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BENDING THE MEDICARE COST CURVE IN 12 MONTHS OR LESS: HOW PREVENTATIVE HEALTH CARE CAN YIELD SIGNIFICANT NEAR-TERM SAVINGS FOR ACUTE CARE IN ALBERTA[†]

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SUMMARY

Over the course of more than 30 years, a series of Canadian government commissions and health policy researchers have repeatedly identified the importance of “bending the cost curve” to sustain publicly funded health care, and the potential to do so through upstream investment in health promotion and disease prevention. So far, however, the level of public investment in prevention represents only a slight portion of total public health care expenditure, largely consisting of traditional public health initiatives such as vaccinations, disease screening and information campaigns.

This study of the Pure North S’Energy Foundation’s preventative health care program — wherein health care usage by program participants was measured against age- and sex-matched control samples — finds that the sort of preventative health care services offered by Pure North can lead to genuine and significant near-term cost savings for Canada’s single-payer health care system. Participants in the first year of the program required 25 per cent fewer hospital visits and 17 per cent fewer emergency room visits compared to the control group. Among those who persisted in the program for a year or longer, the effects were even more significant: 45 per cent fewer hospital visits in the year after joining, and 28 per cent fewer visits to emergency departments, compared to the control group.

This represents real cost savings for a public health service: From \$388 per person who joined the program to \$677 per person who persisted beyond the first year. As a proportion of annual health spending for these participants on hospitals, emergency departments and general practitioners, this represents a cost reduction ranging from 22 to 39 per cent. If the Alberta government were able to implement this kind of program province-wide (at an estimated cost of \$500 per participant), and were to realize similar results in terms of reduced strain on acute care services, it is possible that the province could free-up the equivalent of 1,632 hospital beds every year. That is roughly the same as building two entirely new hospitals each on the scale of Calgary’s Foothills Medical Centre.

This demonstrates that “bending the cost curve” for public health care spending is not merely something that is realizable in the long term, but rather in the immediate future, as quickly as within a year after this kind of program could be implemented province-wide. And yet, the near-term savings in acute care services represent only the first wave of benefits. The prevalence of chronic diseases and conditions, including diabetes, heart disease, cancer and mental illness, have been rising and are projected to keep doing so over the coming decade. The Pure North program aims to prevent and address these health conditions and chronic diseases through a combination of screening and testing, lifestyle modification, nutrition education, the identification of nutritional deficiencies, and dietary supplements. The long-term benefits of a Pure North-style program implemented province-wide in Alberta are likely to be that much greater as the prevalence of diabetes, heart disease, cancer and mental illness is tempered through the use of widespread preventative care.

Then there are the broader “indirect benefits” of a generally healthier population: higher labour productivity, higher incomes and greater well-being. These returns to the Alberta government, and taxpayer, have the potential to be as large, if not larger, than the direct benefits of significantly reduced acute care costs.

[†] We thank two anonymous referees for their comments. We have also benefited from comments from Dr. Reinhold Vieth, Professor Paul Veugelers and Dr. Edward Giovannucci. The study of the Pure North program received ethical approval from the University of Calgary’s Conjoint Health Research Ethics Board (Ethics ID: 24890). Data linkage was performed by the Data Integration, Measurement and Reporting unit at Alberta Health Services according to a Research Agreement designed to keep all health information confidential. The data used in this study are all unidentified and confidential.

INTRODUCTION

For over 30 years, Canadian government commissions and health policy researchers have identified the potential to “bend the cost curve” facing Canada’s iconic single-payer health care system (Medicare) through upstream investment in health promotion and disease prevention.¹ To date, the level of public investment in prevention represents a small portion of the total public expenditure on health care, and initiatives implemented largely fall within the traditional domains of public health (vaccinations, screening for diseases, environmental regulation, and information campaigns).² Public health strategies and information campaigns targeting regulation and fortification of foods in Canada have had some success in improving diet and lifestyle choices, but given that the prevalence of chronic diseases and conditions (including diabetes, heart disease, cancer and mental illness) continues to rise and is projected to continue to do so over the coming decade, it appears that more can be done. Thus there is increasing pressure on government to implement policy addressing the social determinants of health (including education, housing and income) to improve health outcomes for Canadians.³ Governments are being asked to consider tax subsidies for positive lifestyle choices, such as exercising, and to impose taxes on poorer choices, such as smoking and eating “junk food.” Secondary prevention (preventing conditions from getting worse) and better management of chronic conditions are central to health care reform.⁴

Policymakers are faced with determining which health prevention programs and interventions should be supported to improve the health of the population beyond traditional actions in the domain of public health, and what programs are actually feasible for public support and/or delivery. Without clear evidence of the likely effectiveness of such programs and interventions, or information regarding the returns to the public payer, decision-makers may be hesitant to commit scarce resources to prevention rather than treatment.⁵ The not-for-profit Pure North S’Energy Foundation’s (henceforth “Pure North”) preventative and integrative health program provides a rare opportunity to investigate the impact of preventative care services on health care utilization. Since 2007, Pure North has spent \$172 million to provide over 35,000 participants in Western Canada with personalized, preventive health care services

¹ S. Duckett, *Where to from Here? Keeping Medicare Sustainable* (Kingston and Montreal: McGill-Queen’s University Press, 2012); S. Lewis and T. Sullivan, “How to Bend the Cost Curve in Health Care,” *IRPP Insight* 1 (May 2013). The need to prioritize efforts to improve the health of the Canadian population to promote the fiscal sustainability of Medicare dates back to at least the Lalonde report (1974), and was proposed in the Kirby commission (2002) and the Romanow commission (2002): M. Lalonde, *A new perspective on the health of Canadians. A working document* (Ottawa: Government of Canada, 1974); M.J.L. Kirby, *The Health of Canadians — The Federal Role: Final Report on the State of the Health Care System in Canada* (Ottawa: Senate, Standing Committee on Social Affairs, Science and Technology, 2002); R. J. Romanow, *Building on Values: The Future of Health Care in Canada: Final Report of the Commission on the Future of Health Care in Canada* (Ottawa: Queen’s Printer, 2002). See: J. Ball et al., “Investing in prevention the economic perspective: Key Findings from a Survey of the Recent Evidence” (Public Health Agency of Canada, 2009); Greg Finlayson et al., “The Additional Cost of Chronic Disease in Manitoba,” *Manitoba Centre for Health Policy* (April 2010); Don Drummond, “Benefactor’s Lecture, 2011: Therapy or Surgery? A Prescription for Canada’s Health System” (Toronto: C.D. Howe Institute, 2011), 4-5, http://www.cdhowe.org/pdf/Benefactors_Lecture_2011.pdf.

² Only 5.3 per cent of total health expenditure was projected to be spent on public health in 2011 and 2012; Canadian Institute for Health Information, “National Health Expenditure Trends, 1975 to 2012” (Ottawa: CIHI, 2012).

³ See Drummond, “Benefactor’s Lecture”; and Lewis and Sullivan, “How to Bend.”

⁴ Lewis and Sullivan (“How to Bend,” 10) argue that “Every structure and incentive should be aimed at preventing or postponing avoidable health breakdown” but “the focus of health care should be on secondary prevention — preventing conditions from getting worse” because “Most of the preventable burden of disease results from social and economic conditions that are beyond the purview of health care to change.”

⁵ The lack of resource allocation is also in part attributable to many preventative health care services currently falling outside of the required scope of public services for public payment in the Canadian Medicare system. The 1984 Canada Health Act only requires that public payment be full payment for medically necessary services provided by a physician and/or in a hospital. See Herbert Emery and Ronald Kneebone, “The Challenge of Defining Medicare Coverage in Canada,” *The SPP Research Papers* 6, 32 (2013), <http://policyschool.ucalgary.ca/sites/default/files/research/emery-kneebone-Medicare.pdf>.

through access to lifestyle and diet counselling, health assessment, nutritional supplementation and dental services from a team of physicians, nurse practitioners, nurses naturopaths and dentists on the same “no out-of-pocket costs” terms as illness treatment in Canadian Medicare.

Our interest is in measuring the impact of the Pure North program on participants’ use of hospitals, emergency departments and general practitioners. To that end, we have a data set of health care utilization for 5,689 program participants in Alberta who consented to provide their personal health number, and for an equal number of age- and sex-matched controls. The data track utilization from fiscal year 2003/04 to fiscal year 2013/14 using the province of Alberta’s Discharge Abstract Database; Ambulatory Care Database and Practitioner Payments Database.⁶ The changes that we describe represent the immediate impact of the program. The value of the health care costs avoided in the immediate term would be augmented by future health care costs avoided through the prevention of chronic diseases.⁷ Assessing the effectiveness of the program for preventing chronic diseases is the focus of ongoing work. We interpret our results as representing the impact of the program in totality and we are not able to attribute changes to particular parts of the program.

For program participants in the first year of the program, there are statistically significant reductions of 25 per cent in the number of hospital visits and of 17 per cent in the number of emergency department visits, relative to what we observe in the age- and sex-matched controls. For the participants whom we can confirm persisted in the program at least one year, the effect sizes are larger. There are 45 per cent fewer visits to hospital in the year after joining and 28 per cent fewer visits to emergency departments. In terms of health care costs attributable to the population represented by this sample, these reductions in annual health care utilization attributable to the program are worth from \$388 per person who joined the program, to \$677 per person known to have persisted in the program. These represent reductions in annual health spending of 22 per cent to 39 per cent of the \$1,750 average cost of hospitals, emergency departments and general practitioners used for the sample in the year prior to joining the program. While these are the more direct, immediate benefits of the program for the Alberta taxpayer, we also expect the program is reducing the risk of participants developing chronic diseases. We have not incorporated the broader “indirect benefits” of better health that come from higher labour productivity, higher incomes and greater well-being, but it should be noted that these costs are typically found to be as large, if not substantially larger, than the direct benefits as represented by medical treatment costs in other studies.⁸

⁶ As discussed below, Pure North did not request personal health numbers from persons joining the program prior to 2012. For persons who joined the program prior to 2012, the personal health numbers, and consent to use them, were collected retroactively.

⁷ The health care costs avoided from chronic diseases avoided are broader than the health care utilization categories we analyze. For example, avoiding chronic diseases avoids the need for pharmaceutical use, services from non-physician providers (e.g., physiotherapy) and out-of-pocket costs borne by individuals with the diseases.

⁸ See Public Health Agency of Canada, “Investing in prevention the economic perspective: Key Findings from a Survey of the Recent Evidence” (May 2009), 2.

THE PURE NORTH PROGRAM

During the period studied, Pure North delivered preventative health care services at little to no direct cost to the participant.⁹ Pure North's stated goal 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." The organization operates out of Calgary, AB but has established clinics across Alberta, British Columbia and Saskatchewan.¹⁰

Pure North's origins are as a workplace-based program for oilfield workers in Alberta employed by Canadian Natural Resource Ltd. (CNRL). Until May 2012, program participants were primarily associated with CNRL, but after May 2012 the program expanded to provide access to its preventative health care services to a broader population including seniors, aboriginals, and those who are homeless, suffering from addiction, living in isolated areas, and/or with low income. These groups have had more limited access to health promotion and prevention services as the out-of-pocket costs for these services are a substantial barrier to access.¹¹

Pure North aims to prevent and address the most common health conditions and chronic diseases seen in the Canadian population, including cardiovascular disease, diabetes, mental illness and cancers.¹² All of these conditions have been shown to lead to premature death and are associated with alterable risk factors such as poor nutrition, inactivity, tobacco use and excessive alcohol consumption.¹³ The program focuses on primary prevention through a combination of screening/testing, lifestyle modification,

⁹ Participants enrolled prior to January 2013 were not charged any fees for participation. After January 2013, participants with incomes over \$24,000 per year were asked to pay \$1,200 for the first year and \$700 for the following years. Pure North reports that under 10 per cent of participants enrolled since January 2013 pay to participate and 90 per cent continue with no costs for participation. Our study period consists of program participants who started the program no later than March 31, 2013. In our entire sample of 6,570 program participants, only 211 were paying out of the 1,410 who joined the program between January and March 2013.

¹⁰ 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-In Centre, the Alberta Adolescent Recovery Centre in Calgary, a satellite clinic in Fort St. John, 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 not served by their traditional-style clinics to operate mobile clinics at sites including 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 in Calgary known as the Pure North Outreach Health and Dental Care Clinic at the Mustard Seed, and one in Lloydminster at the Thorpe Recovery Centre.

¹¹ Canadian Institute for Health Information, *Exploring the 70/30 Split: How Canada's Health Care System is Financed* (Ottawa: CIHI, 2005); Nadeem Esmail, "Complementary and Alternative Medicine in Canada: Trends in Use and Public Attitudes 1997-2006," *Public Policy Sources* 87 (Vancouver: Fraser Institute, 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 most comparable to the program charge clients \$3,200 to \$6,200 per year. It appears that the cost of dietary supplements is in addition to those amounts (*Calgary Herald*, "Options: Your Guide to Private Medicine," Advertising Supplement, February 23, 2013).

¹² Pure North S'Energy Foundation website, "Goals of the Foundation," http://www.purenorth.ca/?page_id=122; and "About Pure North," http://www.purenorth.ca/?page_id=104.

¹³ A. Mokdad et al., "Actual Causes of Death in the United States, 2000," *Journal of the American Medical Association* 291 (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: World Health Organization: 2008-2013 *Action plan for the global strategy for the prevention and control of noncommunicable diseases* (2008), <http://www.who.int/nmh/publications/9789241597418/en/>; A. Drewnowski and B. M. Popkin, "The nutrition transition: new trends in the global diet," *Nutrition Reviews* 55 (1997): 31-43.

nutrition education, identification of nutritional deficiencies and dietary supplementation.¹⁴ As in other health promotion programs, the Pure North program assesses health needs and monitors health changes through the use of questionnaires, laboratory tests and biometric measurements.¹⁵

Pure North's program provides participants with access to multidisciplinary teams of physicians, 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). The organization provides participants with dietary supplements for health promotion, some of which are tailored to the individual's assessed needs. 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. Counselling for lifestyle recommendations is 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/her commitment to the potential program.

The dietary supplements used in the program are selected by Pure North's clinical team to address common problems such as vitamin D insufficiency, insulin resistance, obesity and hypercholesterolemia. Dietary supplements available to participants include multivitamins, fish oil, vitamin D₃, probiotics, magnesium, vitamin B12, vitamin C, alpha lipoic acid and N-Acetyl cysteine. With the exception of vitamin D₃, all dietary supplements provided are within Health Canada's tolerable upper level of intake (UL) (Appendix 1 lists the contents of the supplement). According to Pure North's "Goals of the Foundation," special emphasis is given to the importance of vitamin D₃ supplementation to address vitamin D insufficiency in the Canadian population.¹⁶ Consequently, Pure North recommends an intake of vitamin D₃ of 6,000 to 12,000 IU per day depending on vitamin D nutritional status, measured as serum 25-hydroxyvitamin D [25(OH)D]. As this intake is higher than Health Canada's upper tolerable limit for vitamin D₃ of 4,000 IUs per day, the organization must have medical oversight of the participants and doctors monitor 25(OH)D and calcium levels every six to 12 months to ensure that participants do not have increased calcium levels and other symptoms of toxicity.¹⁷ Interventions are

¹⁴ 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, cholesterol levels, blood pressure and weight and stress management. Corporate/ workplace-based and community-sponsored programs for health promotion have become more prevalent over the last 15 years: Association for Worksite Health Promotion and William M. Mercer Inc., *National Worksite Health Promotion Survey* (Northbrook, Ill.: U.S. Department of Health and Human Services, 1999). Corporate programs are usually intended 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 (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 (1990): 1101-1105; Aldana et al., "Financial impact."

¹⁵ See for example, 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 (1999): 93-101.

¹⁶ Pure North S'Energy Foundation website, "Goals" and "About." Research using Pure North data demonstrated that vitamin D deficiency and insufficiency is prevalent in this CNRL population: Y.S. Chao et al., "Vitamin D status of Canadians employed in Northern latitudes," *Occupational Medicine* 63 (2013): 485-93.

¹⁷ Pure North has protocols in place so that when high serum-calcium results are obtained, a repeat serum-calcium sample, PTH and urine calcium sample are collected. Analysis of program data showed that with supplementation levels of up to 20,000 IU per day, there were no substantial or statistically significant increases in serum calcium or in the risk for hypercalcemia. See J.P. Ekwaru et al., "The importance of body weight for the dose response relationship of oral vitamin D supplementation and serum 25-hydroxyvitamin D in healthy volunteers," *PLOS ONE* (September 29, 2014, in press).

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 clinical staff. Follow-up and program adherence is completely voluntary.

Defining a cost of the program for a given participant is not straightforward given the variability over time in what the program has provided participants, how the care model has been organized, where the program is provided (e.g., mobile clinics travelling to remote communities), capital purchases (e.g., dental clinics), education and outreach, and efforts toward program evaluation and research. For example, select dental services have been a sizeable expense for Pure North but they have been provided to only one-quarter of participants, and for around half of those participants the services have been for the removal of amalgam fillings.¹⁸ The total operating costs have been higher in the past due to the extent of laboratory tests and supplements provided, which reflected research interests including the evaluation of the program and the safety and effectiveness of vitamin D₃ for improving health.

Pure North reported that the per participant cost of the parts of the program offered to all participants on an ongoing basis (dietary supplements, laboratory testing and health consultation) was \$2,300 in 2012/2013, two-thirds of which was accounted for by the cost of the dietary supplements. Over time, it has reduced these costs per participant to \$1,535 in 2013/2014 and projects an average cost of \$1,280 in 2014/2015. This trend in per participant costs of the program is attributed to changes in the content and delivery of the program reflecting the experience gained through eight years of operating combined with the results of internal program evaluation and external research on the program. The quantity, mixture and costs of dietary supplements have decreased as the program focuses on effectiveness and consistency in compliance. Health consultation costs have decreased as the program moved to fewer consultations per year, and shorter duration consultations within the scope of practice of registered nurses, nurse practitioners and naturopathic doctors, rather than physicians. The costs associated with laboratory services have been significantly reduced due to completed research-related program inquiries for safety and efficacy. Pure North projects that the program can be delivered for \$500 per participant per year.

ALBERTA HEALTH SERVICES UTILIZATION DATA

From 2012 onwards, upon entry to the program, participants were asked for their personal health number (PHN) and permission for their information to be used for research purposes. For participants who joined prior to 2012, Pure North collected PHNs and permission at follow-up visits to a Pure North clinic or contacted the participants by phone and/or email to request PHNs and permission to use their PHN and linked information for research purposes. For Alberta-based participants granting permission to use their PHN, the organization provided those PHNs to Alberta Health Services (AHS) to link with provincially funded health care utilization data from three different databases at the individual level. There were 6,570 program participants successfully linked by AHS.¹⁹

For these linked individuals, information from three databases, jointly referred to as the provincial registries, was available from the fiscal year starting April 1, 2003 until the fiscal year ending March 31,

¹⁸ The Pure North program covers dental amalgam removal and replacement, with an average cost of \$1,600 per participant who opts in to amalgam removal. Regular dental maintenance is not part of the program.

¹⁹ A number of PHNs were not linked because they did not correspond with numbers in the AHS registry. This can occur when the health number provided is for another province, the PHN is incorrectly reported by the participant, or the participant was not in the AHS database during the study time period.

2014. The first database is an inpatient database regarding hospital stays and hospital morbidity called the Discharge Abstract Database. The second database, the Ambulatory Care Database (emergency departments and day surgery), provides us with information on visits to the emergency department. The third database, the Practitioner Payments Database, provides information on fee-for-service payments made to Alberta physicians according to a pre-approved schedule of payments and billing codes, which we accessed for general practitioner billing. Therefore, for each participant with a valid PHN we have information on hospital use, emergency department use, and general practitioner use.²⁰

Along with PHNs, Pure North provided age, sex, and program-entry dates to AHS. Using this information, for each participant in the program, a random member of the general Alberta population was drawn from the provincial registries to serve as a matched control. Each control was drawn from the pool of individuals with identical age and sex to the participant, from the registry for the fiscal year corresponding to the year the participant joined the program. For example, a 50-year-old man who joined the program in January 2010 would be matched with a man who was 50 years old in the 2009/10 fiscal year. Individuals migrating to Alberta within the study period would be ineligible for matching, so our controls might under-represent in-migrants. Individuals who left Alberta and changed their PHN after obtaining coverage under another provincial health care plan were ineligible to provide a match for program participants. However, if an individual left Alberta and did not report their move to Alberta Health Services (i.e., they did not register for another provincial health card) they would falsely show up as using no health care. Thus, temporary out-migrants may be a source of downward bias in the level of health care utilization in the AHS registries and an influence on our study if Pure North participants are more likely to temporarily reside out of Alberta than are their matched controls.

After utilization data from the registries were compiled for the participants and their corresponding controls, that information was delivered to a data analyst at Pure North who removed all identifying information from the records and assigned randomized alphanumeric identification labels to the participants and controls. For participants, information provided from Pure North was available for biological measures (e.g., vitamin D (25(OH)D) blood serum level).

Each entry in any of the registries represents one interaction with the health care system for one most-responsible diagnosis. This is straightforward for the majority of emergency department and general practitioner visits, since those are often one single contact with the health care system. For longer stays in hospitals, one visit can count as multiple visits if the most-responsible diagnosis changes. For example, if someone is treated for an injury, and then received four additional weeks of rehabilitation in a hospital, the treatment and the rehabilitation would count as two visits since the individual's reason for being at the hospital and the associated resource use changed. Separating long visits into multiple shorter visits is done by AHS to track resources associated with hospital use.

Not all of the 6,570 participants linked to AHS data were used in our analysis. First, we focused on adults, age 25 and up upon joining the program, which eliminated 478 observations for participants under the age of 25.²¹ Second, we removed 50 program participants (less than one per cent of our sample) who either spent more than 100 nights in hospital, or who had a matched control that spent more than 100 nights in hospital. There are 19 excluded heavy users of health care in the Pure North participant

²⁰ Information on general practitioner utilization is only available until the fiscal year ending March 31, 2013; i.e., the physician-billing database is one fiscal year behind the other two databases in terms of data availability.

²¹ Some of the participants under the age of 25 in the program are elite athletes, including Olympic athletes, who are not likely to be representative of the general population with respect to health and health care needs. In our data set, almost three-quarters of participants under age 25 do not persist in the program, compared to less than half in the sample aged 25 and over.

group and 31 in the control group. Of those, seven participants and six controls are in the post-joining year. Twelve Pure North-participant heavy users and 25 of the control heavy users are from the five-year pre-joining period. Spending any time in hospital is rare (greater than 90 per cent of our sample spends no nights in hospital in any given year), so including those with over 100 nights in hospital could unduly influence estimates of the average change in hospital nights.²² We base our analysis on the model estimation results with heavy users excluded from the sample but we did estimate all models with them included and observed no major differences (an appendix with full regression results for all models is available upon request). Finally, we used the most common biomarker measurement, vitamin D blood serum level (25(OH)D in nmol/L), to determine whether a participant continued with the program, so 353 participants without a baseline measure of 25(OH)D were excluded.²³ These three restrictions left us with a final sample size of 5,689 participants and their matched controls, or 87 per cent of the original matched sample.

DATA ANALYSIS

The health care utilization of the age- and sex-matched control sample provides the counterfactual case for program participants: what would their health care utilization have been on average if they had not joined the program? Defining prevention as the avoidance of a negative health outcome means that we can compare the average change in utilization across time between participants and controls. Any successful program that prevents health-system utilization would exhibit a lower rate of increase (which could include an absolute decrease) in utilization than the controls.

Since the sample of program participants consists of persons who joined over different calendar years between 2008 and 2012, time in our models is defined relative to date of joining. Each individual in our sample provides a full year of post-joining utilization data. The date someone joins and 365 days afterward counts as the first year after joining. Each 365-day period before joining counts as a year prior to joining.

We estimate two types of models with a difference-in-differences approach. The first type is analogous to the intention-to-treat (ITT) analysis employed in studies with randomized treatment assignment: we do not require individuals to adhere to the program to count as being “treated” — we consider all participants as having access to the same treatment, though we acknowledge that individuals received access to the treatment and could elect not to participate. Throughout we refer to the group who had access to the treatment regimen as the “participants.” This method has the advantage of providing estimates of effect mimicking real-life circumstances when offering a voluntary intervention; that is, individuals will participate with varying levels of intensity.

We adopt a difference-in-differences approach to study the impact of the program. The effect of the program is the difference in utilization between the first year after joining the program and the year prior to joining the program compared to the difference observed in matched controls across the same two

²² One hundred nights is approximately 16 standard deviations away from overall mean nights in hospital. Using ICD-10 codes, we were able to establish these heavy users were hospitalized for serious conditions like schizophrenia, COPD with heart failure and numerous infections, paraplegia and associated rehabilitation, cancer, different mental health issues, and repeated admissions relating to drug abuse.

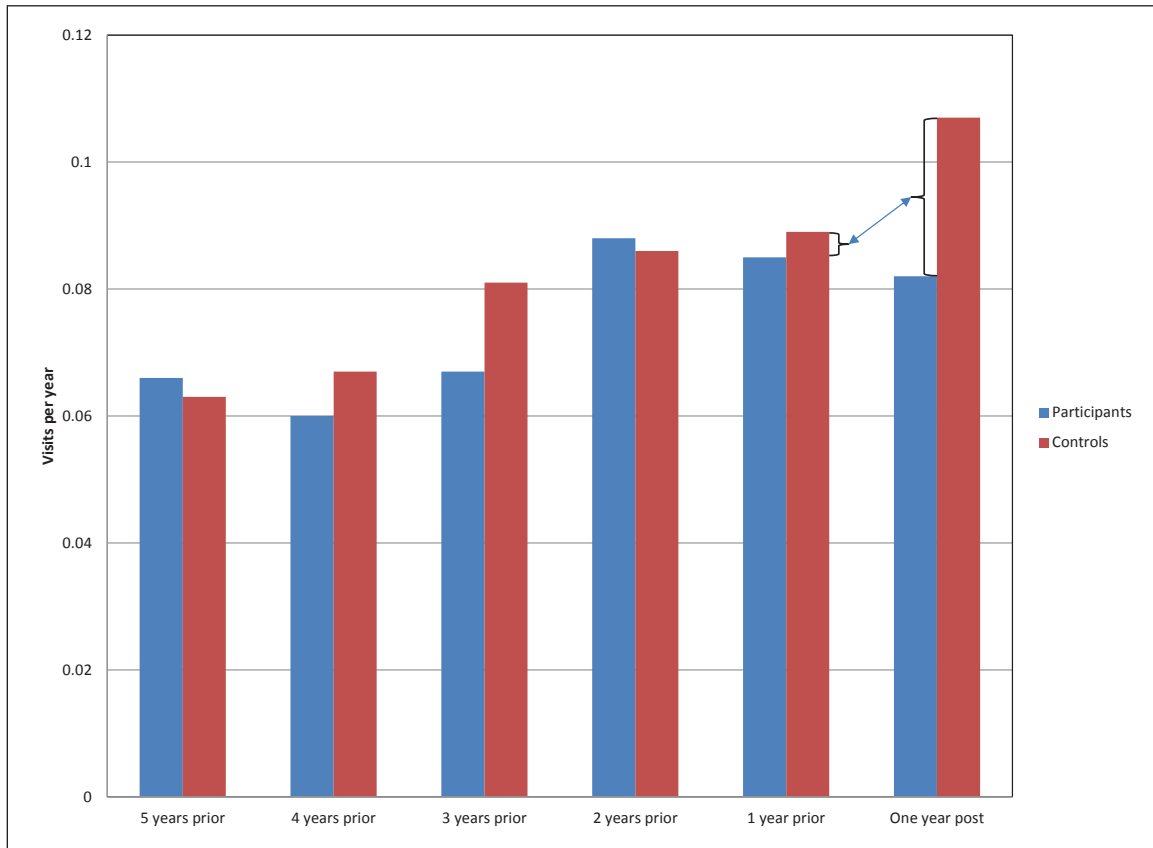
²³ We also estimated models using self-reported health and serum B12 measures to define persistence in the program. These estimates resulted in smaller sample sizes for persisting participants but confirmed the results we present based on 25(OH)D measures.

years. We estimate linear regression models that provide coefficients for the average utilization of the variable of interest in each year pre-joining (up to five years) and one year post-joining for participants and controls. The intention-to-treat model for health care utilization of person i in year t is:

$$HC_{it} = \beta_1^c \cdot Y_1 + \beta_1^{pn} \cdot Y_1 \cdot PN_i + \sum_{t=-4}^0 (\beta_t^c \cdot Y_t + \beta_t^{pn} \cdot Y_t \cdot PN_i) + u_{it}$$

u_{it} is the model's error term. Each year has its own average provided by the variables included in the model. " PN_i " is an indicator variable equal to one if an observation is for a participant, and zero if the observation is for a control. Y_t is an indicator variable equal to one if the observed utilization is in a given year t , and zero otherwise. $t=1$ denotes one year after joining the program, $t=0$ denotes the first year prior to joining the program, $t=-1$ is two years prior to joining, $t=-2$ is three years prior to joining, and so on. While controls are never in the program, the period of time where their matched participant is in the program is still denoted $t=1$. Thus, the difference in utilization between the controls across the period of interest (one year after their matched PN participant joins the program) is $\beta_1^c - \beta_0^c$ and the difference in utilization for the participants is $(\beta_1^c + \beta_1^{pn}) - (\beta_0^c + \beta_0^{pn})$. The difference between these differences is $\beta_0^{pn} - \beta_1^{pn}$. If the difference-in-differences term is positive, it means the controls exhibited a larger increase, or less of a decrease, in utilization across the year the participants joined the program than the participants did. Figure 1 conceptually illustrates the ITT result using the example of hospital visits per year from five years prior to joining to one year after.

FIGURE 1 ILLUSTRATION OF ITT PROGRAM EFFECT ON HOSPITAL UTILIZATION (NUMBER OF VISITS PER PERSON PER YEAR)



NOTES: The difference in utilization between the cases and controls during the year prior to joining is shown by the left brace. The right brace shows the difference in utilization during the year after joining. The arrows indicate the differences being compared, the difference between these differences is the quantity we use to describe the impact of the program.

We extend the preceding model to account for the fact that some individuals in the program may have stopped participating, or are not adhering to the program. Since the program is voluntary, we can only observe contact with the program rather than conclusive evidence of adherence to the program. Thus, we define “persisting” in the program with respect to the most ubiquitous variable gathered by Pure North: blood serum 25(OH)D (nmol/L). All of the participants in our data set have a 25(OH)D measure at baseline. We include measures taken up to 90 days after an individual enters the program as baseline, since individuals might register in the database some time before actually beginning the program. If a participant has a second measure of 25(OH)D six to 18 months after joining, we define them as “persisting” in the program. If they do not have a second measure, then they are classified as “non-persisting.”²⁴ We recognize that the decision to persist or not persist in the Pure North program is not necessarily exogenous to the program’s impact on a joiner’s health. The samples of persisting and non-persisting joiners are selected rather than assigned randomly, which introduces a potential bias into the model’s coefficient estimates. For example, the reduction in health care use suggested by the coefficient estimates may overstate the true causal effect of the program if the persisting versus non-persisting members reflects a sorting of the participant sample into healthy and less healthy persons.

²⁴ We do not know whether the individual has truly stopped following the program protocol. Individuals do not have to contact Pure North to cancel their program participation, they can simply stop returning. It is also possible for individuals to participate without having a follow-up 25(OH)D measurement. However, our results indicate that the proxy for participation seems reasonable. We have chosen to use the term “persisting” over “adhering” since, even if participants have a baseline and follow-up measure of 25(OH)D, we still do not know the degree to which they are following the program.

When we account for persisting, versus not persisting, in the program we augment the preceding model to:

$$HC_{it} = \beta_1^c \cdot Y_1 + \beta_1^{pn} Y_1 \cdot PN_i + \beta_1^{pn-np} Y_1 \cdot PN_i \cdot NP_i + \sum_{t=-4}^0 (\beta_t^c \cdot Y_t + \beta_t^{pn} \cdot Y_t \cdot PN_i) + u_{it}$$

NP_i is an indicator equal to one if the individual has a baseline measure upon entry to the program but no follow-up measure, and zero for a persisting program participant. β_1^{pn} is the difference in mean utilization between participants known to persist in the program at least one year over that of the age- and sex-matched controls.²⁵ Note that that coefficient estimates in this model for the pre-joining period will be identical to those in the ITT model.

Now we have three difference terms: the difference in the controls $\beta_1^c - \beta_0^c$, the difference in those who persist in the program $(\beta_1^c + \beta_1^{pn}) - (\beta_0^c + \beta_0^{pn})$, and the difference in those who do not persist in the program $(\beta_1^c + \beta_1^{pn} + \beta_1^{pn-np}) - (\beta_0^c + \beta_0^{pn})$. The difference-in-differences for those who persist is $\beta_0^{pn} - \beta_1^{pn}$ and the difference-in-differences for those who quit is $\beta_0^{pn} - \beta_1^{pn} - \beta_1^{pn-np}$.

Our data set is longitudinal and allows us to track individual-level changes in utilization over time. Data of this format allow us to address individual-level tendencies to use health care that are constant yet unobservable over time. However, since our model only includes a year-dummy variable (“year fixed effects”), different ways of addressing the individual-specific variation are unrelated to the variables in the model and do not change the coefficient estimates.²⁶ Thus, we estimated these models with OLS, using standard errors clustered by individual and bootstrapped 1,000 times to address the non-normal distribution of health care utilization.²⁷

We estimate the utilization models for two samples: the overall sample, and a group we refer to as “Vital 2.2” in reference to the name of the formulation of the multivitamin they received from Pure North. Three-quarters of our overall sample is represented by the Vital 2.2 cohort. Vital 2.2 is a group of interest because the revision of the multivitamin formulation coincided with Pure North expanding their program from a workplace-specific program to being available to the general population (occurring May 2012). The earlier cohorts of joiners who were largely employed by CNRL likely faced poorer access to acute care services through hospitals and doctors due to the remoteness of the region of the province in which they reside and work. CNRL participants could systematically differ in socioeconomic status and geographic location from the overall adult Alberta population from which the controls are drawn. As geographic location and socioeconomic status are known determinants for health-services usage and health outcomes, our estimates of program effects on health care utilization including the CNRL

²⁵ We also estimate models for the stratified samples of persisting program participants and their matched controls and non-persisting program participants and their matched controls. The point estimates of the models’ coefficients are statistically equivalent to the model described above, but there is a loss of statistical power due to the larger number of model parameters.

²⁶ Cameron and Trivedi, “Models for Panel Data,” in *Microeconometrics: Methods and Applications* (Cambridge, Mass: Cambridge University Press, 2005), 695-701.

²⁷ We ran an alternative specification of our model with a random-effects estimator and Huber-White standard errors, also bootstrapped 1,000 times, resulting in no major changes. The results of that model are available upon request in an appendix.

participants are less likely to be generalizable to the Alberta population than the sample restricted to Vital 2.2 participants.

RESULTS

The summary statistics in Table 1 show that program participants have a mean age of 51 years overall. Fifty-seven per cent of participants are female. In terms of health care utilization, for hospitals, program participants prior to joining the program overall had lower frequency of use and lower mean nights in hospital per year than the matched controls. This contrasts with the Vital 2.2 cohort where the frequency of hospital utilization compares to the controls, but the average nights in hospital are lower. The lower hospitalization use of the overall sample could reflect that the Pure North participants are healthier than their matched controls, and/or that the earlier CNRL participants had poorer access to services. With respect to emergency department visits, in the year prior to joining, program participants had higher average use than the matched controls in both samples.

TABLE 1 MEAN VALUES OF DEMOGRAPHIC AND HEALTH CARE UTILIZATION MEASURES FOR PROGRAM PARTICIPANTS AND MATCHED CONTROLS IN YEAR PRIOR TO JOINING PURE NORTH

	Overall		Vital 2.2	
	Participants	Controls	Participants	Controls
Average age	51.44		53.57	
Proportion female	56.65%		60.09%	
Proportion user (DAD)	6.24%	6.40%	6.80%	6.73%
Average use (DAD)	0.085	0.089	0.093	0.095
Average nights (DAD)	0.429	0.538	0.485	0.602
Proportion user (ED)	27.19% [†]	22.24%	27.47% [†]	23.08%
Average use (ED)	0.586 [*]	0.479	0.618 [*]	0.499
Proportion user (GP)	79.53% [†]	74.43%	-	-
Average use (GP)	3.91	3.88	-	-
Proportion of participants persisting (DAD & ED)	0.55		0.54	
Proportion of participants persisting (GP)	0.59		-	
N (DAD & ED)	5689		4277	
N (GP)	1275			

NOTES: * indicates difference between participants and controls is statistically significant (Mann-Whitney U test, $p < 0.05$). [†] indicates difference between participants and controls is statistically significant (Z test of proportions, $p < 0.05$). The GP sample size is lower due to there being no data available for the 2013/14 fiscal year at the time we requested the data (and thus no Vital 2.2 information for GPs). DAD (discharge abstract database) is hospital visits or nights, ED is emergency department visits, and GP is general practitioner visits.

Some assumptions have to hold for difference-in-differences estimates to be considered valid. One condition necessary for difference-in-differences is that the participants and controls satisfy the common support assumption. The principle is that, based on observables in the treatment group, suitable matches can be drawn. Suitability can be questioned if controls are drawn from a separate population than the one generating the participants. The Vital 2.2 cohort of participants is not associated with workplace settings and composes approximately 75 per cent of our entire sample, so drawing controls from the Alberta population is more likely to satisfy the common support assumption than the 25 per cent of our overall sample who were associated with CNRL. Second, we need to assume there are no pre-treatment effects in the participant group. There is a possibility (as with any non-random intervention) that the

individuals who choose to participate are motivated to do so by a negative health shock or worry. There is also a possibility that participants are more health conscious than the general population. Finally, to support a causal interpretation of a difference-in-differences estimate, the treatment and control groups must have parallel or common trends across time before the intervention.

Tables 2a and 2b provide information on the trends in health care use for the overall sample and matched controls for the five years prior to joining. Table 2a presents mean values of numbers of visits to hospital, emergency departments and general practitioners for the overall and Vital 2.2 samples. Table 2b presents the proportions of samples using hospitals, emergency departments and general practitioners at least once in a given year. Overall, the statistics in tables 2a and 2b suggest that for both the overall and Vital 2.2 samples, we have a good degree of matching between the participants and controls with matching based only on age and sex, and that the necessary conditions for difference-in-differences estimation are satisfied for all of the utilization measures. Using OLS regression (not shown) we verified that the slope of the cross-time utilization increases in the participant and control groups in Table 2a is statistically equivalent for all utilization variables, indicating that the common trend assumption appears to valid.

TABLE 2A MEAN VISITS TO HOSPITAL, EMERGENCY DEPARTMENT AND GENERAL PRACTITIONERS IN THE FIVE YEARS PRIOR TO JOINING PURE NORTH

OVERALL SAMPLE Years prior to joining	Hospital Visits (Number per year per person)		Emergency Department Visits (Number per year per person)		General Practitioner Visits (Number per year per person)	
	Participants	Controls	Participants	Controls	Participants	Controls
5	0.066	0.063	0.334	0.385	3.376	3.26
4	0.06	0.067	0.342	0.381	3.544	3.462
3	0.067	0.081	0.384	0.463	3.515	3.695
2	0.088	0.086	0.489*	0.48	3.893*	3.757
1	0.085	0.089	0.586*	0.479	3.911	3.876
Year after joining	0.082*	0.107	0.566**	0.522	3.983	4.227
N		5,689		5,689		1,275

VITAL 2.2 SAMPLE Years prior to joining	Hospital Visits (Number per year per person)		Emergency Department Visits (Number per year per person)	
	Participants	Controls	Participants	Controls
5	0.070	0.065	0.336	0.407
4	0.063	0.069	0.334	0.398
3	0.070	0.088	0.394	0.486
2	0.099	0.092	0.494*	0.499
1	0.093 [†]	0.095	0.618*	0.499
Year after joining	0.092*	0.117	0.558**	0.547
N		4,277		4,277

NOTES: * indicates difference between participants and controls is statistically significant (Mann-Whitney U test, $p < 0.05$).
[†] indicates that the difference between a year and the one preceding it is statistically significant compared to the previous difference within participants or controls (ANOVA with Scheffé post-test correction, $p < 0.05$).

TABLE 2B PER CENT OF SAMPLE THAT USES HOSPITAL, EMERGENCY DEPARTMENT AND GENERAL PRACTITIONERS IN THE FIVE YEARS PRIOR TO JOINING PURE NORTH

OVERALL SAMPLE Years prior to joining	Hospital Visits (% using per year)		Emergency Department Visits (% using per year)		General Practitioner Visits (% using per year)	
	Participants	Controls	Participants	Controls	Participants	Controls
5	5.3	4.9	18.1	18.9	69.3	66.9
4	4.9	5.6	18.5	18.5	73.3	71.1
3	5.6	6.3	21.3	20.7	75.0	71.8
2	6.7	6.6	24.8	21.3	80.4	73.3
1	6.2	6.4	27.2	22.2	79.5	74.4
Year after joining	6.0	7.4	26.5	23.3	82.8	76.6
N		5,689		5,689		1,275

VITAL 2.2 SAMPLE Years prior to joining	Hospital Visits (% using per year)		Emergency Department Visits (% using per year)	
	Participants	Controls	Participants	Controls
5	5.6	5.1	18.1	19.2
4	5.1	5.8	17.9	19.0
3	5.9	6.7	21.8	21.4
2	7.5	6.9	24.5	22.0
1	6.8	6.7	27.5	23.1
Year after joining	6.4	7.9	27.0	23.8
N		4,277		4,277

NOTES: * indicates difference between participants and controls is statistically significant (Mann-Whitney U test, $p < 0.05$). † indicates that the difference between a year and the one preceding it is statistically significant compared to the previous difference within participants or controls (ANOVA with Scheffé post-test correction, $p < 0.05$).

Table 3 presents the ITT difference-in-differences estimates derived from the OLS regression models. These estimates show the changes in utilization over what was observed in the matched controls for all participants. For example, a positive number indicates that the difference over time in the controls is larger than the difference over time for the participants.

Table 3 shows that Pure North participants have a statistically significant reduction in the number of visits to hospital of 0.0216 per person per year (2.16 per 100 participants per year) ($p = 0.024$). Relative to the year prior to joining Pure North, this is a 25 per cent reduction in the number of hospital visits per person per year. These results are driven by the changes observed for the Vital 2.2 sample. There is no significant change in per person average nights in hospital. Vital 2.2 participants show a statistically significant reduction in emergency department visits (10.7 per 100 participants per year) of around 17 per cent of the mean number of visits in the year prior to joining ($p = 0.004$). The ITT results show no significant reductions in general practitioner visits but we do not have post-joining observations of general practitioner visits for the Vital 2.2 cohort due to the general practitioner database having data only up to the 2012/2013 fiscal year.

TABLE 3 ITT ESTIMATES OF MEAN REDUCTIONS IN HEALTH CARE UTILIZATION OF PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS

Sample (n)	Hospital		Emergency Department	GP
	Number admissions per year	Nights in Hospital per year	Number of visits per year	Number of visits per year
Overall (11,378)	0.0216*	0.0276	0.0638	0.28
	(0.024)	(0.799)	(0.125)	(0.078)
Vital 2.2 (8,554)	0.0234*	-0.0115	0.107*	-
	(0.033)	(0.933)	(0.004)	

NOTES: *p*-values in parentheses. * indicates the estimate is statistically significantly different from zero ($p < 0.05$). Based on bootstrapped standard errors (1,000 replications). GP visits not available for post-joining year for Vital 2.2 sample. GP is general practitioner visits.

We also estimated probit maximum-likelihood models with dependent variables equal to one if an individual used a health care service (hospital, emergency department and general practitioner) in a given year, and zero otherwise. The statistically significant reductions in the probability of visiting a hospital suggests that the reduction in hospital visits is from fewer people going to hospital at all and/or from people who go to hospital at least once going less frequently. There was no statistically significant ITT effect for the probit models for emergency departments or general practitioners. While the statistically insignificant effect of the program for GP visits in the probit model agrees with the statistically insignificant effect for numbers of GP visits, the statistically insignificant effect from the probit model for emergency department visits suggests that the effect for the Vital 2.2 cohort in Table 3 is solely driven by people who go to the emergency department at least once going less frequently.

TABLE 3B ITT ESTIMATES OF PROBIT MARGINAL EFFECTS FOR HEALTH CARE UTILIZATION OF PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS

Sample (n)	Hospital	Emergency Department	GP
	Number admissions per year	Number of visits per year	Number of visits per year
Overall (11,378)	0.0111*	0.0163	-0.0166
	(0.042)	(0.077)	(0.385)
Vital 2.2 (8,554)	0.0145*	0.0114	-
	(0.029)	(0.276)	-

NOTES: *p*-values in parentheses. * indicates the estimate is statistically significantly different from zero ($p < 0.05$). Based on bootstrapped standard errors (1,000 replications). GP visits not available for post-joining year for Vital 2.2 sample. GP is general practitioner visits.

In Table 4, where we consider participants as persisting or not, we see a larger reduction in hospital visits after joining for persisting participants than for participants as a whole in the ITT models in Table 3. Now the reductions in hospital visits per person per year are 0.035 (3.5 per 100 participants) and 0.042 (4.2 per 100 participants) for the overall sample and the Vital 2.2 sample, respectively, approximately a 45 per cent reduction in the mean number of hospital visits observed in the year prior to joining. As before, there are no significant changes in average nights in hospital for those who persist but this likely reflects the variation in nights in hospital conditional on visiting the hospital.²⁸ There are significant reductions in emergency department visits for Vital 2.2 participants of 0.17 visits per person per year (17 per 100 participants), which is a reduction of around 28 per cent of mean visits per person per year in the

²⁸ For example, we know that there are fewer visits to hospital in the year after joining, but for some people who go to hospital, long stays in hospital confound the change in mean nights.

year prior to joining. For non-persisting participants in the overall sample and Vital 2.2, outcomes are statistically the same as what is observed for age- and sex-matched controls, suggesting that they were not adhering to the program.

The results for GP visits are unexpected in the sense that non-persisting participants show a significant reduction in the number of GP visits where persisting members do not. These GP estimates contrast with those for hospitals where the non-persisting joiners had utilization changes that were no different from the controls. We are not sure why this is the case but we note that the GP estimates are only for the CNRL-based participants due to the lack of GP-utilization data for fiscal year 2013/14. Potential reasons for this result could be a poorer match between age- and sex-matched controls and CNRL participants, selection bias in the composition of the persisting and non-persisting groups, or a common shock that influences both groups (e.g., spurious correlation). When we estimated probit models on the outcome that an individual visited a GP at least once in a given year, we find no significant changes in GP utilization in either persisting or non-persisting participants relative to the controls.

TABLE 4 ESTIMATES OF MEAN REDUCTIONS IN HEALTH CARE UTILIZATION OF PERSISTING AND NON-PERSISTING PROGRAM PARTICIPANTS VERSUS THAT OF AGE- AND SEX-MATCHED CONTROLS

Sample (n)		Hospital		Emergency Department	GP
		Number admissions per year	Nights in Hospital per year	Number of visits per year	Number of visits per year
Overall	Persist	0.0348*	0.144	0.0835	0.21
(11,378)		(0.001)	(0.22)	(0.156)	(0.249)
	Non-Persist	0.00554	-0.115	0.0398	0.383*
		(0.646)	(0.397)	(0.27)	(0.049)
Vital 2.2	Persist	0.0419*	0.143	0.171*	-
(8,554)		(0.001)	(0.322)	(<0.001)	
	Non-Persist	0.00198	-0.19	0.0331	-
		(0.892)	(0.265)	(0.465)	

NOTES: p-values in parentheses. * indicates the estimate is statistically significantly different from zero ($p < 0.05$). Based on bootstrapped standard errors (1,000 replications). GP visits not available for post-joining year for Vital 2.2 sample. GP is general practitioner visits.

To better understand why program participants, and those who persist in particular, were not going to hospital as frequently as the age- and sex-matched controls, we looked at the ICD-10 codes for each hospital visit observed in the participants and controls in the year prior to joining Pure North and the year after joining.

For the overall sample of participants, there were 109 fewer visits to hospital compared to what was seen in matched controls in the first year after joining the PN program. If we exclude visits to hospital due to pregnancy-related issues, then the difference is 69 hospital visits. For the Vital 2.2 cohort, compared to controls there were 92 fewer visits after joining (85 if pregnancy excluded). Participants who persisted in the program had absolute decreases in numbers of hospital visits while those who did not persist experienced increases in visits comparable in magnitude to the controls.

Attributing reductions in specific diseases to any one aspect of the program is challenging, but participation in general is associated with decreases in hospital utilization. We inspected the ICD-10 codes associated with hospital visits; there are some classes of diseases that are lower post-joining in the participants, which could be attributable to a healthier lifestyle. For example, in our overall sample, hospital visits attributable to fractures decrease in the sample of participants who persist at least

one year in the program. The observed reduction in the frequency of leg and arm fractures could be associated with fewer falls due to greater bone and muscle strength. Potentially related, hospitalization due to pneumonia is less prevalent in the program participants after joining. Based on the frequency of hospitalization, chronic obstructive pulmonary disease (COPD), arthritis, and arthrosis all seem better controlled in the participants after joining the program than in the controls. In the Vital 2.2 sample, we note similar trends for fractures and lung diseases (pneumonia and COPD), as well as a small decrease in visits related to mental health and drug abuse issues. This trend of accident avoidance and mental health improvement was identified in a much larger study on guaranteed annual income.²⁹ In a similar vein, the impact on fractures, mental health and drug abuse issues we observe could be driven by program characteristics, what the Public Health Agency of Canada defines as “health promotion.” While program participation intensity can vary, the counselling and supplementation that participants receive can change their ability, or perception of their ability, to control their own health outcomes.

We also inspected ICD-10 codes associated with emergency department visits. Emergency departments are used more frequently than hospitals, so consequently we observe larger numerical decreases in utilization, but the pattern is the same as for hospital visits. The participants exhibit a greater decrease in emergency department use for drug and mental health issues, injuries, and lung diseases (COPD and pneumonia). Emergency department visits for bone-related issues, such as arthritis and arthrosis, were similar between participants and controls. Additionally, there was a decrease in utilization attributable to general unclassified symptoms (e.g., headaches, fainting, fatigue, and shortness of breath) in the participants compared to virtually no change in the controls.

MAGNITUDES AND VALUES OF THE HEALTH CHANGES

Relative to the frequency of hospital and emergency department visits of the program participants and matched controls in the year prior to joining the program, the program reduces hospital visits by 25 per cent (ITT) to 45 per cent (persisting participants) and emergency department visits by 17 per cent (ITT) to 28 per cent (persisting participants). As Table 5 shows, these reductions in contacts result in annual health care costs avoided of 22 per cent (ITT) to 39 per cent (persisting).

Table 5 presents the number of contacts per year for the Vital 2.2 sample. We focus on Vital 2.2 since that cohort is the majority of the overall sample and the outcomes are attributable to the program in its current form. For hospital visits, we represent the expected nights of hospitalization avoided per visit avoided as the mean nights for people visiting the hospital in the year prior to joining.³⁰ For the Vital 2.2 control sample that was nine nights per hospitalization. For costs of utilization we use \$1,414 per night in hospital based on the billing rate for a night in hospital in Calgary; \$840 per emergency department

²⁹ Forget reported on the Manitoba MINCOME experiment of the 1970s where participants received a guaranteed minimum income each year regardless of wages and hours worked. The mechanism for improved health was hypothesized to be lower family-level stress due to the existence of guaranteed income, regardless of whether or not the guaranteed income was claimed: Evelyn Forget, “The Town with No Poverty: The Health Effects of a Canadian Guaranteed Annual Income Field Experiment,” *Canadian Public Policy* 37, 3 (2011): 283-305.

³⁰ We assume that the expected impact of the decrease in hospital visits on hospital nights can be represented by the average number of nights amongst those who spent at least one night in hospital in the year prior to joining. The statistically insignificant change in the mean number of nights despite a statistically significant reduction in the number of visits to hospital could reflect that most of the visits avoided were for shorter stays in hospital. We find, however, that the lack of significant change in average nights in hospital for participants overall after joining reflects that the right skew of the distribution of hospital lengths of stay increased. Approximately 30 individuals from susceptible sub-populations (homeless, remote community, or seniors) experienced long stays in hospital after joining the program. Other than these 30 participants, the avoided hospital visits are coming from throughout the distribution of hospital lengths of stay, not just the highest or lowest users.

visit and \$50 per general practitioner visit. Based on the mean frequencies of use in the year prior to joining the program, average health care costs for the public payer in Alberta would have been \$1,749 per participant.³¹ The health care utilization of the Vital 2.2 participants is around half of the per capita cost of hospital and doctors for Alberta in 2013 (\$3,365) reported by the Canadian Institute for Health Information.³² The lower costs implied for the participant's health care utilization could reflect that the reductions in utilization are being generated from the relatively healthy persons; that the per capita Alberta figure includes visits to specialist physicians and day surgeries; and that our assumed costs of nights in hospital or visits to the emergency department are low compared to actual costs. It also appears to be the case that our sample does not represent the small portion of the population with multiple chronic conditions who account for a large share of total health care costs in the province.

For the Vital 2.2 cohort, the ITT reductions in hospital and emergency department utilization represent \$388 in health care costs avoided due to the program representing 22 per cent of health care costs in the year prior to joining. For program participants who persisted at least one year in the program, costs avoided are \$677, representing 39 per cent of health care costs of hospital, emergency department and GP use.³³

³¹ This cost of a night in hospital is the 2014 purchasing-power value of the average billing rate of \$1,350 per night for Rockyview General and Peter Lougheed Centre hospitals in Calgary for April 2012. If Foothills Hospital, which serves higher-risk patients through its cardiac, trauma and neonatal ICU programs were included, the per night cost would be higher. This cost per night was provided by Alberta Health Services (Activity and Costing) in response to our query. The values are from the "Inter-provincial Standard Ward Per Diem Rates" in Alberta Health, Ministerial Order 28/2012. The cost of an emergency department visit was provided to us in response to our query of the Alberta Ministry of Health's Surveillance and Assessment Branch. The cost of ambulatory care as measured in the average cost of \$630–\$770 per ambulatory event is based on event-level records from 2009, accounting for physician (where available), clinic, imaging, drug, emergency room, lab, nursing, rehab and ventilator costs, as well as a patient-specific estimation for overhead costs (hospital administrators, etc). We use the upper end of that range, \$770, which is \$840 in 2014 purchasing power. For general practitioner visits we use \$50 per visit in 2014 purchasing power. This assumes that the average visit is more involved than a basic visit to see a GP for which \$35 is billed to the government (for 15 minutes). It is \$50 if the patient stays for another 15 minutes. The baseline billing code in the Schedule of Medical Benefits is 03.03A (SKLL GP) in the following pdf: <http://www.policyschool.ucalgary.ca/sites/default/files/SOMB-Medical-Prices-2014-10.pdf>; the billing code for each additional 10 minute interval (up to a maximum) is 03.03A CMPX CMGP in the same section. The Oct. 1, 2014 Schedule of Medical Benefits is copyrighted by the Government of Alberta. We convert all values to 2014 purchasing power using CANSIM series v41692327 Alberta; All-items CPI (2002=100).

³² From Canadian Institute for Health Information, *National Health Expenditure Trends, 1975 to 2013*, "Health Expenditure in the Provinces and Territories," Table 6, Chapter 4, https://secure.cihi.ca/free_products/4.0_TotalHealthExpenditureProvTerrEN.pdf.

³³ If we consider the ITT change in GP utilization for the overall sample that is 0.28 fewer visits per year for program participants relative to the matched controls, which is statistically significant at size 10 per cent, then there would be another \$14 in costs avoided. The overall sample produces smaller difference-in-differences estimates in utilization than the Vital 2.2 sample, so it is possible that 0.28 fewer GP visits would be reasonable to use as the utilization change for the more recent cohort.

TABLE 5 BASELINE HEALTH CARE UTILIZATION AND COST AND COSTS AVOIDED FOR VITAL 2.2 PN PARTICIPANTS

	Pooled average visits per year	Average nights per visit	Cost per visit (1 night)	Total annual expenditure	Costs avoided –ITT estimate	Costs avoided – persisting estimate
Hospital	0.087	9	\$1,414	\$1,107.16	\$297.79	\$533.22
ED	0.532		\$840	\$446.88	\$89.88	\$143.64
GPs	3.9		\$50	\$195.00	-	-
Total				\$1,749.04	\$387.67	\$676.86
Proportion of total cost					0.22	0.39

NOTES: Pooled average visits are the average visits for participants and controls pooled the year prior to joining.

We can project the immediate health care system level impacts of preventative services, recognizing that the selected nature of the Pure North participant sample does not guarantee that the program effects we report will generalize for the adult population in Alberta. In 2014, the Alberta population aged 25 and over is 2,828,884. Applying the ITT estimates for the Vital 2.2 sample in Table 3 to the total Alberta population aged 25 and over, if we use nine nights per hospital stay, which is the mean for our control sample, then there would be 595,763 fewer nights in hospital for the population in the province in 2013/14.³⁴ These nights in hospital avoided represent 23 per cent of the 2,640,201 total hospital days in Alberta in 2012/13. On an annualized basis (total nights avoided divided by 365 days), the hospital nights avoided represent the equivalent of 1,632 more beds available per year in the province, which is around 20 per cent of Alberta’s 2013 capacity of 8,230 acute care beds. In terms of bed capacity, the beds freed up through improved health in the population are equivalent to adding the acute care bed capacity of two of Calgary’s Foothills Medical Centres. Put another way, this freed-up bed capacity is roughly 2.5 times the number of acute care beds occupied each day in Alberta by patients waiting placement in a facility with an alternative level of care (e.g., nursing home).³⁵ As the issue of the “bed blockers” has been prominently discussed in Alberta for backing-up emergency departments and delaying surgeries and generating lengthy wait times for the emergency department and surgeries, the Pure North ITT program effect could be projected to provide considerable benefit for freeing-up beds and reducing emergency department wait times. The ITT-program effect in Vital 2.2 for emergency department use shows the potential for preventative care to directly reduce pressure on the province’s over-burdened emergency departments. Applying the ITT estimate for emergency department visits to the Alberta population aged 25 and over, we project that 302,691 emergency department visits could have been avoided in fiscal year 2013/14. This would represent a 14 per cent reduction in the 2,116,474 emergency department visits in Alberta in fiscal year 2012/13.

The gains to the public payer in terms of health care costs avoided need to be considered in terms of the costs of the intervention that generate the benefits. Pure North identified three categories of service that it sees as the core of the program, which are services provided to all participants. The costs shown in Table 6 provided to us by Pure North are what it defines as representative of the costs associated with the delivery of the program for the fiscal years 2012/13 to 2014/15.

³⁴ According to Alberta Health Services, the average stay in hospital for the entire Alberta population, including children, in 2012/13 was 6.8 nights. Using this value results in 450,132 fewer nights spent in hospital in Alberta in fiscal year 2013/14.

³⁵ Matt McClure, “Surgery waits lengthen despite hike in hospital spending,” *Calgary Herald*, November 25, 2014, A7, reports that a median of 632 hospital beds were clogged each day with patients waiting an average of 32 weeks — nearly a month longer than a year earlier — for a less expensive bed in the community.

TABLE 6 SUMMARY OF COSTS PER PERSON PER YEAR ASSOCIATED WITH DELIVERY OF THE PROGRAM 2012/13 TO 2014/15

Fiscal Year	Health Consultation	Laboratory Services	Dietary Supplements	Total
2012/13	\$240	\$460	\$1,600	\$2,300
2013/14	\$200	\$435	\$900	\$1,535
2014/15	\$130	\$360	\$440	\$930
Projected feasible cost	\$70	\$100	\$330	\$500

The trend reduction in costs of the program in Table 6 is driven by changes in the content and delivery of the program reflecting the experience gained by Pure North through eight years of operating the program, combined with the results of internal program evaluation and external research on the program. The quantity, mixture and costs of dietary supplements have decreased as the program focuses on consistency in compliance and effectiveness of the program. Health consultation costs have decreased as the program moved to delivery with fewer consultations per year, and through shorter-duration consultations within the scope of practice of registered nurses, nurse practitioners and naturopathic doctors rather than physicians. Laboratory-service costs to date have reflected costs incurred for purposes of program evaluation and research interests of the foundation. Laboratory costs for the subset of biometric measures that the organization sees as necessary for the preventative health care program are one-quarter of the laboratory costs per participant incurred to date. Pure North has projected that its program can be delivered for \$500 per year.

The health care costs avoided for hospitals and emergency department visits for the Vital 2.2 cohort are attributable to the program in the fiscal years 2012/13 and 2013/14. Using the 2013/14 fiscal year cost from Table 6, health care costs avoided for a persisting program participant represent 44 per cent of total program costs, but as noted, these costs are not necessarily the minimum costs for delivering the program. If the benefits in terms of health care costs avoided can be achieved with the projected program cost of \$500 per participant, then each dollar of program cost yields \$1.35 in health care costs avoided.

From the perspective of a public payer, however, the ITT estimates of costs avoided could be most relevant since that effect-size considers the full range of adherence to the program in return for the cost of the program. Considering that little over half of the Vital 2.2 cohort persisted in the program, the expected cost for a joiner is not the full program cost. Pure North estimates that a non-persisting joiner would still result in an expense that is half the amount of the full program. That would make the relevant program cost for comparison to the ITT program effects \$1,181 per year, using the organization’s costs from 2013/14. In this case, the ITT costs avoided are 33 per cent of the ITT-relevant program cost per participant. If the benefits in terms of health care costs avoided can be achieved with the projected program cost of \$500 per persisting participant, or \$385 per ITT participant, then each dollar of program cost yields \$1.01 in health care costs avoided.

Perhaps the appropriate perspective for valuing the immediate benefit of the program on health costs avoided when the objective of the program is the prevention of chronic diseases to reduce health care costs in future, is that of the “net price” of preventative care — the cost of preventative services net of reduced health care costs in the immediate term. With preventative care, benefits from the care are additive and are more likely to generate positive side effects, which contrasts with treatments that are typically aimed at specific outcomes and can come with increased risks and negative side effects. If the cost of preventative services is the 2013/14 cost of \$1,535, then the net price of preventative care would be \$847 after accounting for the \$688 in health costs avoided, so the issue would be whether the health costs avoided from reduced chronic disease prevalence are sufficient to cover that amount. If the program can be delivered for \$500 per participant, then the net price of preventative care is

negative since the health cost savings more than offset the costs of service delivery. In that case, the values of future health spending avoided by reducing the number of persons who will develop diabetes, cardiovascular disease, cancers and mental health problems are “pure return” to Alberta taxpayers. These direct returns to chronic disease prevention could be large. Denton and Spencer show that “the savings from even a modest reduction in the prevalence of chronic conditions would be substantial,” on the magnitude of about 16 per cent reduction in nights in hospital and a 10 per cent reduction in consultations with family physicians.³⁶ An Alberta Health projection in 2013 showed that if the prevalence of diabetes between 2012 and 2020 could be held at 2011 levels, \$1.9 billion in health care costs could be avoided over that period of time.³⁷

Beyond the direct benefits of health costs avoided from preventative care, the indirect benefits of improved health are broader than just health care utilization. The indirect benefits of better health from improved labour productivity and income are typically found to be as large, if not larger, than the direct costs.³⁸ The income-equivalent value of the well-being, or quality-of-life improvement from better health can be enormous.³⁹

LIMITATIONS

We recognize several limitations of our analysis. First, we have only matched program participants to controls in the population on the basis of age and sex. In future work, we could include a participant’s postal code as a geographic dimension for matching, which would have allowed us to control for socioeconomic status and geographic region, both of which are important correlates of health care utilization. Second, it is possible that our study was underpowered and matching more than one control to each participant would have allowed us to observe statistically significant, yet smaller magnitude effects. Third, the degree of personalization of services provided to participants, and the changes in what the program does over time, means that the intervention that we investigate is not well defined. Fourth, we lack direct measures of program adherence and we rely on a crude proxy of adherence represented by persistence in the program. While that proxy measure has face validity, a more direct measure of persistence is preferable. Fifth, we only have one full fiscal year of health care utilization data for most of our Vital 2.2 sample, which means we cannot determine if the reductions in utilization are maintained. This issue can be addressed after March 31, 2015 when the next fiscal year of data become available.

Importantly, we are studying a program that has voluntary participation. The potential for sample selection of who chooses to join, those who provided valid PHNs, and who chooses to persist in the program, means that there may be systematic, but unobserved, differences in health that influence levels and trajectories of health care utilization between the participant and control groups that undermine

³⁶ Denton and Spencer, “Chronic Health Conditions: Changing Prevalence in an Aging Population and Some Implications for the Delivery of Health Care Services,” *Canadian Journal on Aging* 29, 1 (March 2010): 18.

³⁷ Alberta Health, Surveillance and Assessment Branch, “Health Care System Cost of People with Diabetes,” *Public Health Surveillance Bulletin* 3 (June 2013). That estimate was based on the costs of inpatient hospitalizations, ambulatory care and physician services. Diabetics cost slightly less than twice as much as comparable non-diabetics: roughly \$6,400 per person per year versus roughly \$3,300. The \$1.9 billion in health care costs avoided from 2012 to 2020 has \$317 million net present value in 2011 using a discount rate of five per cent. Ohinmaa et al. estimate the per capita health care system costs of a diabetic person to be \$3,834 (\$3,203 in 2004 purchasing power) per year. A. Ohinmaa et al., “The projection of prevalence and cost of diabetes in Canada: 2000 to 2016,” *Canadian Journal of Diabetes* 28 (2004): 119.

³⁸ See Public Health Agency of Canada, “Investing in prevention the economic perspective: Key Findings from a Survey of the Recent Evidence,” May 2009, 2.

³⁹ Y.S. Chao et al., “Vitamin D and Health-Related Quality of Life in a community sample of older Canadians,” *Quality of Life Research* (April 24, 2014) [Epub ahead of print] doi: 10.1007/s1136-014-0696-6.

a causal interpretation of any ITT. As it is possible that program participants self-selected into the program, the estimated ITT effects could be biased and difficult to generalize to the general population. Thus, strict causal interpretation is impossible despite the strength of our longitudinal data set. Further, whether an individual persists could be endogenous with change in health utilization: If someone experiences improvement they could be more likely to persist, and vice versa.

Finally, in our analysis we are unable to attribute these benefits to any one aspect of the program. The specific aspects of the program are not modular, all individuals are given the baseline program and minor adjustments are made on an individual basis by Pure North clinicians. Pure North has some data on health behaviours (e.g., physical activity, diet, smoking, etc.), but tools used to gather this information have changed over time.

CONCLUSIONS

We have found that participation in the Pure North S'Energy Foundation's preventative health care services program reduces hospital visits by 25 per cent (ITT) to 45 per cent (persisting participants) and emergency department visits by 17 per cent (ITT) to 28 per cent (persisting participants) for program joiners and persisting participants respectively. These reductions in utilization represent health care costs avoided of 22 per cent (ITT) to 39 per cent (persisting participants) per year relative to age- and sex-matched controls. The immediacy and size of the impact on acute health care utilization of a program providing preventative services to prevent chronic diseases and conditions could be considered surprising for a program focusing on chronic disease prevention in a healthy population rather than secondary prevention, or chronic disease management. One might expect that any dividends earned by preventative health programs investing in sustained good health would be realized years out from the initial investment, once chronic conditions had been avoided. Second, the potential effectiveness of dietary supplements — vitamins and minerals — for reducing health care utilization of healthy adults presents a challenge to the recent skepticism over the value of dietary supplements.⁴⁰ This program represents a unique initiative in Canada. The scale, the focus on supplementation and behavioural counselling, and the focus on individuals who would be considered “healthy” in the sense that they are not targeted for a specific disease status, means that the ITT estimates associated with this initiative are a realistic estimate of the potential impact of wide-scale preventative health care programming on the use of acute care health services by Canadians.

Given the program costs in 2013/14, the value proposition of this prevention strategy cannot be made solely on the basis of the immediate impact on health care utilization. It is likely the case that the annual program costs are recouped through the health care system when future costs avoided due to the better health of the population are considered. From a social perspective that takes into account the indirect benefits of better health as at least equal to the value of the health care costs avoided, the program costs are recouped by society. With the projected feasible costs for delivering the program of \$500 per participant per year, the reductions in public expenditure on hospitals, emergency departments and general practitioners fully cover the program costs. This means that the gains to the system from future reductions in health care spending for treating and managing chronic diseases prevented and the indirect benefits (e.g., labour productivity) of better health and improved well-being of the population are pure return for the public payer.

⁴⁰ Eliseo Guallar et al., “Enough Is Enough: Stop Wasting Money on Vitamin and Mineral Supplements,” *Annals of Internal Medicine* 159, 12 (2013): 850-851, doi:10.7326/0003-4819-159-12-201312170.

Why should decision-makers take notice of these reductions in health care utilization through investment in preventative health care services for members of the population? First, chronic disease is now the leading cause of death and disability in Canada, resulting in great and rising expense through Canada's publicly funded medical treatment system — Medicare. The reductions in health care utilization demonstrate that prevention is an effective approach for “bending the health care cost curve” that can begin in the immediate term, not just years out. The results lend support to policy commentators who call for greater emphasis in the health care system on chronic disease prevention and health improvement to address the sustainability of Canada's publicly funded health care systems. Don Drummond suggests that “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.”⁴¹ Lewis and Sullivan argue “that bending the needs curve is the best way to bend the cost curve. Every structure and incentive should be aimed at preventing or postponing avoidable health breakdown.”⁴² In 2013, Canadian Medical Association President, Dr. Louis Hugo Francescutti argued that “Policymakers should start looking at the health system beyond disease treatment and think about prevention. Prevention can pay a fiscal dividend.”⁴³ Stephen Duckett recommends that provincial governments address the upstream causes of acute care health spending through an expansion of the scope of public payment for health care to include cost-effective services for health promotion and disease prevention.⁴⁴

Our estimates of the immediate impact of preventative health care on hospital and emergency-department utilization shows how large the returns to lowering health care needs and demands can be for a straining publicly funded medical treatment system. Preventative care delivered to the Alberta population has the potential to free-up acute care bed capacity that is equivalent to the addition of the bed capacity of two of Alberta's larger hospitals. In other words, investing in health promotion eliminates the need to build more acute care bed capacity with the positive side effects that come with the improved health and well-being of Albertans.

⁴¹ Drummond, “Benefactor's Lecture.”

⁴² Lewis and Sullivan see the actual role of the health care system as being one of secondary prevention, preventing conditions from getting worse through better management of chronic disease. This is because they believe that primary prevention, avoidance of conditions in the first place, are the product of social and economic conditions that are beyond the purview of health care to change.

⁴³ “So can improved social and economic conditions”: Dr. Louis Hugo Francescutti, President, Canadian Medical Association. Louis Hugo Francescutti, “Here is another reason to improve CPP — your health,” Press Release, Canadian Newswire, December 20, 2013, <http://www.newswire.ca/en/story/1283341/here-is-another-reason-to-improve-cpp-your-health-by-dr-louis-hugo-francescutti-president-canadian-medical-association>.

⁴⁴ Duckett, *Where to*.

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