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# A difference-in-differences approach to estimate the effect of income-supplementation on food insecurity

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ABSTRACT

*Objective.* The Universal Child Care Benefit (UCCB) is a 2006 Canadian federal policy of income supplementation that provides parents with $100 monthly in Canadian dollars for each child aged <6 years. The study main objective was to estimate the causal effect of UCCB on self-reported food insecurity overall and in vulnerable subgroups.

*Method.* The Canadian Community Health Survey (2001–2009) was used to conduct a difference-in-differences (DID) regression analysis for the effect of the UCCB on self-reported food insecurity. Respondents were ages ≥12 in families with at least one child aged <6 years (UCCB-eligible, n = 22,737) or a child aged 6–11 but no child <6 years (control group, n = 17,664).

*Results.* Over the study period 16.3% of respondents experienced some level of food insecurity. Overall, UCCB reduced the proportion of respondents reporting food insecurity by 2.4% (95% CI: −4.0%, −0.9%). There was a significantly stronger impact on food insecurity for respondents from households with yearly income below the population median (−4.3%, 95% CI: −7.2%, −1.4%) and respondents from single parent families (−5.4%, 95% CI: −10.3%, −0.6%).

*Conclusion.* We found that a relatively small monthly income supplementation results in a significant reduction in food insecurity at the population level, with larger effects in vulnerable groups.



## Introduction

Socio-economic status (SES) affects health through multiple pathways, including the maintenance of a salubrious lifestyle, a key component of which is diet. Having inadequate financial resources to provide nutritionally for one's self or one's family is one of the key components of "food insecurity," (Webb et al., 2006; US Department of Agriculture 2014) and represents an important pathway through which material deprivation affects health. Adverse consequences of food insecurity include not only the direct impact of reduced diet quality, but also harm through the chronic stress of caregivers who are unable to provide for their families (Laraia, 2013).

Pervasive socioeconomic inequality in North America produces the somewhat counterintuitive situation in which high levels of overall wealth and nutritional abundance exist alongside endemic levels of food insecurity: in the United States, up to 50 million persons may be considered to be food insecure (Gundersen, 2013), while in Canada, the prevalence appears to be between 10 and 20% of the total population (Kirkpatrick and Tarasuk, 2008).

Since food insecurity arises from material deprivation, it could logically be alleviated through food subsidy and/or income supplementation interventions. Nonetheless, careful evaluations of such interventions for their effects on food insecurity have rarely been reported because they pose methodological challenges related to potentially strong confounding due to unmeasured differences between program participants and non-participants, and also the difficulty of comparing program beneficiaries before and after the policy intervention due to secular trends. For example, the US Supplemental Nutrition Assistance Program (SNAP) is the largest US federal food-stamp program that targets low-income families. While many studies investigated the SNAP impact on food insecurity, most of these studies were cross-sectional and had inadequate adjustment for confounding. One recent study overcame some of these limitations by assessing the subjects' food insecurity both at the time of SNAP application assistance and after 3 months of participation in the program and by using a control population (Leung et al., 2014). Nonetheless, this study relied on a small convenience sample of 64 SNAP recipients and 43 non-recipients that may have not been representative to the general population of low-income families.

*Abbreviations:* CAD, Canadian dollars (currency); CCHS, Canadian Community Health Survey (survey); DID, difference-in-differences (analysis, model); ITT, intention to treat (analysis); SES, socio-economic status; UCCB, Universal Child Care Benefit (policy).

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Implemented in July 2006, the Universal Child Care Benefit Policy (UCCB) is a Canadian federal policy of income supplementation that provides parents with $100 monthly in Canadian dollars for each child aged < 6 years. All eligible families are automatically included, regardless of income or other factors, and parents do not need to account in any way for how this money is spent. Because this policy is automatic and universal, there is no question of compliance or self-selection into the policy, aside from the decision to have a child. This exogenous quality of the UCCB can be exploited to estimate both the causal effect of the policy itself and causal effect of income supplementation on food insecurity.

This study aimed to: (1) estimate the causal effect of the UCCB policy on self-reported food insecurity; (2) identify specific population subgroups in which the UCCB policy has the largest effects; and (3) infer the causal effect of income supplementation on food insecurity using the UCCB policy as an instrument with perfect compliance.

## Methods

### *Data source*

We used the Canadian Community Health Survey (CCHS), an ongoing cross-sectional health survey among Canadians aged ≥12 years (Béland, 2002). Households across Canada are selected using a multistage sampling strategy that gives relatively equal importance to each of Canada's provinces and health regions. Once a household is selected, all members aged ≥12 years are listed and one respondent is automatically selected from the list. At the time of the analysis, the survey had data from population samples selected in pre-UCCB years 2001, 2003, 2005, and post-UCCB years 2007, 2008 and 2009 (Appendix A, Fig. A1; for more details on the CCHS survey, please see Appendix B). Among other things, the CCHS collected data on: the number of children age <6 years, 6–11 years and 12–17 years in each household, self-reported before-tax total household income, socio-demographic characteristics of the respondent and household, and self-reported food insecurity (Statistics Canada, 2013).

### *Study design*

A difference-in-differences (DID) design was used, in which food insecurity was compared before and after the 2006 UCCB implementation for respondents living in households that satisfied the UCCB child age eligibility criterion (i.e., had at least one child aged < 6 years in the household, regardless of whether children of other ages were present). Since other factors that change over time can affect food insecurity and confound a simple before–after policy comparison, the spurious effect due to the secular trends was removed using a DID model (Donald and Lang, 2007). The DID method relies on identifying a control group that (1) does not satisfy the UCCB eligibility criteria and (2) experiences the same secular trends in food insecurity as the respondents from the eligible households. The effect of the UCCB on food insecurity was estimated as the difference between the change in outcome before–after the introduction of the UCCB in the eligible group (i.e., the true effect of the UCCB plus the secular trends in outcome) and the change in outcome before–after UCCB in the control group (i.e., only the secular trends in outcome) (Appendix C, Fig. C1). This DID estimate is unbiased when the secular trends in food insecurity due to unobserved factors in the control group are the same as they would have been in eligible group, had the eligible group not been exposed to the policy (Angrist and Pischke, 2008). Ideally, the control group should be similar to the eligible group, except for the characteristics that define eligibility. Given that the UCCB eligibility is determined by the presence of a child aged <6 years in the household, the closest potential control group that was identifiable using the CCHS survey was households with children aged 6–11, but no children aged <6 years (families with children aged <6 are more likely to have similar incomes and expenses with families with children aged 6–11 than with families that have only children aged ≥12 years). Children aged ≥12 years were allowed, but not required, to be present in both the eligible and control households. Both eligible and control households were required to include at least one parent of the children aged <6 and 6–11 years, respectively.

### *Target population*

The population for whom the study inferences apply was driven by the respondents targeted by the CCHS survey and by the requirements of the DID analysis and included individuals aged ≥12 years living in households with child(ren) aged <6 years (UCCB-eligible).

### *Study sample*

Of 593,693 CCHS respondents interviewed in 2001–2010, 22,737 were in families eligible for the UCCB (i.e., with children < 6 years of age, eligible group families) and 17,764 were in control group families (with children 6–11 years old) (Fig. 1). All study subjects were from the six provinces and territories that requested food insecurity data for all survey cycles: Nova Scotia, Quebec, Alberta, British Columbia, North–West territories and Nunavut, which together accounted for >50% of the 2009 Canadian population (Statistics Canada, 2012).

### *Measurements*

The self-reported food insecurity (yes/no) outcome was selected because it is susceptible to acute effects of UCCB policy, it is a likely mediator of longer-term health outcomes, and because it had complete data across all study-years for half of the Canadian provinces and territories. Although some changes were made in 2003 to the food insecurity questions (Appendix D), these are not expected to affect the validity of the food insecurity analyses. Self-reported household income was included for validation purposes, since the true effect of UCCB policy on pre-tax household income can be calculated by multiplying the number of eligible children by the expected $100 monthly benefit (in Canadian dollars). All individual-level, household-level and macroeconomic covariates listed in the descriptive Table 1 were selected a priori from the CCHS questionnaire data based on their potential to confound the pre-post policy comparison of food insecurity and income outcomes. All selected covariates were used as adjustment variables in the analyses.

### *Statistical analysis*

Descriptive statistics included distributional summaries for continuous covariates and proportions for categorical covariates. Comparisons were performed pre-post policy among controls and between eligible and control groups in the years before the UCCB implementation (to assess the DID assumptions) using Wilcoxon tests for continuous variables and $\chi^2$ tests for categorical variables.

The UCCB effect on household income was estimated from an adjusted DID ordinary least squares regression (OLS) model, while the UCCB effect on food insecurity was estimated from an adjusted DID linear probability model. DID is an attractive choice because it avoids the need to control for all confounding variables (Lechner, 2010) because the pre-post design uses the eligible group as its own control, while the non-eligible control group provides an aggregate estimate for all confounding due to secular trends. Additional details on the DID models used in this study are provided in Appendix E. The DID analyses were also replicated in several population subgroups that were a priori hypothesized to benefit more from an income supplementation intervention.

Adjusted changes in the outcome over the study period were estimated and presented graphically for the standard marginal population (the population obtained by standardizing each study group in each year to the covariate distribution of the full population across all years).

Because Statistics Canada does not allow both weighted and un-weighted descriptive statistics to be released for the same data, we present descriptive statistics that did not employ the sampling weights. This allowed us to present the actual study sample used in the estimation of the causal effects, and also resulted in greater statistical efficiency for the regression models (Platt and Harper, 2013).

## Results

The mean total household income among respondents in years 2000–2009 was $65,338 (median $60,000) and 16.3% respondents reported some level of food insecurity. However, there were important changes in these outcomes from 2001 to 2009: total household income increased from $52,734 to $78,461 among eligibles and from $57,169 to $78,852 among controls, and reported food insecurity decreased from 27.3% to 9.9% among eligibles and from 24.5% to 9.3% among controls. While controls had higher income and lower food insecurity than eligibles at all times, the differences between the two groups shrank