

A micro-costing analysis of a comprehensive dental care program

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ABSTRACT

Background: Understanding the costs associated with implementing a comprehensive dental care program is paramount for informing evidence-based policies. This study estimates the direct and indirect costs of delivering a comprehensive dental care program for individuals who experience financial barriers to care. **Methods:** This costing analysis uses data from a single-group repeated-measures study conducted in Toronto, Canada to assess the impact of receiving cost-free comprehensive dental care. Eligible participants received comprehensive dental services and were followed until oral health stability was achieved. A micro-costing approach was used to estimate program costs. Direct costs included dental treatments rendered and medications prescribed. Indirect costs included travel expenses, productivity losses, and caregiving expenses. **Results:** The program was launched in November 2021. Data from 134 adult participants who completed one year of follow-up were analyzed. The mean age was 48 years (SD: 17); 65% (n=87) were under 55 years, and 58% (n=77) identified as female. Over one year of treatment, the mean direct costs per participant were CAD 2,699 (SD: 1,610). The mean indirect costs were CAD 715 (SD: 618). Travel expenses, productivity losses, caregiving costs, and other costs contributed mean amounts of \$141 (SD: 182), \$466 (SD: 397), \$70 (SD: 189), and \$38 (SD: 63), respectively. **Discussion and Conclusion:** This is the first study to use participant-level data and micro-costing methods to estimate the costs of implementing a comprehensive dental care program, including indirect costs. These findings will inform future dental care policy and program planning.

Keywords: cost and cost analysis; follow-up studies; health care economics and organizations

CDHA Research Agenda category: access to dental hygiene care and unmet needs

PRACTICAL IMPLICATIONS OF THIS RESEARCH

1. Reporting the costs of dental programs for people with unmet needs is important to understand the design and delivery of these programs
2. This costing analysis will help inform policies around publicly funded dental care programs

INTRODUCTION

Access to oral health care is a longstanding public health issue in Canada, with unmet dental needs leading to significant consequences such as pain, reduced quality of life, limited social interactions, and impaired academic performance.¹⁻⁷ This lack of access extends to family members, needing to take time off work or dealing with stress related to their dependent's oral health issues.^{8,9} Research also links periodontal diseases to systemic conditions like diabetes and cardiovascular issues.¹⁰⁻¹² Untreated dental problems burden the healthcare system, resulting in costly emergency department visits and productivity losses.¹³⁻¹⁵ It is estimated that Canadians adults and children lose around 40 million hours annually due to dental problems and treatments with a subsequent productivity loss of over 1 billion dollars.¹⁶

In Canada, dental care is predominately privately financed and delivered. According to the latest estimates, approximately 95% of services are funded through private insurance plans or out-of-pocket payments, and provided via a fee-for-service model in privately owned dental clinics.¹⁷ This system is often criticized for contributing to the lack of access to essential dental care for low-income Canadians and those without dental insurance.¹⁸ Around 35% of Canadians lack dental insurance, and nearly 40% of uninsured individuals avoid dental care due to costs, a rate significantly higher than those with insurance (14%).¹⁸

In 2022, the Liberal party, as part of a “confidence and supply” agreement with the New Democratic Party (NDP), announced the establishment of the Canadian Dental Care Plan (CDCP) dental care coverage for uninsured Canadians with a household income of

less than \$90,000 a year and with no co-payments for those earning under \$70,000.¹⁹ The program, expected to cover 9 million uninsured Canadians, was launched in May 2024 with a staggered approach, starting with seniors. Children and people with disabilities started getting enrolled in June 2024, and finally all family members of households earning less than 90,000 were eligible to enroll by June 2025.²⁰

A 2015 study by Rashid et al.²¹ estimated the annual cost of implementing a dental care program for uninsured, low-income Ontarians, based on existing provincial and regional programs. The programs offered basic and comprehensive services for children in low-income households, low-income seniors, and unemployed adults. Costs ranged from \$174 to \$262 million, based on survey data and government-set low-income thresholds representing 1.91 million people. Lange and colleagues estimated the costs of two national dental care programs, Denticare and Denticaid, which cover diagnostic, restorative, periodontic, and endodontic services, as well as sedation.²² For Denticare, the first-year cost was projected at \$27.5 billion (\$737 per capita), with a range from \$15.5 to \$38.4 billion depending on service levels. Denticaid was estimated at \$15.09 billion (\$405 per capita), ranging from \$8.39 to \$21.32 billion. Over the following five years (2019–2024), costs were expected to increase due to rising service costs and population growth.

More recently, a 2021 report published by the Office of the Parliamentary Budget Officer estimated the costs of implementing a comprehensive national dental care program for Canadians, but only for individuals living in households with a total annual income of less than \$90,000.²³ Co-payments were required for those with a household income between \$70,000 and \$90,000 and would increase up to 100% contribution from

\$90,000 and upward. The proposed program offers routine services (dental exam, scaling, and polishing), and disease treatment services according to age, based on the diseases identified through the 2007 Canadian Health Measures Survey (CHMS). The report found that the program would cover around 6.5 million Canadians and cost approximately \$1.5 billion annually, with an additional upfront cost of \$3 billion to cover the anticipated initial unmet dental needs of eligible beneficiaries. However, according to the latest estimates published by the Government of Canada, of the Canadians approved for coverage, 2.8 million have been to a dental clinic, and to date, those visits have already cost \$3.37 billion.²⁴

Despite their merits, previous costing studies have limitations. First, they used top-down methods, lacking the precision of participant-level (micro-costing) analysis. Additionally, even studies using bottom-up approaches, like Lange et al., relied on outdated data, not reflecting current Canadian dental needs.²⁵ Second, these studies focused only on healthcare system costs, overlooking indirect societal costs.²⁶ Capturing the costs from healthcare and societal perspectives will help make informed economic decisions about the governmental financial expectations for implementing the proposed program, as well as the costs incurred by participants while utilizing care. This analysis aims to address these gaps by estimating the total costs of a comprehensive, no co-payment dental program for individuals facing financial barriers, considering both healthcare and societal perspectives.

METHODS

Overview of the study and the basket of services

The "One Smile Program," a single-group clinical trial, began in November 2021 after receiving ethics approval from the University of Toronto Research Ethics Board (REB), protocol #399888. The program aimed to assess the impact of receiving cost-free dental care at the individual, family, healthcare system, and societal levels. Participants were eligible if they had not sought dental care (aside from emergency or urgent needs) in the past two years due to cost. Enrolled participants completed a baseline survey (T0) and received the appropriate treatment over a series of appointments (depending on their needs). Once the participants' treatment needs were addressed, they were assumed to reach the state of 'oral health stability' (i.e., no pain or infection, and no immediate needs). The criteria are based on the adapted Canadian Forces Dental Care Program criteria for dental fitness classification 1 and 2 outline in Appendix 1. Participants were then scheduled for follow-ups at 15 days (T1), at six months (T2), and then at a one-, two-, and three-year intervals (T3-T5). Figure 1 depicts an overview of the process. Importantly, participants could seek care for any emergency or other dental need between the follow-up appointments as in any conventional dental clinic.

The program offered a comprehensive range of services similar to treatments outlined in public dental care service schedules in Ontario, including Healthy Smiles Ontario ²⁷ and the Ontario Seniors Dental Care programs that provide a range of assessment, preventive, restorative, and prosthodontic services for children (17 years and

under) living in low-income households and low-income seniors (65 years or older), respectively.²⁸ However, the program does not have a yearly cap on spending or frequency limits for services. The basket of services offered by this program includes examinations, radiographs, periodontal debridement, fluoride, restorative treatments, endodontics for tooth infections, periodontal care for gum diseases, oral surgery, and denture services for tooth replacement. This program provides essential dental services that promote oral health, prevent oral diseases, as well as provide appropriate rehabilitation services, such as crowns and dentures, that aim to maintain health, productivity, and quality of life.²⁹ The program does not provide advanced oral health services such as specialist care, complex surgical, restorative, and rehabilitative services, orthodontic or advanced prosthetic services such as bridges and implants.

Setting and target population

The program is offered through a dental clinic established at the Faculty of Dentistry, University of Toronto. The program is funded by a philanthropic gift from Green Shield Canada (GSC) as part of their “Green Door Project” aimed at improving access to effective, evidence-based health care.³⁰ All services are provided in a conventional clinical setting that resembles non-research general dental practice. The participants considered for this costing analysis were adults (aged 17 years and older) who self-reported cost-barriers to dental care in the last two years (aside from emergency and urgent care such as addressing pain and infection).

Participant recruitment

Participants were recruited through various routes including referrals by the Faculty of Dentistry, University of Toronto dental clinics, city of Toronto dental clinics, and word-of-mouth. Screening for eligibility against the inclusion and exclusion criteria was done over the phone. If an individual was eligible, they were scheduled for their first appointment as described in the enrolment process in Figure 1.

Perspective

We conducted this costing analysis from two perspectives. For the base case, we used the publicly funded health care payer perspective (i.e., the provincial government would fully cover the direct costs), with an assumption that the program would be delivered through private clinics, as most routinely happens in Canada. Additionally, for a scenario analysis we used the societal perspective to capture the broader costs of the program. The societal perspective adds the costs incurred by participants and society (i.e. time needed to receive care) and is proportionate with the burden of disease – these were classified as the indirect costs.

Time horizon and discounting

We conducted this analysis based on the costs associated with the first year of follow-up for the 134 participants enrolled. This is anticipated to be the biggest investment as it will address the sizable unmet needs created by the extended lack of access to dental care. Given the one-year time frame, no discount rate was applied in this analysis.

Resource use and costs

The tools and methods utilized for estimating the costs for this program encompass the common expenses associated with receiving dental care in a conventional setting (i.e., private dental clinic). Some assumptions were made regarding the scope of the items included in our analysis, to ensure a balanced compromise between accuracy and practicality. These assumptions are described below in detail.

The framework used for this costing-analysis is based on the recommendations by Drummond et al.³¹ and the Canada's Drug Agency (CDA).³² This involves 1) the identification of the relevant costing items; 2) development of tools to measure it; and 3) assignment of a monetary value based on current market estimates.

Measurement of the quantities of resource use and unit cost

The data used for this analysis were participant-level, and were collected/extracted using the following sources:

1. Self-reported questionnaires: These included but were not limited to information about the participants' income, productivity losses and travel expenses associated with attending the dental appointments.
2. Clinical records: These included the number and types of services provided by the dental team, and the medications prescribed as part of the treatment provision.

For estimating the value of the resources reported, we used market prices or closest substitutes whenever applicable. These valuations were calculated in 2023

Canadian dollars (CAD) and reflect the provincial prices of goods and services of the respective year. These values were retrieved from:

1. Official governmental websites and reports (e.g., the Ontario Drug Benefit Formulary (ODBF), Government of Canada job bank, etc.)
2. Professional association documents (i.e., the Ontario Dental Association (ODA) suggested fee guide)
3. Previous economic evaluations from the dental and medical literature

Costs of the program

According to the perspectives taken, the costs associated with receiving healthcare interventions were divided broadly into direct and indirect costs. Direct costs are the costs directly related to the delivery of the services, including all diagnostic, preventive and curative services related to the care provided. Indirect costs are non-healthcare costs related to the consumption of the services, which are spent by the consumer in cash or in-kind.

Finally, while capital costs such as expenditures on assets with utility extending beyond one year, such as buildings, equipment, and infrastructure are considered in the direct costs of many costing analyses, and given our healthcare perspective, we did not include them in this analysis as we assumed the dental care program would be provided in established private dental clinics, on a fee for service model, in the Canadian context.

Direct costs

Dental procedures

The dental services provided to the participants were extracted from their clinical records and valued based on the fees reported in the ODA's suggested fee guide. The guide is well accepted and is used by most dentists in Ontario. It is worth mentioning that the formula used to calculate the fees accounts for overhead costs, and therefore we did not include operating costs as a separate category to avoid double counting.

Prescribed medications

In addition to the dental services rendered, dentists may prescribe medications as part of the treatment plan, which generally includes anti-inflammatory drugs, antibiotics, and analgesics. Since they constitute part of the treatment plan, we included these costs in our analysis regardless of the participants' ability to pay, or their adherence to the prescription. We extracted the type and frequency of medications prescribed from the participant's chart and estimated the generic cost based on the generic version of the medication from the ODBF website. The ODBF is a comprehensive database that contains cost information on more than 5,000 types of medication covered by the Ontario Ministry of Health and Long-Term Care through the Ontario Drug Benefit program.³³ Since the prices reported by the ODBF do not include markup or dispensing fees, we added an 8% markup fee, and \$11.04 dispensing fees (the average of Ontario rates) as per the latest provincial fee policies for public drug plans published by the government of Canada.^{34,35} The calculation of the cost was done based on the methodology reported by the CDA costing guidance document, Costing of Health Care Resources in the Canadian Setting.³² If a

medication was not listed in the ODBF (e.g., Chlorohexidine), we used the lowest retail value available as an alternative.³⁶

Indirect costs

In this study, we captured travel expenses, caregiving costs, productivity losses, in addition to any other costs related to the treatment appointment reported by participants. For simplicity and to reduce the survey fatigue filling out numerous questionnaires, participants were asked to report the indirect costs for one visit/year (i.e., T0, T3-T5) and extrapolated these costs to all appointments within the respective year. This reflected their yearly indirect costs associated with receiving dental care. Appendix 2 outlines the questionnaire used to capture all the indirect costs stated below. The questionnaire was adapted from a survey used by Christell et al. to cost a diagnostic method for maxillary canines with eruption disturbances.³⁷

Traveling expenses

All travel expenses related to the appointments were collected using the self-reported questionnaire outlined in Appendix 2. Questions 3 and 4 captured information about the mode of transportation and the cost of a one-way journey. If a participant used a privately-owned vehicle, they were asked about the distance traveled as well as any costs related to parking and/or traffic tolls. If they used more than one mode of transport, they were instructed to choose the one they used to travel the longest distance. For those who walked or used a non-motorized private vehicle (e.g., bicycles), the travel cost was estimated to be zero. For those who used a motorized private vehicle (e.g., cars and

motorcycles), the number of kilometers travelled from which their journey started – using the postal code or the closest major intersection – to the clinic was calculated. The distance between their starting point and the clinic's address was calculated using Google Maps. If more than one route were presented, the shorter was assumed. The cost per kilometer was based on the Ontario provincial standard kilometer rate (59 ¢/km) used by the Northern Health Travel Grant.³⁸ The one-way travel cost was doubled to account for the cost of the return trip.

Productivity losses

Opportunity costs refer to the forgone benefits by choosing one intervention over the other.³⁹ In this context, participants attending the clinic are forgoing time at work, normal or leisure activities for the duration of the appointment and the travel time. The sum of the travel and treatment times constituted the total time spent on each appointment. All participants were asked about their commute time (one-way to the clinic) which was multiplied by two to account for their return trip. All reported times were rounded up to the nearest hour. Sign in and sign out times were recorded by the research staff, and only time related to the treatment was captured as part of the indirect cost. To monetize the productivity losses, we multiplied the time spent on each appointment by their hourly wage using the human capital method. This method assumes that the time lost from work was not replaced by another employee.⁴⁰ This is a common method of monetization used to estimate opportunity costs for short-time loss of employment.

We calculated the participants' hourly wage by using their employment status and self-reported personal income at baseline. The before-tax income was divided by the total

number of hours worked/year, assuming 39 and 19 hours for full-time and part-time employees, respectively. These figures were based on the Ontario annual actual hours worked per annum as reported by Statistics Canada.⁴¹ For students, retired, unemployed participants, and anyone who did not report their income or their employment status, we used the provincial minimum wage as their hourly wage for the year 2023.⁴² If based on this calculation, the rate/hour was found to be below the province's minimum wage, it was rounded up to match the current value. We also assumed the same wage regardless of the nature of the activity that they would have rather done if it was not for the appointment (i.e., work, or other non-market activities such as household chores or leisure activities).

Caregiving expenses

If a participant was responsible for dependents and reported having a formal (i.e., a paid caregiver) or an informal caregiver (i.e., asked a friend or relative) to look after them, the caregiving expenses were captured. The total duration of the appointment, as described earlier, was multiplied by the Toronto median hourly wage of a home child care provider, according to Statistics Canada's job bank for the year 2023.⁴³ For simplicity, we estimated both formal and informal caregiving services at the same rate. Like productivity losses, the total cost of caregiving was estimated by multiplying the cost/appointment by the number of appointments needed to complete the treatment.

Other indirect costs

Participants were also given the chance to identify any other additional costs associated with their appointment such as parking costs, meals, etc. The total other indirect costs were estimated using the same method described above.

RESULTS

From the beginning of the study (November 2021) to January 2024, 134 participants completed their treatment as planned and reached their one-year follow-up time-point (T3). The mean age of participants was 48 years (SD: 17). Sixty-five percent (n=87) were under the age of 55 years old, 58% (n=77) identified as females, and the most represented ethnic group were Caucasians (35.5% (n=50)) followed by East/Southeast Asians (22.7% (n=32)). Sixty-two percent (n=83) of participants were born outside of Canada. In terms of education and employment status, around half of participants (45.6%, n=61) had a bachelor's degree or more as their highest educational attainment and worked a full-time or a part-time paid job (45.5%, n=61). Lastly, the average personal annual before-tax income reported by participants was \$23,386 (SD: 17,194). Tables 1a and 1b provide a summary of the socio-demographic characteristics of our study participants. Clinically, the average number of untreated tooth decay was 5.2 (SD: 5.1), two thirds of our sample had active periodontal disease with some form of bone loss, and the average bleeding index was 40.9% (SD: 19.2).

Direct costs

The direct costs represented a significant proportion of the total cost of treatment. The breakdown of the treatments provided is described in Table 2. Patients received a combination of services that was based on an informed discussion between them and the dental team from the program's basket of services. All patients received diagnostic services (i.e., oral exam, radiographs), and almost everyone received preventive (97.8%)

and restorative (89.5%) treatments. Lesser common services were surgical, removable, endodontic, and removable prosthesis representing 32.1%, 14.9%, and 9.7% of cases, respectively. Table 3 outlines the breakdown of the services provided. We excluded the outlier values of those whose costs were above the 90% percentile (\$8,000 or more) from our analysis. After excluding outliers, the average direct cost of treatment/participant within the first year was approximately \$2,699 (SD: 1,610), and treatments were completed over six appointments, on average. Ten participants were prescribed medications as part of their treatment plan. The three medications prescribed were Amoxicillin, Chlorhexidine, and Ketoralac. We further stratified the costs by age groups to adults (18 – 64 years) and older adults (65 years and older). The average costs were 2,729 (SD: 1,537) and 2,690 (SD: 1,634), respectively. Tables 3 and 4 describe the breakdown of the direct costs of treatment.

Indirect costs

Table 5 shows the indirect costs associated with every appointment over the first year of treatment. The detailed breakdown is described below:

Time commitment

The average travel time was around 2 hours, and the average treatment time was around 1.5 hours. Over the first year of treatment, participants spent a total of approximately 24 hours (SD: 14) commuting and receiving dental treatment.

Travel costs

Most participants (n=61, 46%) used a private vehicle to travel to their appointments, and 35% (n=47) used public transportation (e.g., the metro). Of those who used a private vehicle, the average one-way distance travelled was about 33 km (SD: 20). When translated into monetary values, the average total cost over the year was \$141 (SD: 182). Table 6 describes the modes of transportation used by participants.

Productivity losses

Participants with extensive dental needs experienced significant productivity losses. On average, participants required six appointments to complete their treatment plan and reach oral health stability. The average losses were estimated at around \$466 (SD: 397). Productivity losses ranged from \$45 for participants with minimal treatment needs to \$2,917 for participants with substantial unmet treatment needs requiring numerous and lengthy appointments.

Caregiving and other indirect costs

Nineteen participants (14.2%) reported having a formal or informal caregiver looking after their dependents during their dental appointments. The average cost was estimated at \$70 (SD: 189) over the year. Other indirect costs reported by participants were parking fees with an annual average cost of \$38 (SD: 63). When combining all the expenses associated with providing and maintaining access to dental care over the first year, the average cost amounts to \$715 (SD: 618).

DISCUSSION

This micro-costing analysis describes the direct and indirect costs of providing a free comprehensive dental care program from both a public payer system and societal perspectives. The average first year annual cost for addressing the needs of individuals who have not accessed dental care for two or more years was \$2,699 (SD: 1,610). The average annual indirect costs incurred by participants were \$715 (SD: 618).

This study is the first to provide an in-depth costing analysis of a dental program that offers a heterogeneous and comprehensive basket of services (i.e., diagnostic, preventive, restorative, endodontic, etc.) in a setting that resembles a conventional dental practice. It is also the first study to include a robust estimation of indirect costs associated with receiving dental care; an aspect often not captured in many economic evaluations in the extant dental literature. This is important since a full understanding of dental care requires consideration of both the cost of delivering services and the cost of accessing them. Although there might be no out-of-pocket cost at the point of service, there were other significant costs (i.e., indirect costs) which represented a considerable proportion of the assessed costs and can act as a deterrent for accessing care. To optimize the use of dental care programs, both aspects of the costs incurred need to be assessed. Our estimates highlight the need for an initial sizable investment to address the backlog of demand as well as the considerable societal costs associated with receiving care. This also underscores the importance of including indirect costs in future cost analyses.

When our direct cost-per-patient estimates were extrapolated to the 7.29 million targeted CDCP beneficiaries (5.58 million adults and 1.71 million older adults), based on Statistics Canada's 2025 population data⁴⁴, the total direct cost of the first year of implementation ranged from \$0.79 billion (assuming a 60% copay and 10% utilization rate) to an upper limit of \$19.70 billion (assuming no copay and a 75% utilization rate). When considering the currently announced first-year expenditure of \$3.37 billion for 2.8 million beneficiaries, the total figures of the CDCP appear broadly consistent with our estimates, although it falls towards the lower end of the range. The initial high cost is unsurprising given the backlogged demand of our participants who faced financial barriers to essential dental services for at least two years prior to their enrollment. While the aim of this study was not to cost the CDCP, it is interesting to compare the projected costs of this program if extrapolated to all beneficiaries of the CDCP with the federal government's budget estimate (13 billion over five years). The higher cost suggested by our extrapolation is explained by the assumption of a 75% utilization rate, and the provision of all services needed without limitation. While we use Government of Canada estimates to contextualize our findings, this analysis is not intended to generalize results to the broader population, given the small and relatively homogeneous sample. Rather, the purpose is to highlight the substantial costs associated with addressing dental needs among individuals with a prolonged history of limited access to care.

When comparing our estimates to those reported by Lange et al. and the Office of the Parliamentary Budget Officer, it is crucial to consider the differences in the methodologies utilized, data sources, and the characteristics of the included population. It

is worth noting that the beneficiaries of our program represented a particularly disadvantaged group of people with a long history of lack of access to care (two years at minimum) and disproportionately burdened with dental diseases, which is reflected by their baseline unmet dental needs and self-reported annual incomes. According to the 2021 Labor Force Survey, the median annual income in Ontario was \$32,600, compared to our population's self-reported estimate of \$20,000.⁴⁵ Those differences have likely translated into higher prevalence and severity of oral diseases as well as higher productivity losses. This was particularly obvious when comparing the level of treatment needs and the level of untreated tooth decay at baseline. According to the CHMS, two-thirds (65.8%) of dentate individuals had no treatment needs, whereas 98% of our sample had at least one unmet preventive, restorative, or endodontic need. The differences in the number of untreated tooth decay further confirmed these differences. The average number of untreated decayed teeth within our sample was comparable to that of the dentate adults reported by the CHMS. Therefore, it was unsurprising that our cost estimates were substantial over the first year. Nevertheless, we anticipate these costs to decline in subsequent years as participants continue to access primary oral health care services. As our study will continue beyond one year follow-up, we will have the opportunity to assess the annual cost of the program when participants enter the maintenance phase.

The novelty of this research stems from the development of tools and methodologies that encourage the inclusion of both: 1) direct cost of the provision of a comprehensive mixed basket of services; and 2) indirect costs associated with dental programs in future studies. The foundation laid by this study will help researchers ensure

that future economic evaluations are robust and reflective of the governmental vision of public dental care programs. More broadly, it will also have significant implications for Canada's national dental care program. This study is conducted as the Federal government announces the implementation of the CDCP for households with annual income less than \$90,000/year.⁴⁶ The announced budget assumes the cost from the healthcare system perspective and has not taken into consideration the societal and individual costs associated with receiving care.

While affordability issues have been historically the most significant barrier to dental care for many Canadians, lack of access to care might persist despite the implementation of the CDCP. This is highlighted by the considerable indirect costs for participants in this study, particularly those with significant unmet dental needs. Being mindful of these barriers and considering strategies such as transportation and caregiving subsidies, as well as covering prescribed medications and accommodating operating clinical hours, can act as facilitators and increase the effectiveness of the CDCP and other similar programs.

This analysis has some limitations that must be considered when interpreting the findings. First, some estimates used in this analysis were based on participant self-reported values (i.e., traveling times, yearly income), and thus, may be subject to recall error. Second, we used the estimates of indirect costs at the first appointment and extrapolated them over all subsequent appointments. The impact of this extrapolation on our estimates is unclear. However, it is likely to be marginal in either direction. Third, our

indirect cost estimates were based on participants traveling to our dental clinic located in downtown Toronto. This is likely to be lower when large-scale programs are implemented as individuals would opt to visit a geographically proximal clinic, therefore reducing their indirect costs and productivity losses. This was partially rectified by limiting our enrollment to participants who reside in the Greater Toronto Area. It is also likely an underestimation, especially for those living in remote and rural areas and must travel far distances to visit a dental clinic. This analysis assumes the provision of all services, regardless of any workforce challenges that may complicate access to care. It also includes assumptions in estimating caregiving costs, such as counting these expenses even when care may have been provided by a participant's partner. However, these assumptions are unlikely to substantially affect the overall estimates of indirect costs. Furthermore, we based our direct cost estimates according to the ODA fee guide, and therefore, the utilization of the CDCP reimbursement rates or other fee guides will result in different projected costs. Lastly, this study did not factor in the capital costs, the salaries of the dental team, or administrative costs, which were applicable in the salaried model public delivery.

CONCLUSION

Populations with long-standing lack of access to dental care experience significant unmet dental needs. Along with the costs of treatment, this analysis underscores the need to understand other costs incurred by participants (i.e. travel expenses, absence from work etc.) which can act as a barrier to care. A fulsome understanding of the costs associated with delivering and receiving oral health care services can inform policies designed to

facilitate access among the most marginalized and contribute towards attaining oral health equity.

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CONFLICTS OF INTEREST

The authors have no competing interests to declare.

Plain language summary

The estimation of the cost of a comprehensive dental care program is the first step in conducting robust economic evaluations. This study estimates the costs of providing a cost-free, comprehensive dental care program from the healthcare payer perspective, as well as the financial burden incurred by individuals receiving care.

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Table 1a. Age and income (continuous variables) characteristics of the study participants

	Freq.	Mean (SD)	Median	Range	
				Min	Max
Age (years)	134	48 (17)	45	18	87
Personal annual before-tax income (\$)	119	23,386 (17,194)	20,000	0	85,000
Household annual before-tax income (\$)	119	37,055 (24,963)	33,000	0	150,000

Freq: Frequency, SD: standard deviation, Min: minimum, Max: maximum

Table 1b. Socio-demographic (categorical variables) characteristics of the study participants

	Freq.	%
Age categorized		
18-34 years	33	24.6
35-44 years	33	24.6
45-54 years	21	15.7
55-64 years	19	14.2
65 and older	28	20.9
Sex		
Male	57	42.6
Female	77	57.5
Race/ethnicity (Multi-select options: total percentage might add up to more than 100)		
Black	11	7.8
East/Southeast Asian	32	22.7
Latino	6	4.3
Middle Eastern	16	11.4
South Asian	20	14.2
White	50	35.5
Another race category	2	1.4
Prefer not to say	3	2.1
Don't know	1	0.7
Born in Canada		
Yes	50	37.3
No	83	61.9
Prefer not to say	1	0.8
Highest education attainment		
Less than high school diploma	10	7.5
High school diploma	29	21.6
Trade certificate or diploma	11	8.2
College	5	3.7
University certificate or diploma below bachelor's level	10	7.5
Bachelor's degree	36	26.9
University certificate or diploma above bachelor's level	25	18.7

	Freq.	%
Prefer not to say	8	6.0
Paid job (full-time, part-time, or self-employed)		
Yes	61	45.5
No	60	44.8
Prefer not to say	13	9.7
Marital status		
Married/common-law	61	45.5
Widowed	5	3.7
Separated/divorced	12	9.0
Single/never married	49	36.6
Prefer not to say	7	5.2
Number of people in the household		
1	15	11.2
2	36	26.8
3	28	20.9
4	17	12.7
5 or more	30	22.4
Prefer not to say	8	6.0
Household ownership		
Owned by you or a member of this household (even if the mortgage is still being paid)	46	34.3
Rented (even if no cash rent is paid)	70	52.2
Prefer not to say	18	13.4

Freq: Frequency

Table 2. Breakdown of services provided

	Freq.	% of cases
Diagnostic	134	100.0%
Preventive	131	97.8%
Restorative	120	89.5%
Endodontic	20	14.9%
Periodontic	8	6.0%
Removable prosthodontics	13	9.7%
Fixed prosthodontics	3	2.2%
Surgery	43	32.1%
Orthodontics	1	0.8%

Freq: Frequency

Table 3. The cost of medications prescribed as part of the treatment plan

Type of medication	Freq.	Cost/unit or retail cost (\$)	Total cost* (\$)
Amoxicillin	6	0.1	13.9
Chlorhexidine	3	20.0	31.0
Ketoralac	1	0.6	24.1

Freq: Frequency, SD: standard deviation, Min: minimum, Max: maximum

*The medication fees include dispensing and markup fees

Table 4. The direct costs of the provision of dental care

Cost of treatment (\$) Including medications	Freq.	Mean (\$) (SD)	Median (\$)	Range (\$)	
				Min	Max
All participants	131	2,699 (1,610)	2,305	364	7,176
Adults (18 – 64 years)	104	2,690 (1,634)	2,283	364	6,866
Older adults (≥65 years)	27	2,729 (1,537)	2,822	589	7,176
Number of appointments	133	6 (3)	6	1	13

Freq: Frequency, SD: standard deviation, Min: minimum, Max: maximum

*The medication fees include dispensing and markup fees

Table 5. Time commitment and indirect costs for one appointment/visit

	Mean (SD)	Median	Range	
			Min	Max
Time commitment				
Travel time (hrs.)	2.2 (1.1)	2.0	0.3	6.5
Treatment time (hrs.)	1.4 (0.5)	1.4	0.5	4.0
Total time commitment (hrs.) (Travel time + Treatment time)	3.6 (1.2)	3.5	1.6	8.0
Indirect costs				
Travel cost (\$)	21.7 (22.7)	8.4	0	108.7
Productivity losses (\$)	69.2 (36.4)	62.6	29.5	324.1
Caregiving costs (\$)	9.2 (23.7)	0	0	94.9
Other costs (\$)	5.9 (8.7)	0	0	30.0
Total indirect costs (\$) (Travel costs + productivity losses + caregiving costs + other costs)	106.0 (61.5)	91.5	31.0	417.0

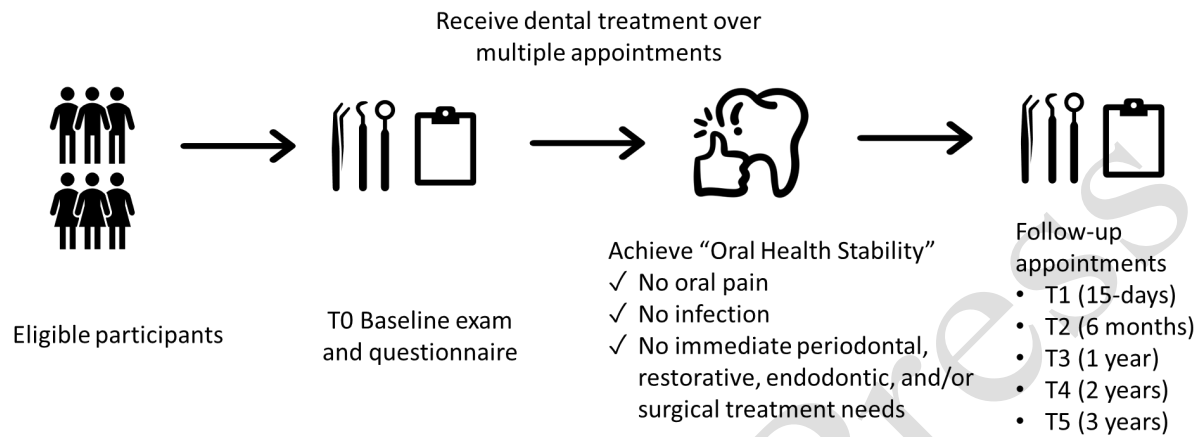
SD: standard deviation, Min: minimum, Max: maximum

Table 6. Modes of transportation used by participants

	Valuation (\$)	Freq.	%
\$0 (e.g., walked or biked)	0	13	9.7
\$1-5 (e.g., subway)	3	47	35.1
\$6-15 (e.g., short taxi ride)	11	10	7.5
\$16-30 (e.g., long taxi ride)	23	3	2.2
Used a private vehicle	0.59 x number of kilometers travelled	61	45.5

Freq: Frequency

Figure 1. Overview of the dental care provided through the program



Appendices

Appendix 1. Oral health stability criteria

Pain	1. Individuals are free of pain. Specific to the oral cavity; does not include gum tenderness resulting from treatment/oral self-care, or other things.
Soft tissue	1. There are no suspicious lesions that require evaluation or biopsy. Note: Benign oral lesions may be present that require monitoring.
Radiography	1. Current radiographs are free from suspicious lesions that require evaluation or biopsy. 2. Benign radiographic lesions may be present that require monitoring
Dental caries	1. There is no evidence of active (progressing) caries extending into the dentine. 2. Active (progressing) caries are limited to enamel and preventive care is indicated.
Pulp and periapical tissues	1. There are no teeth with symptoms and signs of irreversible pulpal damage or necrotic pulp. 2. There are no teeth with incomplete endodontic treatment (in other words, RCT has to be completed).
Periodontal diseases	1. There is no evidence of active periodontal diseases that are beyond control by primary self-care. Professional care in the form of maintenance therapy may be required as a secondary measure to control the patient's condition. 2. There are no periodontally involved teeth with associated apical involvement, which are untreated, and when treated, do not show both clinical and radiographic signs of resolution.
Restorations	1. There are no defective permanent restorations (cracked, loose, or leaking) that are causing symptoms or tissue damage or cannot be maintained by the patient. 2. There are no posterior teeth requiring immediate protective cuspal coverage to maintain the structural integrity of the tooth.
Teeth and roots	1. There are no unerupted, partially erupted, or malposed teeth with historical, clinical, or radiographic signs or symptoms of pathosis that require extraction. 2. There are no non-restorable teeth. 3. There are no functionless roots in communication with the oral cavity. Note: Buried roots with no

	associated pathology may be left in situ and monitored.
Third molars	There are no unerupted, partially erupted, or malposed third molars with historical, clinical, or radiographic signs or symptoms of pathosis that require extraction.
Temporomandibular Disorders (TMD)	TMD or occlusal dysfunction is being managed and the patient is asymptomatic.

Adapted from the Canadian Forces Dental Care Program criteria ⁴⁷ for dental fitness classification 1 and 2.

Appendix 2. Indirect cost questionnaire

Participant ID: _____ Time in: _____ AM / PM Time out: _____ AM / PM

THE ONE SMILE RESEARCH PROGRAM: INDIRECT COSTS QUESTIONNAIRE

1. At what time did you approximately leave home or any other location to attend today's appointment?

_____ AM / PM (circle one)

2. If you have a child or other dependent, did you have to hire a caregiver or ask your partner, relative, or someone else to look after them in order to attend today's appointment?

☐ Yes

☐ No

☐ Not applicable

3. If you travelled by private vehicle, please provide us with the postal code of your place of departure or an estimate of how many kilometers you travelled one-way?

If you cannot remember exactly, write the closet major intersection.

Postal code _____ or _____ km

Closest intersection _____

☐ Not applicable

4. If you travelled by public transport, what were your one-way travel costs for getting to the clinic today?

☐ \$0 (e.g., walked or biked)

☐ \$1-5 (e.g., subway)

☐ \$5-15 (e.g., short taxi ride)

☐ \$15-30 (e.g., long taxi ride)

☐ \$>\$30 (e.g., came from out of town)

☐ Other \$ _____

5. If there have been any other costs related to your travel to the clinic today, please record the amount (in dollars) and provide a description of the related costs below (e.g., tolls or parking fees).

\$ _____ Description: _____

\$ _____ Description: _____