary; as well as a central clinic in Calgary that is accessible to the public. Pure North also flies teams of clinicians to sites in Alberta not served by their traditional clinics, operating mobile clinics in St. Albert, Medicine Hat, and in rural areas such as Taber, Wabasca, Spirit River, and Slave Lake. Pure North also works with over 40 dental clinics and operates two of its own dental centres: one at Calgary's Mustard Seed Street Ministry, known as the Pure North Outreach Health and Dental Care Clinic; and one at the Thorpe Recovery Centre in Lloydminster. Pure North offers much-needed dental services to vulnerable populations, such as the homeless.

Health-promotion and disease-management programs vary greatly in scope and scale, but tend to focus on common health problems where effective interventions are readily available. Prevention programs typically concentrate on smoking cessation, physical fitness, nutrition, and managing cholesterol levels, blood pressure, and weight and stress.[7,8,9] The Pure North S'Energy program aims to prevent and address the most common health conditions and chronic diseases seen in the North American and European populations. These include diabetes, cardiovascular disease and cancer, all of which are conditions leading to premature death and are associated with alterable risk factors such as poor nutrition, inactivity, tobacco use and excessive alcohol consumption.[10] Primary prevention through a combination of screening/testing, lifestyle modification, nutrition education, identification of nutritional deficiencies and dietary supplementation is considered to be a cost-effective, affordable and sustainable approach to reducing morbidity from these epidemics.[11,12] Research also shows that providing individualized risk-reduction-interventions is critical for the effectiveness of wellness programs.[13] Consequently, this is the approach used for participants involved in the Pure North

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[7] Corporate/workplace-based and community sponsored programs for health promotion have become more prevalent over the last 15 years (Association for Worksite Health Promotion, U.S. Department of Health and Human Services, 1999; and National Worksite Health Promotion Survey, Association for Worksite Health Promotion and William M. Mercer, Inc., 2000). Corporate programs are usually driven by a need to curtail employee-related expenses such as health-care costs and lost productivity (S.G. Aldana et al., "Financial impact of a comprehensive multisite workplace health promotion program," *Preventive Medicine* 40, 2 (February 2005): 131–137). These programs often offer health and safety workshops, health assessment surveys, screening programs and incentives for participation (R.L. Bertera, "The Effects of Workplace Health Promotion on Absenteeism and Employment Costs in a Large Industrial Population," *American Journal of Public Health* 80, 9 (September 1990): 1101-1105.

[8] A.I. Talvi, J.O. Jarvisalo and L.R. Knuts, "A health promotion programme for oil refinery employees: changes of health promotion needs observed at three years," *Occupational Medicine* 49, 2 (February 1999): 93-101.

[9] S. G. Aldana et al., "Financial impact of a comprehensive multisite workplace health promotion program."

[10] A. Mokdad et al., "Actual Causes of Death in the United States, 2000," *Journal of the American Medical Association* 291, 10 (March 2004): 1238-1245. The burden associated with these chronic diseases is increasing rapidly with recent estimates showing that 60 per cent of all deaths worldwide are preventable. See: World Health Organization, *2008-2013 Action plan for the global strategy for the prevention and control of noncommunicable diseases*, 2009, http://www.who.int/nmh/publications/9789241597418/en/; and A. Drewnowski and B.M. Popkin "The nutrition transition: new trends in the global diet," *Nutrition Reviews* 55, 2 (February 1997): 31-43. The incidence of chronic diseases has increased in developed countries partly due to an ever-increasing consumption of refined-food items.

[11] World Health Organization, *2008-2013 Action plan for the global strategy for the prevention and control of noncommunicable diseases*, 2009.

[12] World Health Organization, *Diet, Nutrition and the Prevention of Chronic Diseases*, WHO Technical Report Series 916, 2003.

[13] R. W. Whitmer et al., "A wake-up call for corporate America," *Journal of Occupational and Environmental Medicine* 45, 9 (September 2003): 916-25.

S'Energy program. As in many health-promotion programs, in the Pure North program, health improvements are typically assessed through the use of questionnaires, laboratory tests and biometric measurements.[14] For programs structured like Pure North's, results have been promising.[15]

Pure North's program can be described as an exemplar of complementary and integrative medicine (CIM), combining access to interdisciplinary teams of MDs, naturopathic doctors, nurses, nurse practitioners and dentists for diet and lifestyle counselling and education, treatment of acute conditions, navigation of medicare services and other required services (e.g., addiction treatment), and a personalized regime for dietary supplements for health promotion. Building on approaches to preventative health care currently in use in Alberta, Pure North's health program is more comprehensive than the norm. First, as with most preventative care, a participant undergoes a baseline health assessment based upon responses to a lifestyle questionnaire, physiological measurements, blood analysis and interviews with clinicians. Health indicators that are assessed over time include weight, blood pressure, body mass index (BMI), waist circumference, smoking status, nutrition, physical activity, sleep, alcohol consumption and simple indicators of stress. Counselling for lifestyle recommendations are based on an individual's characteristics and personal circumstances identified through the baseline assessment. Recommendations include behaviour change, encouragements for weight loss, smoking cessation, nutrition interventions, and physical activity. Lifestyle strategies are individualized based on an individual's willingness to change and his or her commitment to the proposed program.

The unique approaches to preventative care of Pure North are its personalized programs for dietary supplementation, heavy-metal reduction and dental care. The degree to which the program is personalized and monitored for participants is distinctive. The detailed personalized program for supplementation is based on 49 markers in blood and urine, including:[16]

· Vitamin D	· Insulin	· DHEA-S
· Serum Calcium	· Homocysteine	· TSH
· Vitamin B12	· Hs-CRP	· Free T3 & T4
· Total Cholesterol	· Ferritin	· Anti-thyroglobulin
· HDL	· Omega 6/3 ratio	· Anti TPO
· LDL	· ALT	· Thyroglobulin
· Apo B	· GGT	· CBC
· Oxidized LDL	· Alkaline Phosphatase	· Urinary Minerals such as Calcium
· Hemoglobin A1C	· Glutathione	· Urinary Metals such as Lead, Cadmium, Mercury and Arsenic
· Fasting glucose	· Creatinine	

[14] A.I. Talvi, J.O. Jarvisalo and L.R. Knuts, "A health promotion programme for oil refinery employees: changes of health promotion needs observed at three years."

[15] For example, in the long-term health program at Johnson & Johnson, results showed significant improvements in eight of 13 categories, including: tobacco use, aerobic exercise, high blood-pressure, high cholesterol, dietary fibre intake, seatbelt use, and drinking and driving habits. See: R.G. Goetzel et al., "The Long-Term Impact of Johnson & Johnson's Health and Wellness Program on Employee Health Risks," *Journal of Occupational and Environmental Medicine* 44, 5 (May 2002): 417-424.

[16] According to the Pure North S'Energy Foundation, blood tests are selected for their relevance and are periodically reviewed based on new evidence and results for participants in the program.

The baseline health assessment based on the blood and urine markers is used to develop a program for dietary supplements.[17] The dietary supplements used in the Pure North S'Energy Program are selected by a clinical team to address common problems such as vitamin-D deficiency, insulin resistance, obesity and hypercholesterolemia. Special emphasis is placed on the importance of vitamin-D supplementation, given results from the Canadian Health Measures Survey revealing that vitamin-D insufficiency is widespread in the Canadian population. Dietary supplements available to Pure North patients include multivitamins, fish oil, vitamin D, probiotics, magnesium, vitamin B12, vitamin C, alpha lipoic acid and Acetylcysteine. Finally, interventions are periodically reviewed and evaluated for efficacy at follow-up meetings and counselling sessions. Blood tests are repeated yearly to monitor progress and select measurements may be repeated more frequently if deemed necessary by medical staff.

SUMMARY OF COSTS ASSOCIATED WITH DELIVERY OF THE PURE NORTH PROGRAM[18]

	Total Cost	Medical Consult and Administration Cost	Laboratory Services	Dietary Supplements
Per person per year	$2,300	$240.00	$460.00	$1,600

The total cost of the Pure North Program per participant is $2,300, two-thirds of which is comprised of the costs of dietary supplements.[19] The program cost is clearly beyond the means of low-income Albertans, so it is important to highlight that Pure North S'Energy Foundation has been covering this cost for its participants, effectively removing all financial barriers to a "Cadillac-grade" health-promotion program.[20]

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[17] These products are often recommended on an ad hoc basis with recommended products based on one's age, sex and co-morbid health conditions. There is typically no follow up.

[18] The Pure North program also covers dental care at a per-participant cost of $1,600 per year. We have not investigated health improvements due to improved dental health, so we do not consider these costs in this study.

[19] These costs pertain to the program as of December 31, 2012. Since that time, the program has modified the supplementation program and lab testing, which has reduced the total program cost to $1,600 per participant. We work with the $2,300 per participant cost since that was the cost of the program over the period of time the information in our data-set was collected. Further, the higher per-participant cost will produce a more conservative estimate of program returns, which will provide a stronger test of the economic case for the program.

[20] Participants are asked to pay for the mail delivery costs of the "maintenance packs" of dietary supplements. Pure North also covers the costs of dental work performed on its participants. As of January 1, 2013, participants who have the means are being asked to pay $50 per month for the program so that the foundation can target more of its resources at vulnerable populations.

ASSESSING THE IMPACT OF THE PURE NORTH PROGRAM ON THE HEALTH OF PARTICIPANTS

We have been provided with de-identified client-level questionnaire data and data on blood and urine markers by the Pure North S'Energy Foundation following receipt of ethics approval from the University of Calgary's Conjoint Health Research Ethics Board (CHREB). Our focus for evaluating the economic returns to this preventative health-care program is the self-reported health measures. We use the blood and urine information to validate the health information in the self-reported responses, as well as changes in those responses, and to corroborate that the changes in self-reported health can be associated with the program. We chose to compare questionnaire responses at entry into the program with a second questionnaire completed at least six months (180 days) after entering the program. The questionnaire responses are self-reported outcomes that have well-recognized limitations relative to purely objective measures of health and lifestyle. That said, self-reported health questions have proven to be good predictors of health-care utilization and mortality.[21]

Pure North participants complete a lifestyle questionnaire at entry into the program and again at selected repeat visits. The self-reported health questions asked by Pure North correspond to questions asked on national surveys in Canada, such as the National Population Health Survey (NPHS), the Canadian Community Health Survey and the Survey of Labour Income and Dynamics. For self-reported health, the question answered was "compared to others in your age group, how would you rate your health?" The categories for responses are Excellent, Very Good, Good, Fair and Needs Improvement.[22]

Figure 1 shows the relative frequencies of self-reported health status collapsed to three categories (Excellent/Very Good, Good and Fair/Needs Improvement) for two samples of interest for the Pure North program and for the adult Canadian population, derived from the 1996 National Population Health Survey and data for males over 50 from the 2000 National Population Health Survey.[23] The first sample for the Pure North program consists of the 7,429 participants who completed at least one lifestyle questionnaire and who answered the self-reported health question. The second sample is the one we wish to analyze in-depth and it pertains to the 2,581 participants who completed two or more questionnaires at least six months apart. The latter sample is of interest since we can see if there are changes in self-reported health. The former sample is of interest for determining if our sample of those who completed two questionnaires is representative of all participants who enter the program.

Figure 1 shows that in terms of self-reported health status, the participants in the Pure North program who have completed a second lifestyle questionnaire are comparable to all persons who completed at least one questionnaire. As such, we believe that our two-questionnaire sample selected for analysis is representative of the participants who enter the program.

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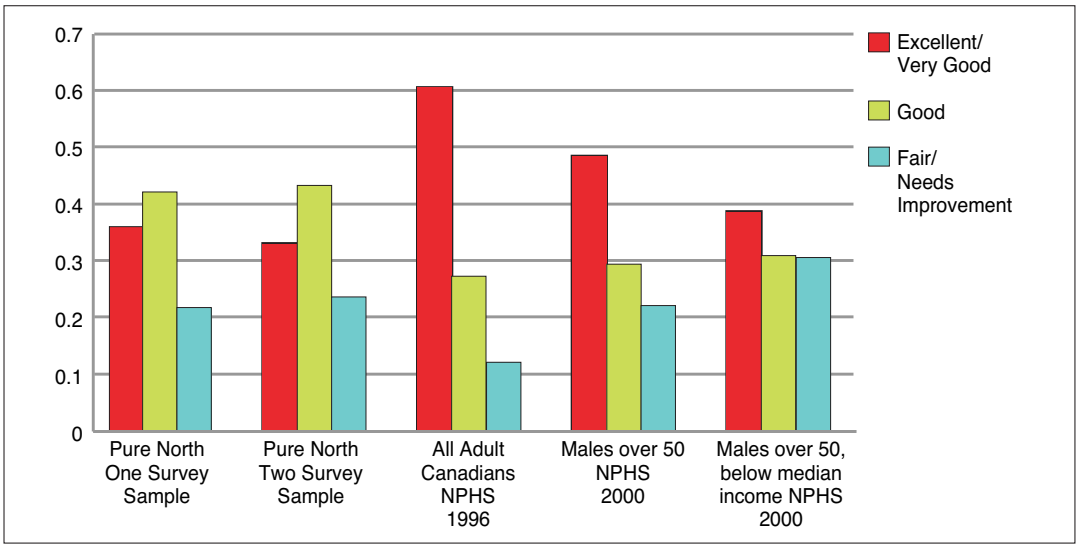
[21] See Neil Buckley et al., "The transition from good to poor health: An econometric study of the older population," *Journal of Health Economics* 23, 5 (September 2004): 1013-1034.

[22] For ease of presentation and in following convention in many published studies, we will refer to the latter two categories as "poor health" and the former three categories as "good or better health."

[23] The "self-reported health" questions in the NPHS are not identical to the one used by Pure North's questionnaire. McLeod and Veall (2006, 2133) indicate that the NPHS question is "How would you evaluate your health status?" with the available responses: Poor, Fair, Good, Very Good or Excellent. The answers are coded as 1, 2, 3, 4 and 5 respectively.

FIGURE 1: RELATIVE FREQUENCIES OF SELF-REPORTED HEALTH STATUS, PURE NORTH S'ENERGY PARTICIPANT SAMPLES, ALL ADULT CANADIANS AND CANADIAN MALES OVER AGE 50



Notes: These 1994 NPHS numbers are from Elizabeth Badley et al., "Determinants of Changes in Self-Reported Health and Outcomes Associated with Those Changes." Arthritis Community Research and Evaluation Unit (ACREU), Working Report 00-5, 2000, Table 1. The 2000 NPHS numbers are derived from Neil J. Buckley et al., "The Transition from Good to Poor Health: An Econometric Study of the Older Population," Social and Economic Dimensions of an Aging Population Research Papers *94, McMaster University (2003): Table 4. Those figures are adjusted to remove the proportion of the sample in 2000 which was deceased or institutionalized.*

Figure 1 shows that Pure North participants self-report poorer health more frequently than the Canadian adult population and the population of Canadian males over age 50.[24] The comparisons of health statuses in Figure 1 likely reflect that Pure North participants with a median age of 42 are typically older than the NPHS samples for the Canadian population, but younger than the "Male over 50" population which includes a larger proportion of older Canadians. Pure North's move to include seniors in its program has been relatively recent, and proportionately, they would have less representation in the Pure North sample than Buckley et al.[25] have for their sample of Canadian males over age 50.[26] This makes it all the more striking that Pure North participants have such poor health even in comparison to the older male population.

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[24] McLeod and Veall (2006, Table A.1) report self-reported health frequencies that are comparable to the Badley et al. NPHS frequencies, so they are not reported here. McLeod and Veall actually show higher frequency of Very Good/Excellent health and lower frequencies of Fair/Poor health in the 1996 and 1998 NPHS sample that they use. Logan McLeod and Michael Veall, "The dynamics of food insecurity and overall health: evidence from the Canadian National Population Health Survey," *Applied Economics* 38, 18 (2006): 2131-2146.

[25] Neil Buckley et al., "The transition from good to poor health: An econometric study of the older population," *Journal of Health Economics* 23, 5 (September 2004): 1013-1034.

[26] There is good reason to believe that Pure North participants have poorer health than that seen in the general population. Data from baseline health-assessments of Pure North participants show that 32 per cent of participants have elevated blood pressure values: above 130/90; 57 per cent of men in the program need to reduce their hs-CRP (high-sensitivity C-reactive protein), a clinical marker of future heart disease; 73 per cent of participants are overweight or obese and 38 per cent suffer from obesity; 21 per cent of participants have elevated liver enzymes; 54 per cent of men have elevated total cholesterol levels and 64 per cent have abnormal cholesterol ratios; 17 per cent of participants have elevated TSH (thyroid-stimulating hormone) levels, an indicator of thyroid dysfunction and eight per cent of participants have antibodies suggesting an autoimmune dysfunction affecting the thyroid gland; and 22 per cent of participants had insulin levels above 60, predisposing them to Type 2 diabetes.

Using the sample of Pure North participants with two self-reported health measures at least 180 days apart, we investigated whether the self-reported health values reflect other more objective, or measured, indicators of health. Biomarkers such as cholesterol, glucose, insulin, blood pressure and so on, are often referred to as "surrogate endpoints." They are considered to be statistically associated with "primary endpoints" — ultimate health outcomes of interest, such as mortality, future chronic diseases or risks of developing chronic diseases. Surrogate endpoints are not necessarily associated with symptoms in the present.[27] Consequently people with elevated cholesterol, triglycerides, insulin, glucose and BMI might be classified as "unhealthy" even if they report feeling fine. For example, lower HDL (high-density lipoprotein), higher triglycerides and higher fasting insulin are all associated with elevated risk for cardiovascular disease (CVD), stroke and Type 2 diabetes. In terms of more immediate feelings of health, low HDL can result from less exercise/activity, while higher triglycerides and higher insulin speak to the onset of metabolic syndrome.

Compared to those who self-report being in poor health, Pure North participants self-reporting good or better health had the same median age, lower BMI and lower weight, lower systolic blood pressure, higher HDL cholesterol, and lower triglyceride, glucose, hemoglobin A1C and fasting-insulin levels. While none of these differences are statistically significant given the large variability in the sample, they point to a consistent picture that self-reported health measures represent health conditions and risk factors that would be seen as reflective of one's objective health.[28]

To see if self-reported health is correlated, or associated, with surrogate endpoint measures of health, we looked at the influence of glucose, vitamin-D serum blood level, HDL cholesterol, total cholesterol, triglycerides and hemoglobin A1C, on the probability that someone in our sample reported good or better health rather than fair/needs improvement. We grouped the five self-reported health categories into two: "Good or Better" and "Poor." We then estimated the probability that an individual reported good or better health at the time of entry into the program as a function of the surrogate endpoints listed above using probit maximum likelihood estimation. We report the "marginal effects" of the explanatory variables on the probability of reporting good or better health. These marginal effects can be interpreted to be the change in the probability of reporting good or better health due to a one-unit change in the explanatory variable. For example, in Table 1, the marginal effect of HDL cholesterol, measured in mmol/L, indicates for each one mmol/L increase in HDL cholesterol, we expect to observe a 0.17 increase in the probability of reporting good or better health at entry into the program.

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[27] Thomas R. Fleming, "Surrogate Endpoints and FDA's Accelerated Approval Process," Health Affairs 24, 1 (January 2005): 167-78; Kunal Gupta, Jyotsna Gupta and Sukhdeep Singh, "Surrogate Endpoints: How Reliable Are They?" *Journal of Clinical Research Best Practices* 6, 5 (May 2010) http://firstclinical.com/journal/2010/1005_Surrogate.pdf.

[28] See Appendix Table 1 for the summary statistics. The differences between surrogate endpoint measures for Pure North participants in good or better health and those in poor health could be interpreted as clinically important. CIHI (2012, 15) reports that "Controlling modifiable cardiovascular risk factors such as tobacco smoking, diabetes, elevated blood cholesterol, high blood pressure, obesity and low physical activity has been demonstrated to reduce IHD risk. One meta-analysis found that a reduction of one unit (1 mmol/L) in mean plasma cholesterol was associated with about one-sixth to one-half reduction in IHD mortality, depending on age. The decreased prevalence of smoking over the last five decades has also contributed to lowering the risk of ischemic heart disease. Though the overall prevalence of high blood pressure in Canada has been on the rise, a study showed that an absolute decrease of 1.4 mm Hg in systolic blood pressure was reported between 1994 and 2005, which was associated with a 20-per-cent reduction in IHD mortality. Moreover, the percentage of Canadians who are aware of their high blood pressure but are not being treated is decreasing." Canadian Institute for Health Information, *Health Indicator*s 2012 (Ottawa: Canadian Institute for Health Information, 2012) https://secure.cihi.ca/free_products/health_indicators_2012_en.pdf.

TABLE 1: ESTIMATED MARGINAL EFFECTS FOR PROBIT MODEL OF LIKELIHOOD A PURE NORTH PARTICIPANT REPORTS HAVING GOOD OR BETTER HEALTH AT START OF PROGRAM

Explanatory Variable	Marginal Effect	Standard Error	Mean of Explanatory Variable
Glucose	-0.019	0.02	4.83
HDL Cholesterol	0.17*	0.05	1.47
Total Cholesterol	0.015	0.018	4.97
Triglycerides	-0.027	0.023	1.3
Hemo A1C	-0.008	0.039	5.7
Systolic	-0.0012	0.001	123.8
25(OH)D	0.0016*	0.0004	89
Female	0.13*	0.03	0.52
Pseudo R2	0.06		
N	837		

*NOTES: * statistically significant at size 0.05.*

Table 1 shows that higher levels of HDL cholesterol and vitamin-D 25(OH)D blood serum levels have statistically significant marginal effects on the likelihood that a participant self-reported good or better health. Participants with higher systolic blood pressure, and blood measures of glucose, triglycerides, total cholesterol and hemoglobinA1C have lower probability of self-reported good or better health, but these effects are not statistically significant.

The rows of Table 2 report the frequency counts of self-reported health statuses of 2,581 Pure North participants at the start of the program while the columns report the frequency counts of the self-reported health statuses after at least 180 days after the start of the program. Mean [overall] self-reported health improved slightly for 2,581 clients, with 27 per cent (n=708) of the sample reporting improved health after at least six months; 49 per cent (n=1263) reported the same health; and 24 per cent (n=610) reported a decline in health after six months.

TABLE 2: CROSS-TABULATION OF SELF-REPORTED HEALTH STATUS ON FIRST LIFESTYLE QUESTIONNAIRE AND A SUBSEQUENT LIFESTYLE QUESTIONNAIRE AT LEAST 180 DAYS AFTER THE FIRST QUESTIONNAIRE

Health Status Before	Excellent	Very Good	Good	Fair	Needs Improvement	Total
0 (Excellent)	80	73	18	0	2	173
1 (Very Good)	70	358	216	24	15	683
2 (Good)	19	259	592	153	53	1,076
3 (Fair)	4	23	167	129	56	379
4 (Needs Improvement)	4	15	80	67	104	270
Total	177	728	1,073	373	230	2,581

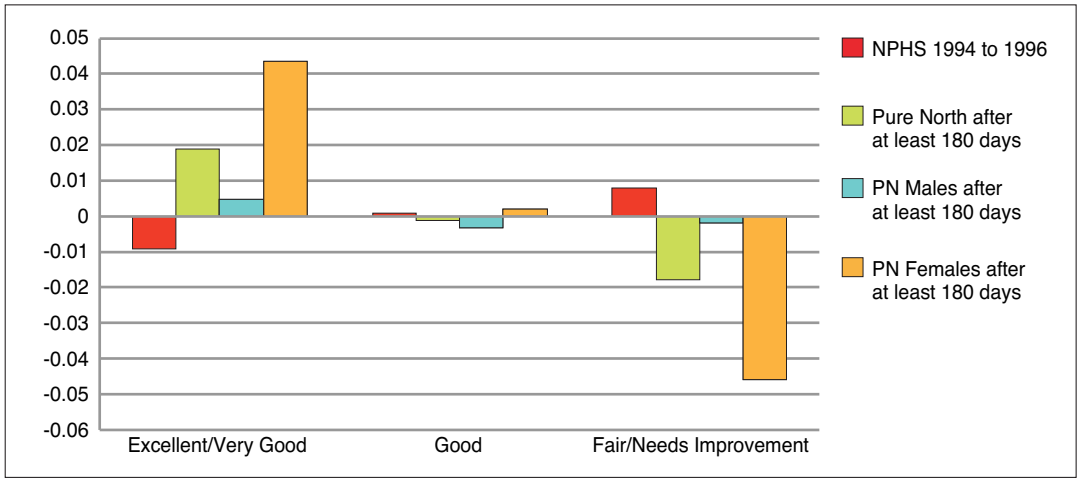
NOTES: Red means self-reported health was worse after at least 180 days, green means unchanged and yellow means improved.

To understand what a remarkable outcome this is for a health-promotion intervention, we need to understand the counterfactual situation of what the distribution of health outcomes would have been in the absence of the Pure North program. Figure 2 shows that the improvement in self-reported health status for Pure North participants after at least 180 days in the program.

There are few studies that examine longitudinally how a person's health status changes over short-run intervals. One study by Badley et al.[29] showed that for all adult Canadians we would not expect to see any systematic changes in the distribution of self-reported health status over a two-year period.[30] The changes in the relative frequencies of self-reported health status for Canadian adults between the 1994 and 1996 National Population Health Survey from Badley et al. are depicted in Figure 2 and show that we would expect a tendency for self-reported health of adults to deteriorate slightly over two years rather than improve as we see in the sample of Pure North participants.[31]

It would appear that the majority of the positive impact from the Pure North program comes from improving the health of those persons who entered the program reporting less-than-good health and a smaller impact, albeit on a larger number of participants, on those who began the program in good or better health and who maintained their good health. It is also the case that much more health improvement is seen for females in the program than for males.

FIGURE 2: CHANGES IN RELATIVE FREQUENCIES OF SELF-REPORTED HEALTH STATUSES AFTER SIX MONTHS IN PURE NORTH PROGRAM AND OVER TWO YEARS FOR THE ADULT CANADIAN POPULATION



NOTES: E/VG=Excellent/Very Good; G=Good, and F/P=Fair/Needs Improvement or Poor. The 1994 and 1996 NPHS numbers are from Elizabeth Badley et al., "Determinants of Changes in Self-Reported Health and Outcomes Associated with Those Changes," Arthritis Community Research & Evaluation Unit (ACREU), Working Report (00-5), 2000, Table 1.

[29] Elizabeth Badley et al., "Determinants of Changes in Self-Reported Health and Outcomes Associated with Those Changes," Arthritis Community Research & Evaluation Unit (ACREU), Working Report (00-5), 2000.

[30] ibid. McLeod and Veall (2006, 133) interpret Badley et al.'s work as showing that "There is some evidence that overall reporting patterns in SRH are consistent over time with equal percentages reporting health improvement and deterioration."

[31] As the adult Canadian population is likely younger than our sample of Pure North participants, the Badley et al. (2000) NPHS numbers may understate the degree to which self-reported health would change over two years in a sample of middle-aged adults comparable to the Pure North sample. Another study by Buckley et al. that focused on adults aged 50-and-over showed that over a two-year period we would see an overall deterioration in health outcomes, with five-per-cent fewer of the adults aged 50-and-over in good health and five-per-cent more of these adults in fair or poor health, or deceased, or in an institution. Much of this reflects changes in health after age 64, which we do not expect to be as prominent in our Pure North sample. Neil Buckley et al., "The transition from good to poor health: An econometric study of the older population," *Journal of Health Economics* 23, 5 (September 2004): 1013-1034.

We have not found a study that looks at the baseline likelihood of someone in poor health moving to better health, but it is clearly remarkable to see as large a reduction in the proportion of the adult population in poor health as seen for the Pure North participants. For the 649 Pure North participants who began the program reporting fair health or health needing improvement, 293 (45 per cent) reported good or better health after at least six months in the program.

Determining the impact of the Pure North program on those who start the program in good or better health is more challenging. The Pure North sample shows that of the 1,932 adults who entered the program reporting good or better health, 247 (13 per cent) reported having health that was fair/needs improvement at least six months later.[32] Buckley et al.'s (2003 and 2004) analyses reveal that for adults 50-64 who are in good or better health, over a two-year period we would expect to see five per cent of high-socio-economic-status-adults fall below having good health and around 15 per cent of low-socio-economic-status adults to move from good or better health to less than good health. Information on the socio-economic status of the Pure North participants is not collected on the questionnaire, but if the Pure North sample is representative of the socio-economic status of the Canadian adult population, then we would infer that observed changes in health for Pure North participants entering the program in good health are what we would expect to see had they not entered the program. On the other hand, if Pure North participants disproportionately have high school as their highest level of education or are below the median income level (e.g., lower-income), then it appears Pure North is maintaining good health better than what would be observed without an intervention.

To corroborate the validity of the observed changes in self-reported health of Pure North participants, we looked at self-reported changes in memory, concentration and energy and 14 specific symptoms thought to be indicative of toxicity from exposure to heavy metals (see Table 3).

TABLE 3: SELF-REPORTED CHANGES IN SYMPTOMS INDICATIVE OF HEAVY METAL TOXICITY AND MEMORY, CONCENTRATION AND ENERGY

	180-Day Difference		180-Day Difference for Participants who Started in "Poor Health"	
	n	Improved	n	Improved
Headache	1,525	45%	430	48%
Memory loss	1,526	49%	425	49%
Depression	1,521	46%	426	54%
Fatigue	1,529	52%	430	57%
Anxiety	1,521	48%	426	53%
Moody	1,521	47%	429	53%
Confusion	1,519	37%	426	41%
Stomach Problems	1,517	45%	427	54%
Losing sense of smell or taste	1,515	23%	420	30%
Shaky hands	1,523	28%	430	34%
Paresthesia	1,442	27%	403	33%
Dropping things	1,507	27%	423	35%
Co-ordination Problems	1,509	27%	425	36%
Muscle Weakness	1,515	40%	429	48%
Anger	517	42%	180	47%
Energy	2,493	40%	621	47%
Memory	2,486	39%	617	42%
Concentration	2,506	38%	617	43%

[32] Fourteen per cent of male participants and 10 per cent of female participants who reported good or better health at the start of the program reported that their health was fair/needs improvement after at least 180 days in the program.

For the whole sample, regardless of initial health, 40 per cent of the respondents reported increased energy, 38 per cent reported increased concentration and 39 per cent reported improved memory. Previous studies examining the health of the Canadian population show that we would not expect to see these sorts of changes in health in such a short time frame.[33] For the Pure North participants who entered the program self-reporting "poor health," the improvements after 180 days were even greater with 47 per cent reporting increased energy, 42 per cent reporting improved memory and 43 per cent reporting improved concentration.

Similar improvements are seen over 180 days for the list of "toxicity symptoms," particularly for the 649 participants who entered the program in poor health. For the participants who reported being in poor health at the start of the program, more than half reported improvements in symptoms of depression, fatigue, anxiety, moodiness, and stomach problems.

REASONS FOR HEALTH IMPROVEMENT

What is it about the program that is making people feel healthier? Program participants did report some changes in diet and lifestyle. For example, 26 per cent of respondents reported that they were exercising more and nine per cent reported that they were smoking less. There may have been slight increases in consumption of fruits and vegetables, but for both fruits and vegetables, the median daily servings were still around one to two per day in our two-SRH-value sample. While the observed changes in diet and lifestyle are potentially important, dietary supplementation with vitamins and minerals may be having more of an impact on participant health even in cases where the individuals would not be considered to have clinical deficiencies in nutrition.

As discussed earlier, Pure North participants self-reported having more energy, better concentration and better memory along with other indicators of improved health and it is likely that these changes are related to the dietary supplements. A 2010 clinical trial of a high-dose B-complex vitamin and mineral supplement in healthy males aged 30-55 showed similar outcomes compared to a placebo in terms of improved mental functioning and reduced stress and fatigue.[34] The study's authors were not certain as to how to interpret the improvements in brain function from augmenting vitamin and mineral levels in healthy, normal populations: "It is unclear whether these effects represent an offset of impairment due to marginal deficiencies or an improvement due to sub-optimal levels that would not, under current guidelines, be classified as a deficiency."

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[33] Kathi Wilson et al., "Factors affecting change over time in self-reported health," *Canadian Journal of Public Health* 98, 2 (March 2007): 154-158. This study looked at survey data from Hamilton in 2001 and 2003, finding that 15 per cent got worse and 18 per cent got better in between the two years.

[34] David O. Kennedy et al., "Effects of high-dose B vitamin complex with vitamin C and minerals on subjective mood and performance in healthy males," *Psychopharmacology* 211, 1 (July 2010): 55-68.

One of the most notable impacts of the Pure North program has been on blood serum vitamin-D levels (25(OH)D). Table 4 shows that, at baseline, like most of the Canadian population, the majority of Pure North participants had serum 25(OH)D levels below 75 nmol/L, a level which is considered "optimal" for the prevention of chronic diseases such as diabetes and autoimmune diseases.[35] Better self-reported health appears to be associated with greater increases in serum 25(OH)D levels, which in Table 4 are large enough to take the median value well above the 75 nmol/L threshold. For the participants who remained in poor health, or who moved from good or better health to poor health, the increases in vitamin-D serum levels resulted in increases in the median 25(OH)D level to values below 90 nmol/L, whereas the participants who remained in good or better health, or improved to good or better health from poor health, had median 25(OH)D levels of over 100 nmol/L.

TABLE 4: BASELINE AND CHANGES FOR PARTICIPANTS AFTER AT LEAST 180 DAYS IN VITAMIN D 25(OH)D BY SRH CHANGE

	All		Poor Health to Good Health		Poor Health and Stay in Poor Health		Good Health to Poor Health		Good Health to Good Health	
	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change
Mean	68.3	+42.7	66.7	+49.4	59.7	+32.8	63.8	+39	71.1	+44.6
Median	62	37	60	47	53	30	60	29	64	39
Std. Dev	37.5	52.9	35.8	60.6	36.1	52.1	30.2	49.0	38.8	52.3
N	1,401	1,013	149	102	184	141	154	123	914	647

NOTES: The number of observations differs between baseline and the changes because the sample is defined by a participant having two self-reported health measures at least 180 days apart. Within that sample not all participants had blood-serum measures reported twice.

To get a better sense of the strength of association between Vitamin D 25(OH)D and self-reported health, Table 5 presents the estimated marginal effects of baseline 25(OH)D levels and 180-day changes in 25(OH)D levels on the probability that a male participant entering the program in poor health improves to good or better health, and on the probability that a participant entering the program in good or better health remains in good or better health. For both health transitions of interest, the estimated marginal effects of baseline vitamin-D levels and 180-day changes in vitamin-D levels are statistically significant. The marginal-effect estimates also allow us to infer the effect of increases on vitamin-D levels on the probabilities of improving health or remaining in good health. Evaluating the marginal effect of the 180-day change in vitamin-D levels at the mean increase in serum 25(OH)D levels of 42.7 nmol/L, the probability of a participant in poor health improving to good or better health increases by eight percentage points. For the sample starting in good health, the mean increase in vitamin-D levels raised the probability of remaining in good or better health by 2.6 percentage points.

[35] John F. Aloia et al., "Vitamin D intake to attain a desired serum 25-hydroxyvitamin D concentration," *American Journal of Clinical Nutrition* 87, 6 (June 2008): 1952-1958. A recent study has shown these relationships in Pure North participant data: Robert P. Heaney et al., "A Novel Approach Localizes the Association of Vitamin D Status with Insulin Resistance to One Region of the 25-Hydroxyvitamin D Continuum" *Advances in Nutrition* 4 (May 2013): 303–310.

TABLE 5: ESTIMATED MARGINAL EFFECTS FOR PROBIT MODELS OF HEALTH TRANSITIONS FOR PURE NORTH PARTICIPANTS

	Got Better	Stayed Healthy
Baseline Level 25(OH)D	0.00188*	0.001*
	(0.00071)	(0.0003)
Change in 25(OH)D after 180 Days	0.00189*	0.0006*
	(0.00053)	(0.00021)
Male	-0.044	-0.047*
	(0.05)	(0.02)
Predicted probability at means of variables	0.44	0.87
N	401	1,200
Pseudo R2	0.0285	0.0274

*NOTES: * significant at size 0.05.*

We are not able to determine if the associations between self-reported health changes and changes in 25(OH)D blood serum levels is a causal influence of vitamin D on health or if vitamin D is reflective of an "adherence effect" — higher vitamin-D increases could be reflective of better adherence to the overall program. Higher vitamin-D levels reflect consistent use of all dietary supplements and efforts to change diet, exercise habits, other lifestyle behaviours and other non-specific therapeutic effects of the program.[36]

HOW BIG ARE THE FISCAL, ECONOMIC AND SOCIAL RETURNS TO BETTER HEALTH?

The Pure North S'Energy Foundation pays $2,300 per participant per year for services delivered and dietary supplements, which is roughly two-thirds of per-capita government health-care expenditures in Alberta. From a public payer perspective, this program may seem expensive or at least politically challenging to support, to the extent that the benefits to the public payer and society may not be realized until well into the future. There may be a significant lag between improvements in health and savings in medical expenditures or improvements in productivity. The scope and scale of Pure North's services require a per-participant expenditure that is well above that of other health-promotion programs, which makes published studies uncertain comparators in terms of evaluating the returns to upstream disease prevention and health promotion that could be expected from the Pure North program.[37] Thus, the issue we turn to now is the "value proposition" of the Pure North program

[36] "[W]e now believe that the outcomes of treatment are not solely attributable to the specific action of a drug, but may also depend on other nonspecific therapeutic effects." Ralph I. Horwitz and Sarah M. Horwitz, "Adherence to Treatment and Health Outcomes," *Archives of Internal Medicine* 153, 16 (1993): 1863-1868.

[37] Workplace wellness programs have been shown to be cost-effective in terms of reduced health-care costs and reduced employee absences/disability costs (Ozminkowski et al., 2002; Chapman, 2003). A review of more than 150 trials examining the effectiveness and cost savings of workplace health-promotion programs has found that the studies generally indicate positive results (Pelletier, 2009). In Canada, it is estimated that the cost-effectiveness of workplace health-promotion programs is estimated to be between $1.75 - $6.85 for every corporate dollar spent (Nutrition and the Workplace). A recent large meta-analysis of a variety of different health-promotion programs found that, in general, they are associated with a return on investment for medical costs of $3.27 for every dollar spent on wellness programs, and a return for absentee-day costs of about $2.73 for every dollar spent (Baiker et al., 2010; Naydeck et al., 2008). Typically they have low expenditures per participant, which makes small reductions in medical costs look cost-effective. That said, the program costs per participant are less than $200 as they are often for fitness/exercise promotion and lifestyle modification. The values of reduced health-care spending and other benefits of the program may only be a couple of hundred dollars. The low value of benefits is justified by the low cost of the program.

for Albertans. In other words, if the Pure North program cost is indicative of the required level of public expenditure on upstream health promotion to improve health, then would there be a sufficient "return on investment" for the taxpayer? To address this issue we consider the expected impacts of the health improvements in Pure North participants on the utilization of acute-care medical treatment in hospitals and/or by physicians; the prevalence of chronic diseases; labour productivity; and the happiness/well-being of the participants.

Direct Costs of Illness: Hospitals, Doctors and Chronic Diseases

In Canada, adults self-reporting poor health ("fair" or "needs improvement") tend to require more acute-care health services from doctors and hospitals than Canadians who self-report being in good or better health. Based on work by Curtis and MacMinn,[38] we know that compared to those with poor self-reported health, a Canadian in good or better health will have, on average, seven fewer days in hospital, four fewer GP visits, and two fewer specialist visits per year than one in poor health. This suggests that the annual health-care costs of someone who is in poor health are $10,198 higher than they are for someone who is in good health (based on $1,375 per hospital night, $50 per GP visit and $75 per specialist visit). As the Pure North program saw improvements in health of 45 per cent of its participants who began in poor health, the expected annual cost savings for a Pure North participant entering the program in poor health is around $4,500 (= 0.45 x $10,198). The cost of the Pure North program is $1.5 million for the 649 participants in our sample who entered the program and self-reported having health that was fair or needed improvement. Since 293 of those participants improved to good or better health after at least six months in the program, the results show that an expected $3 million in health-care costs would be avoided.

As an intervention to improve the health of persons in poor health, this is a very high rate of return to program spending. With a Pure North program cost of $2,300 per year per participant, the reduction in acute-care health spending on hospitalization and doctors represents around a 90-per-cent real annual rate of return to the program's spending. It is important to recognize that this estimated return is too low. First off, this direct cost saving from reduced nights in hospital and fewer visits to doctors ignores other potential sources of cost savings such as emergency department visits, other health-care professionals, and pharmaceutical care. Further, these savings estimates do not account for the indirect benefits of reduced hospital utilization on pressure to build more bed capacity (capital costs), the value to the public payer of freeing up acute care beds to improve emergency department wait times, or social gains from healthier worker productivity and reduced caregiver costs.

The potential magnitude of gains for the public payer in terms of reduced need for hospital beds in Alberta is sizable. Consider that roughly nine per cent of the adult population in Alberta would be expected to be in poor health in a given year. If these 242,000 individuals entered the Pure North program, with 45 per cent of these improving to good or better health, these Albertans in total would have 762,300 fewer patient-days in hospital per year, representing nearly a 25-per-cent reduction in total patient days in hospital in the province per year.[39] It would cost $500 million to provide the Pure North program to 242,000 participants, but doing

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[38] Lori J. Curtis and William J. MacMinn, "Health Care Utilization in Canada: Twenty-five Years of Evidence," *Canadian Public Policy* 34, 1 (March 2008): 65-88.

[39] Alberta Health Services, "How Busy Are Our Hospitals?" http://www.albertahealthservices.ca/746.asp.

so would result in the province of Alberta having to spend $1.08 billion less on hospitals, specialists and GPs, for a net gain of over $500 million for the health-care budget.

The downstream effects of health-improvement programs are complex and can be difficult to assess in terms of their impact on health-care utilization. The evidence is mixed as to whether lifestyle-modification and wellness programs will reduce health risks, absenteeism within the first year of an intervention, or whether these changes will only be detectable over the longer term. Liu et al.[40] believe that it is important to take a long-term perspective when evaluating health and wellness programs in terms of medical-cost utilization.[41] The benefits of a health-promotion program on reduced need for medical treatment may be in the immediate term for persons who are in poor health or older.

Dietary supplementation appears to be particularly beneficial for the elderly, reducing infectious illness that results in hospitalization and use of physician services. This is perhaps not surprising, as a 2013 Statistics Canada study estimates that around one-third of seniors living in their own homes are at risk of inadequate nutrition or malnourishment, which could lead to a number of health problems.[42] Canadians aged 65 and over account for nearly half of all acute-care health spending, so it follows that if dietary supplementation can improve the health of seniors, there could be large and immediate impacts on health-care spending. A study by Barringer et al.[43] showed that multi-vitamin supplementation significantly reduced the risk of infectious illness and improved the quality of life in elderly individuals. A large proportion of the difference was accounted for by participants with Type 2 diabetes mellitus. Among diabetic participants receiving placebo, 93 per cent reported an infection compared with 17 per cent of those receiving supplements.[44] Another study on 96 elderly individuals by Chandra et al.[45] also showed that with one year of supplementation, individuals receiving a multi-vitamin showed a statistically significant reduction in the mean number of days with an infection-related illness (23 days versus 48 days). In addition, participants in the treatment group showed statistically significant improvement in several reliable indices of immune function.[46]

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[40] Hangsheng Liu et al., "Effect of an Employer-Sponsored Health and Wellness Program on Medical Cost and Utilization," *Population Health Management* 16,1 (2013): 1-6.

[41] ibid.

[42] Pamela L. Ramage-Morin and Didier Garriguet, "Nutritional Risk Among Older Canadians," Component of Statistics Canada Catalogue no. 82-003-X Health Reports, 2013.

[43] T.A. Barringer et al., "Effect of a Multivitamin and Mineral Supplement on Infection and Quality of Life: A Randomized, Doubles-Blind, Placebo-Controlled Trial," *Annals of Internal Medicine* 138, 5 (2003): 365-371.

[44] ibid. The Barringer study included 130 individuals aged 40-64 and over 65 years of age. Individuals were given either a placebo or a multi-vitamin. This study found that more participants receiving placebo reported an infectious illness over the study year than did participants receiving multi-vitamin and mineral supplements (73 per cent versus 43 per cent) and that infection-related absenteeism was also higher in the placebo group than in the treatment group (57 per cent versus 21 per cent).

[45] R.K. Chandra, "Effect of vitamin and trace-element supplementation on immune responses and infection in elderly subjects," *Lancet* 340, 8828 (November 7, 1992):1124-1127.

[46] ibid.

For healthy adults there is a reduced prospect for immediate avoidance of medical-treatment costs since most of a healthy person's need for hospitals and doctors is expected after age 65.[47] Does the Pure North program make economic sense for non-elderly persons in good or better health? Studies have shown that vitamin and mineral supplementation is beneficial for the health of individuals with sub-clinical deficiencies.[48,49] For healthier and younger participants in the Pure North program, the return to the program should be based on a longer-term focus that looks at the impact of the program on reducing the risks and future prevalence of chronic conditions and diseases. Badley et al. find that Canadians in poor health are more likely to develop new chronic conditions over a two-year period, so maintaining a state of good health will reduce chronic disease prevalence and its associated economic burdens. Thériault et al.[50] estimate that the potential cost savings from reducing risk factors for cardiovascular diseases such as obesity, smoking rates and hypertension in the Canadian population would be $76.4 billion for the 2005 to 2010 period.[51]

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[47] Emery, J.C. Herbert, David A. Still and Tom Cottrell (2012) "Can We Avoid a Sick Fiscal Future: The Non-sustainability of Health-Care Spending with an Aging Population," The School of Public Policy SPP Research Papers, Vol. 5(31).

[48] The Linxian trial confirmed this. This study, which included 29,584 adults between the ages of 40 and 69 years, looked at the effect of dietary supplements for disease prevention. The key factor in this trial is that the vast majority of the participants suffered from sub-clinical nutrient deficiencies at the start of the trial, which is hypothesized to be one of the major contributing factors to an unusually high incidence of esophageal and gastric cancers in the Linxian area. Overall, the results of the trial revealed reductions in total mortality and in cancer mortality and incidence, especially for stomach cancer, in the nearly 15,000 individuals who received daily supplements containing beta-carotene (15 mg), vitamin E (30 mg), and selenium (50 mcg). W.J. Blot et al., "Nutrition Intervention Trials in Linxian, China: Supplementation with Specific Vitamin/Mineral Combinations, Cancer Incidence, and Disease-Specific Mortality in the General Population," *Journal of the National Cancer Institute* 85, 18 (September 15, 1993): 1483-1492.

[49] For instance, the "SUpplementation en VItamines et Minéraux AntioXydants (SU.VI.MAX) Study," conducted in France, examined the benefits of multi-vitamin supplementation for the reduction of disease risk and began in 1994. The study included 13,017 men and women aged 35-60 years over a 7.5-year follow-up period. When subjects were separated by sex, the study did find a significant reduction in all-cause mortality and total cancer incidence (31-per-cent reduction) in men but not in women. The authors suggest that supplementation may have been more beneficial in men because they had a lower baseline status of certain antioxidants, especially of beta-carotene. In general, in this study the women were younger than men and generally had a healthier lifestyle, as suggested by higher serum levels of beta-carotene and vitamin C, and were less likely to smoke. S. Hercberg et al., "The SU.VI.MAX Study: A Randomized, Placebo-Controlled Trial of the Health Effects of Antioxidant Vitamins and Minerals," *Archives of Internal Medicine* 164, 21 (2004): 2335-2342.

[50] Louis Thériault, Carole Stonebridge, and Sabrina Browarski, "The Canadian Heart Health Strategy: Risk Factors and Future Cost Implications," Conference Board of Canada, 2010, http://www.conferenceboard.ca/temp/afd39628-ea60-4632-893e-b068c4fef72b/cdn-heart--health-strategy_web.pdf.

[51] ibid.

Research has established the efficacy of dietary supplementation for reducing chronic disease burdens. A large number of studies have examined the benefits of fish-oil supplements for reducing CVD risk, or related conditions, and the results show fairly strong, consistent and beneficial effects.[52] Numerous observational studies have shown that omega-3-fatty-acid-enriched diets are associated with reduced cardiovascular mortality, myocardial infarction, and sudden death. Fish intake in general has been associated with reduced mortality from cardiovascular causes and clinical studies have provided additional support for a role of fish oils, especially in the secondary prevention of cardiovascular disease.[53,54]

A growing amount of research has supported the health benefits of vitamin D. A recent review has looked at the economic impact and mortality rate associated with vitamin-D deficiency.[55] Vitamin-D supplementation has been shown to be a cost-effective intervention for preventing bone fractures and falls.[56] Higher levels of vitamin D and larger changes in vitamin-D levels are associated with achieving and remaining in good health. A Cochrane Library review studied the link between vitamin-D supplementation and mortality across 50 randomized control trials with more than 90,000 participants.[57] According to that study's meta-analysis, vitamin D3 (the type administered by the Pure North program) shows a significant statistical association with lower mortality in elderly women. The estimated magnitude of the effect is small (the odds of mortality in those taking vitamin D is 0.94 the odds of mortality in those who do not), but this represents a weighted average across many studies with different doses of vitamin D. In 45 of the 50 studies covered in the review, the effect of vitamin D was either preventative of mortality or was statistically insignificant (normally due to wide confidence intervals indicating smaller studies). This study shows that supplementation of Vitamin D3, a relatively innocuous and nonintrusive intervention, can have a tangible effect on mortality, a primary endpoint for health.

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[52] Robert Oh, "Practical Applications of Fish Oil (n-3 Fatty Acids) in Primary Care," The Journal of the American Board of Family Practice 18 (2005): 28 –36.

[53] Robert Oh, "Practical Applications of Fish Oil (n-3 Fatty Acids) in Primary Care"; R. B. Singh et al., "Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: the Indian experiment of infarct survival — 4," *Cardiovascular Drugs and Therapy* 11, 3 (July 1997): 485–91; M. L. Burr et al., Effects of changes in fat, fish and fibre intakes on death and myocardial reinfarction: diet and reinfarction trial (DART)," *Lancet* 2, 8666 (September 30, 1989): 757– 61.

[54] The benefits of fish oil for secondary prevention are so strong that the American Heart Association recommends 1 g of fish oil, via diet or through supplementation, in all patients with documented coronary artery disease after consultation with their physician; Robert Oh, "Practical Applications of Fish Oil (n-3 Fatty Acids) in Primary Care" (2005). Three recent reviews by Wang et al. (2006), He et al. (2009) and Kris-Etherton et al. (2003) all reach the same conclusion: that fish-oil supplements are beneficial for reducing CVD mortality and events in secondary prevention: C. Wang et al., "n-3 Fatty acids from fish or fish-oil supplements, but not alpha-linolenic acid, benefit cardiovascular disease outcomes in primary- and secondary-prevention studies: a systematic review," *The American Journal of Clinical Nutrition* 84, 1 (July 2006): 5–17; K. He "Fish, Long-Chain Omega-3 Polyunsaturated Fatty Acids and Prevention of Cardiovascular Disease — Eat Fish or Take Fish Oil Supplement?" *Progress in Cardiovascular Diseases* 52, 2 (September–October 2009): 95–114; Penny M. Kris-Etherton et al., "Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease," *Arteriosclerois, Thrombosis and Vascular Biology* 23 (2003).

[55] W.B. Grant et al., "An estimate of the economic burden and premature deaths due to vitamin D deficiency in Canada," *Molecular Nutrition and Food Research* 54, 8 (August 2010): 1172-1181.

[56] W.B. Grant et al.,, "Estimated benefit of increased vitamin D status in reducing the economic burden of disease in western Europe," *Progress in Biophysics and Molecular Biology* 99, 2-3 (Feb-Apr 2009): 104–113. The cost-effectiveness of vitamin-D supplementation for the prevention of hip fractures was looked at in seven European countries. The study found that the calculated net financial benefit ranged from 70,000 euros to 711,000 euros per 1,000 women treated.

[57] Bjelakovic et al., "Vitamin D supplementation for prevention of mortality in adults," *Cochrane Database of Systematic Reviews* 8 (2011).

In Canada, it is estimated that increasing 25[OH]D levels to 105 nmol/L would result in $14.4 billion of savings from reduced chronic-disease burdens.[58] Grant et al. estimate that increasing average 25[OH]D levels to 105 nmol/L would decrease the costs of vitamin-D related diseases by 6.9 per cent; reduce the costs associated with pregnancy by 10 per cent; reduce the all-cancer incidence rate by 25 per cent; reduce the incidence of cardiovascular disease by 25 per cent; reduce the incidence of diabetes by 15 per cent; reduce the incidence of multiple sclerosis by 40 per cent; reduce falls and fractures by 30 per cent; and reduce the risk of septicemia by 25 per cent. Referring to Table 4, Pure North participants who reported good or better health after at least six months in the program achieved mean and median 25(OH)D levels above 105 nmol/L, which implies that the improvement in this surrogate endpoint for chronic-disease risk can be expected to achieve these reductions in chronic diseases in the future. Based on the $14.4 billion in population-level reductions of chronic-disease burdens, for each Pure North participant who remains in, or improves to, good or better health, the value of reduced illness costs associated with chronic diseases would be around $500.[59]

Indirect Costs of Disease and Illness: Labour Productivity, Income and Well-Being

It is important to recognize that there are many other potential economic gains from keeping more Canadians in good health. It has been estimated that, in Canada, the indirect costs of illness, lost productivity and lost-life years are at least as large as the direct costs discussed earlier.[60]

Having more Albertans and Canadians in good health will increase the effective labour-supply for the Canadian labour market and increase the GDP. When assessing the value of health programs, employers typically look at medical costs, turnover, absenteeism, workers-compensation program costs, disability-program costs, family medical leave, and on-the-job productivity losses.[61] Poor health is a major reason why many Canadians retire, necessitating their reliance on transfers from provincial and federal governments. Not only do we lose workers due to poor health, we increase fiscal burdens for all levels of government.

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[58] W.B. Grant et al., "An estimate of the economic burden and premature deaths due to vitamin D deficiency in Canada."

[59] This is based on the total cost of illness in Canada. The Public Health Agency of Canada's "The Economic Burden of Illness in Canada," on which Grant et al. based their estimates, estimates that Canadians aged 35 to 64 account for half of the total (direct and indirect) costs of illness in Canada each year. Consequently, we take half of Grant et al.'s estimate of vitamin-D-deficiency-attributable-illness costs of $14.5 billion and divide by the size of the Canadian population aged 35 to 64. This age group matches the ages of our sample of Pure North participants.

[60] Public Health Agency of Canada, "Investing in prevention the economic perspective: Key Findings from a Survey of the Recent Evidence," May 2009.

[61] R. Z. Goetzel et al., "The Health and Productivity Cost Burden of the 'Top 10' Physical and Mental Health Conditions Affecting Six Large U.S. Employers in 1999," *Journal of Occupational and Environmental Medicine* 45, 1 (2003): 5-14.

For those Canadians in poor health who continue to work, their lower productivity on the job (presenteeism) and more frequent absences from work result in 10-to-25-per-cent loss in annual earnings depending on the degree to which their health is "disabling."[62] If we consider that the median annual income of an employed Canadian is around $50,000, then the productivity loss due to a person being in poor health is roughly $5,000 to $12,500 per year. Even non-disabled individuals experience lower productivity. Employees who reported having "poor physical health" are estimated to have approximately two-per-cent lower productivity on the job than employees not reporting poor physical health, and individuals self-reporting poor health "risks," such as stress, poor physical health, low physical activity and more, were estimated to cost their employer approximately $1,200 a year in lost productivity per health risk.[63]

Finally, it is important to recognize that better health improves the happiness, or well-being, of an individual. Helliwell and Barrington-Leigh[64] have shown that each one-per-cent change in self-reported health on the same five-point scale used on the Pure North questionnaire that we are analyzing represents a one-per-cent change in subjective well-being. Helliwell and Barrington-Leigh have shown that each one-per-cent increase in subjective well-being is equivalent to gaining 7.9 per cent in annual income. As the change in average self-reported-health score for all 2,581 Pure North participants was 5.4 per cent, the value of the health gain for the average Pure North participant is equivalent to increasing their annual income by 42 per cent. In other words, for a Canadian with an annual income of $50,000, improving his or her self-reported health by 5.4 per cent would be equivalent to him or her having an additional $21,000 in income.

DISCUSSION

It seems obvious that health promotion and illness prevention have the potential for improving the sustainability of Canada's single-payer medical-treatment systems, improving productivity and improving the happiness and well-being of Canadians.[65] This raises the question of why provincial governments invest so little in health promotion.[66] There are two reasons that come to mind.

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[62] Cara Brown and Herbert Emery, "The Impact of Disability on Earnings and Labour Force Participation in Canada: Evidence form the 2001 PALS and from Canadian Case Law," *Journal of Legal Economics* 16, 2 (2010): 19-59.

[63] W. N. Burton et al., "The Association of Health Risks With On-the-Job Productivity," *Journal of Occupational and Environmental Medicine* 47, 8 (2005): 769-777.

[64] John Helliwell and Christopher Barrington-Leigh, "Measuring and understanding subjective well-being," *Canadian Journal of Economics* 43, 3 (August 2010): 729-753; John Helliwell and Christopher Barrington-Leigh, "How Much is Social Capital Worth?" *NBER Working Papers* no.16025 (2010).

[65] Public Health Agency of Canada, "Economic Burden of Illness in Canada, 2000," 2009; Public Health Agency of Canada, "What Makes Canadians Healthy or Unhealthy?" 2012.

[66] Only 5.3 per cent of total health expenditure expected to be spent on public health in 2011 and 2012. See: Canadian Institute for Health Information, "National Health Expenditure Trends, 1975 to 2012," 2012.

First, there is the view that the government should not have to pay for keeping people healthy. It is widely believed by academics and the public that if Canadians consumed a balanced diet and exercised more, then the population would be much healthier and require much less acute-care medical treatment.[67] Exercise and diet and most other health-promoting behaviour for reducing illness burdens are more likely considered areas of personal responsibility and not the responsibility of government. Consequently, Canadians have chosen to rely on individuals interacting through private markets to invest in their health. Medicare, or acute-care treatment, is "disaster insurance." As Don Drummond[68] points out: "Our health system focuses on patching up people when something has gone wrong." This has likely been the outcome of the historical evolution of Canadian medicare, which resulted in legislation including the Canada Health Act of 1984 and preceding acts (the Hospital Insurance and Diagnostic Services Act and Medical Care Act) that limited a provincial government's obligation for payment for health care to physician and hospital services, largely for the purpose of treating illness.[69]

Health promotion and illness prevention are, perhaps somewhat surprisingly, the part of the overall health-care system that most rely on private payment. Health-care products and services for illness prevention, such as lifestyle counselling and dietary supplements, are mostly purchased by those with higher levels of education and higher income.[70] While this logic of relying on markets and individual sovereignty in choice may be appropriate for maintaining the health of well-off individuals, it is problematic for vulnerable populations, since factors beyond their control, such as poverty, are linked to greater risks of illness and premature death.[71] Not surprisingly, health problems associated with dietary deficiencies and lifestyle persist in the population despite education and information campaigns, preventative care and health promotion through the traditional acute-care medical treatment system, and reliance on private markets, which is indicative of these measures being ineffective going forward. To the extent that poor health and chronic-disease prevalence is greater for those Canadians with lower socio-economic status, greater attention should be paid to the barriers to improving health, such as lack of an individual's knowledge specific to their own health; lack of access to necessary health-improving measures; health monitoring; and empowering individuals to make decisions regarding their health.

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[67] For an entertaining presentation of this conclusion of health research "orthodoxy," see Timothy Caulfield, *The Cure for Everything: Untangling the Twisted Messages About Health, Fitness and Happiness* (Toronto: Viking Canada, 2011).

[68] Don Drummond, "Benefactor's Lecture, 2011: Therapy or Surgery? A Prescription for Canada's Health System," (2011, 4).

[69] For an excellent overview of this evolution of Canadian medicare and its achievements, see Jeffrey Simpson, *Chronic Condition: Why Canada's Health-Care System Needs to Be Dragged Into the 21st Century* (Toronto: Allen Lane, 2012). Whatever the causes, if we looked after cars the way we look after health, then we would rarely see too little emphasis on routine maintenance like oil changes and checking tire pressure, and lots of emphasis on expensive repairs and the disposal of prematurely derelict vehicles.

[70] Canadian Institute for Health Information, *Exploring the 70/30 Split: How Canada's Health Care System is Financed*, 2005; Nadeem Esmail "Complementary and Alternative Medicine in Canada: Trends in Use and Public Attitudes, 1997-2006," Fraser Institute, *Public Policy Sources* 87 (2007) http://www.fraserinstitute.org/uploadedFiles/fraser-ca/Content/research-news/research/publications/complementary-alternative-medicine-in-canada-2007.pdf.

[71] M. Minkler, "Personal Responsibility for Health? A Review of the Arguments and the Evidence at Century's End," *Health Education and Behavior* 26, 1 (1999): 121-40.

A second and more practical reason for the lack of public investment in health promotion and disease prevention is that it is not clear what interventions work and which ones make good use of scarce public dollars. Much of the evidence that has been established around health status and health-care utilization shows cross-sectional associations that demonstrate that people in poorer health use more health-care services. What is lacking is evidence of a causal channel establishing that improving someone's health will reduce his or her utilization of services. In other words, if a provincial government were to commit to promoting the health of the members of its population, could it be confident that there would be measurable returns in terms of reduced health-care spending?

This context should make it clear why provincial governments should be interested in the health outcomes demonstrated by the Pure North program. Philanthropic motives have created an upstream health-promotion, disease-prevention program offered on terms comparable to those of Canada-Health-Act-defined medicare services. The scale of this program is well beyond that of the typical pilot program, providing a clearer picture of population-level health outcomes should the program be scaled up. A summary of the fiscal and social returns to the program's impacts on participants in poor health would be that each dollar spent on improving each participant's health will decrease spending on hospitals and doctors by two dollars; raise labour productivity of that individual by at least two dollars and improve the participant's happiness/well-being by the equivalent of him or her having an additional nine dollars in income. Scaled to the population level in the province of Alberta, this program has the potential to reduce nights in hospital by 25 per cent per year and free up, net of program costs, over $500 million in the health-care budget. Not included in these returns are the benefits of preventing people from falling into poor health in the first place.

The potential to free up almost five per cent of the current Alberta Health Services (AHS) budget through upstream illness and disease prevention, at a time when AHS struggles to keep up with costs of treating illness with budget growth of only three-per-cent, may seem hard to comprehend. But, this estimated potential to reduce spending on the treatment of illness and disease is in line with the potential spending reductions identified in other studies. Illness and disease are expensive. Historically the decision to use public payment for physician services and hospitalization was to address pervasive market failures in health-care markets — notably, a lack of private insurance and ability to pay for costly care. This study's estimates show that the same market failures exist for upstream health promotion and disease prevention that result in a further market failure, the negative spillover to the publicly funded medicare illness-treatment system. The failure of the market to provide the efficient level of upstream investment in health is leading to large and avoidable increases in the need for downstream medical treatment. These efficiency costs are large and the solution should come from government addressing the upstream market failure by expanding public payment for health care to include upstream health promotion and disease prevention. While government would take more responsibility for paying for services and products that improve health and reduce chronic-disease burdens, the government would directly benefit in the present and future from reducing the deadweight loss of illness and chronic disease.

APPENDIX

TABLE 1: SUMMARY STATISTICS OF SELECTED CHARACTERISTICS AND BLOOD BIO-MARKERS OF PURE NORTH PROGRAM PARTICIPANTS BY SELF-REPORTED HEALTH STATUS

Variable		Good	Poor	Variable		Good	Poor
Age	Mean	41.4	42.2	HDL (mmol/L)	Mean	1.4	1.3
	Std Dev	11.3	10.1		Std Dev	0.4	0.4
	Median	42	42		Median	1	1
	N	1,224	384		N	1,668	545
BMI	Mean	26.1	27.7	LDL (mmol/L)	Mean	3	3
	Std Dev	4	4.5		Std Dev	0.9	0.9
	Median	26	28		Median	3	3
	N	681	237		N	1,570	506
Weight (kg)	Mean	83	91.4	Total Cholesterol (mmol/L)	Mean	5	5
	Std Dev	16.8	20		Std Dev	1	1
	Median	83	92		Median	5	5
	N	1,731	546		N	1,675	545
25(OH)D (nmol/L)	Mean	78	68.6	Triglycerides (mmol/L)	Mean	1.3	1.6
	Std Dev	41.7	39.1		Std Dev	0.9	1.1
	Median	70	61		Median	1	1
	N	1,636	534		N	1,579	515
B12 (pmol/L)	Mean	475.1	458.8	Insulin (pmol/L)	Mean	48.5	68
	Std Dev	231.1	251.5		Std Dev	37.9	54.8
	Median	426	404		Median	39	56
	N	670	271		N	1,538	484
Systolic (mmHg)	Mean	123.7	126.5	Glucose	Mean	4.9	5.1
	Std Dev	13.8	15.5		Std Dev	0.9	1.3
	Median	122	124		Median	5	5
	N	1,752	574		N	1,643	551
Diastolic (mmHg)	Mean	78.3	80.7	HemoglobinA1c	Mean	5.7	5.8
	Std Dev	9.7	10.3		Std Dev	0.6	0.6
	Median	78	80		Median	6	6
	N	1,748	573		N	892	321

NOTES: Good = Self-reported health at start of program is "Good," "Very Good" or "Excellent." Poor = Self-reported health at start of program is "Fair" or "Needs Improvement." Number of observations by measure varies because of changes in information collected over time, or more recent participants may have completed two questionnaires but not two blood samples.

About the Author

Herb Emery is Professor of Economics at the University of Calgary. His research interests and publications are focused on economic history, labour economics, and health economics. Current projects include studies on reform of public health care in Canada. Recently, he was appointed Program Director, Health Policy in The School of Public Policy. Dr. Emery currently teaches a statistics/math foundations course in the MPP program.

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