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Diet-Related Medical Expenditure Impacts of a CSA Voucher Program

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Abstract

While Community Supported Agriculture (CSA) is generally considered a market innovation for farmers to reach consumers directly, organizations and researchers have begun to evaluate its potential impacts on consumer health. CSA is a subscription model of produce purchasing where consumer pre-pays for a weekly delivery of a vegetable box. In a previous study, our research team documented statistically significant changes in healthy food lifestyle behaviors. Subscribers exhibit increased consumption of produce, decreased processed food consumption, and many other changes generally associated with long-term health. At the same time, these changes are self-reported.

In this paper, we analyze medical claims from UK employees who participated in pilot CSA voucher programs in 2015 and 2016 to see if behavior change is reflected in billed medical expenses. Our general approach is to compare the billed amounts of CSA subscribers one year before and after they begin participating in a CSA. We received permission to use claims for 82 participants in 2015, and 132 participants in 2016 – though the actual number of voucher recipients for each year was larger.

We had two main categories of billed amounts: diet-related medical and diet-related pharmacy expenditures. We identified each claim related to these two main categories using ICD-9 and ICD-10 codes that specified clinic, hospital, and pharmacy visits associated with type-2 diabetes, obesity, heart disease, and hypertension. We also segmented CSA groups into high and low medical expenditure groups based on their average pre-CSA medical bills. We then generated a difference in billed amounts (post CSA – pre CSA) for each participant for diet-related medical billed amounts. We did the same for diet-related pharmacy bills.

We repeated this process with a comparison group drawn from approximately 4600 UK employees who did not participate in this project. Finally, for each pilot year and each billing category (medical and pharmacy), we ran regressions on billed amount differences using the following independent variables: participant group (comparison, high expenditure, low expenditure), gender, and age.

Regression models provide an indication of how CSA participation relate statistically to changes in billed amounts. For the 2015 pilot, CSA participants in the high-expenditure group had a statistically significant decrease of approximately $900 for the year for diet-related medical claims after participation. This group also had a decrease of $180 in pharmacy expenses for the year after beginning a CSA. The low-expenditure group had no significant change in expenses after participation.

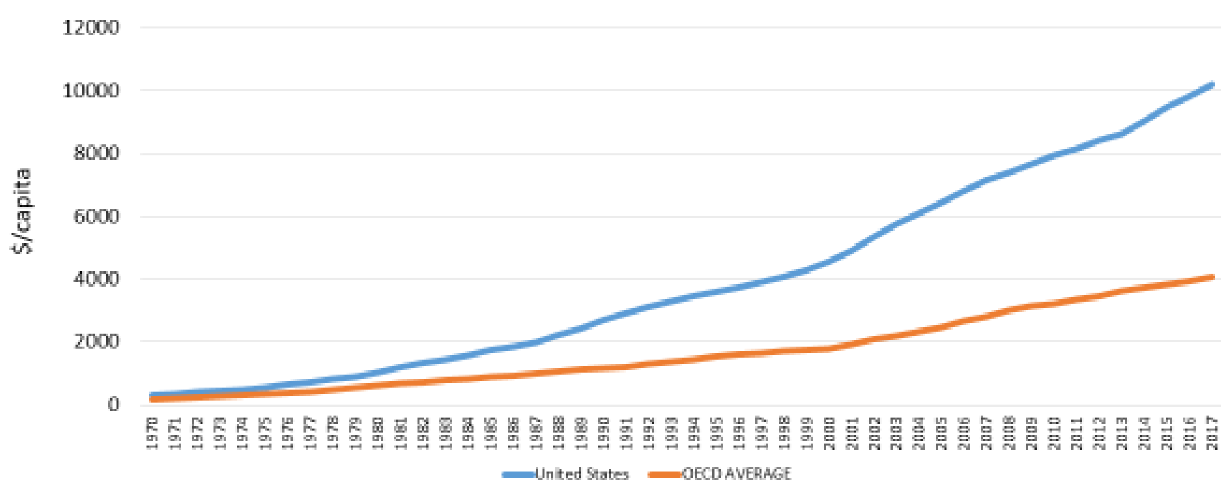
Similarly, in the 2016 pilot, the high-expenditure CSA group had a statistically significant decrease in diet-related medical expenses of approximately $1300 for the year after starting a CSA. The same group also decreased pharmacy expenses by approximately $230 over the same duration. Again, the CSA subscribers with low initial expenditures had no statistically significant change in expenses.

We estimate that these impacts are rather conservative since they only include the claims of the employee, and not his/her household. Additionally, we currently lack the data to examine long-term impacts of CSA on billed expenses. We will be receiving these data in the future and will conduct a comparable analysis.

Introduction –

Health care costs are increasing at much quicker rate in US versus other industrial countries (figure 1). On average, each individual in the US spends $10,000 per year on health care. Citizens and their employers both feel the impact of these cost increases. A significant portion of these costs is directly related to diet, both for general medical and pharmacy expenditures. Efforts by employers to reduce their exposure often focus on wellness interventions that emphasizing exercise, smoking cessation, health screenings, and wellness education. Workplace wellness programs have been documented to significantly reduce medical costs, create positive returns on investment, and decrease absenteeism (Berry et al. 2010; Parks and Steelman 2008). However, diet-related behaviors, while one of the most factors associated with these expenses - particularly involving cardiovascular diseases (Bellavia et al. 2013; Boeing et al. 2012; Dauchet et al. 2006; Roth et al. 2018), are more difficult to effectively design, implement, and evaluate. As such, employers generally do not include diet-related wellness programming in their suite of benefits and wellness options.

Figure 1. Current Expenditure on Health, per capita, US vs OECD Average, 1970-2017



Source: OECD, 2018, http://stats.oecd.org/Index.aspx?DataSetCode=SHA

Recently, the University of Kentucky Health and Wellness program collaborated with researchers in Agricultural Economics to implement and evaluate a novel intervention. This intervention focused on encouraging employees toward better diet and food life style choices. The program provided a voucher to employees to participate in a produce-based community supported agriculture (CSA) program of their choice. CSA is a subscription model of produce purchasing where consumer pre-pays for a weekly delivery of a vegetable box. This vegetable box arrives at a pickup point for approximately 22 weeks.

While Community Supported Agriculture (CSA) is generally considered a transformative market innovation for small-scale farmers to reach consumers directly, their repetitive delivery and engagement structure push recipients into modifying their food consumption and lifestyle behaviors (Rossi et al. 2017). In 2015, we developed a pilot CSA voucher study to document statistically significant changes in healthy food lifestyle behaviors of first-time CSA participants. New and long-time subscribers exhibit increased consumption of produce, decreased processed food consumption, and many other changes generally associated with long-term health (ibid; Allen et al. 2017; Rossi, Woods, Allen 2017) . While these changes are self-reported, these data were compelling enough for UK's Benefits Office to offer an ongoing voucher incentive to employees as part of their Health and Wellness program.

Our intent in this paper is to present the results of changes in medical claims data for individuals involved in the 2015 and 2016 pilot programs. By quantifying the potential changes in medical expenditures for CSA participants, we can measure the health impacts of CSA beyond changes in health lifestyle activities. We can also see if self-perceived behavior modifications result in measurable changes in medical expenditure. By understanding these impacts, we can better assess the potential of CSA as a wellness intervention.

General Approach to Data Collection

Our general approach was to compare billed amounts from medical and pharmacy claims before and after CSA participation. We accessed all medical claims and pharmacy claims of University of Kentucky employees who gave consent to Health & Wellness to use their records for research purposes. All claims were anonymized prior to our receipt.

We collected claims on two groups of employees, CSA voucher participants (test) and non-participants (comparison). We compared participants in two specific pilot programs – 2015 and 2016 voucher programs – for our test group. We acquired claims from 2 years prior to CSA participation and 1 year after for the test group. As we had programs in 2015-2017, the date range of these claims was from May 2013-April 2018. We acquired claims from May 2014- April 2018 for all employees not participating in the CSA to serve as our test group. For our analysis, however, we only considered the claims from 1 year before and after CSA participation for the test group and matched these date ranges for the comparison group.

From these two claims types (medical and pharmacy, we only included billed amounts from services/diagnoses/drugs related to diet. We used ICD-9 and ICD-10 codes to identify which billed amounts should be coded as diet-related and then included them in our pre-/post-CSA comparisons. See below in the *Diet-Related Codes* section (pages 10-11) for more details on how we identified diet related codes.

For context, we use these claims to provide a general overview of total expenditures and diet-related expenditures for all claims we received (table 1). The employee population from which we drew our test and comparison groups had similar medical expenditures to the national average. Overall expenditures, as well as diet-related medical and pharmacy expenditures, have increased over the study duration based on our claims data.

Despite these numbers being in line with the national average, it should be noted that the study population is drawn from a specific subset of employees at the University of Kentucky. We identified all possible participants from a list of individuals who gave UK H&W permission to use claims records in research studies. To give permission, the participant would have at least had a cursory interaction with UK H&W through their annual employee "Wellness Check-in" – an event that pays employees an incentive to have minor biometric screenings.

Table 1. Billed Amounts of Employees (Test and Comparison Groups) by Billing Period and Claim Type

Year		2014		2015		2016		2017		2018
N		210	1834	3396	3610	4114	4213	4899	4931	4836
6 Month Billing Period		2	3	4	5	6	7	8	9	10
Total Expenditures ($/6 mos.)	Mean	2797	1938	3856	3709	5118	4962	4435	4812	6216
	Std Dev	*6185*	*6223*	*11150*	*11669*	*20051*	*14579*	*13682*	*17518*	*23153*
Diet-Related Medical Expenditures ($/6 mos.)	Mean	347	161	400	340	533	535	497	557	671
	Std Dev	*1792*	*685*	*3702*	*3187*	*4352*	*4610*	*4443*	*5841*	*4588*
Diet-Related Pharm Expenditures ($/6 mos.)	Mean	90	96	189	182	175	192	182	196	227
	Std Dev	*263*	*301*	*3564*	*1405*	*704*	*801*	*753*	*793*	*870*

As we discuss later in the *High- and Low-Expenditure Shareholders* section (page 12), when splitting this population up into high- and low-expenditure sub-populations, the majority of subjects ended up being in a lower-expenditure category. While the rates of increase and total billed amounts mirror national trends, many of the individuals in our dataset appear to be relatively healthy if judged by average 6-month expenditures. One compelling pattern from this data is that diet-related medical expenses are consistently 10% of the overall claims amounts. Diet related pharmacy expenditures account for 3-5% of all claims. We coded claims as diet-related only if there was convincing documented evidence of a diagnosis code being directly-related to food intake as we discuss in the *Diet-Related Codes* section on pages 10 and 11.

Subject Population

The employees participating in each year of the program had unique characteristics based on the recruitment strategies of the researchers (in 2015) and UK Health and Wellness (in 2016). In these two years, we moved from a grant-funded to an employer-funded pilot program. In both years, we were able to have some control over participant selection. After 2016, the UK benefits office offered this as a general employee benefit. UK requires incentive programs to be open to all employees. Consequently, the inclusion criteria in 2017 and 2018 was much broader than in the pilot programs from 2015 and 2016. While we are collecting data for the 2017 and 2018 programs now, we restrict our current analysis to the two pilot years. We discuss the CSA voucher recipient characteristics in this section.

2015 Program

The research team received a one-time grant to offer CSA vouchers to individuals who have not participated in a CSA program before. Collaborating with UK Health and Wellness (H&W), we identified a subpopulation of employees who had participated in a 'Wellness Check-in". During a check-in, employees had basic biometric screenings. They also were able to check a box in their consent forms to be included in future research projects.

Of those who gave consent to potentially participate in research projects, we sent each an invitation to explain our CSA voucher program. Two-hundred and fifty-five individuals contacted us with interest. We then randomly offered 180 individuals a $200 voucher to participate in a CSA. The 75 individuals not offered a voucher were given the opportunity to be part of the comparison group. After filling the 90 CSA voucher slots (our budget limit), some of those who declined the voucher were offered the opportunity to be in the comparison group. We had 82 individuals participate in this smaller initial pilot comparison group.

As part of this original project, all participants were required to have no previous experience in CSA. 2015 was the only year in which we had both a test (CSA shareholder) and comparison (non-shareholder) group where all individuals had no prior CSA experience. All participants completed a pre- and post-CSA survey that had them quantify the frequency of specific diet-related lifestyle behaviors (Rossi et al. 2017; Allen et al 2017). Our current project aims to compare these self-reported data to medical expenditure data.

Table 2. 2015 Pilot Employee Descriptive Statistics [1]

Employee Characteristics	CSA	Small Comparison	Full Comparison
	81	76	1688
Male: N, (%)	27, (33)	24, (32)	470, (27)
Age: average	48	49	49
Pre-6 month avg diet-related medical ($/6 mo.)	$150	$238	$146
Post-6 month avg diet-related medical ($/6 mo.)	$233	$390	$388
High expenditure class medical: N, (%)	18, (22)	17, (22)	345, (20)
Low expenditure class medical: N, (%)	63, (78)	59, (78)	1343, (80)
Pre-6 month avg diet-related pharmacy ($/6 mo.)	$100	$156	$114
Post- 6 month avg diet-related pharmacy ($/6 mo.)	$125	$212	$299
High expenditure class pharmacy: N, (%)	23, (28)	23, (30)	710, (46)
Low expenditure class pharmacy: N, (%)	58, (72)	53, (70)	850, (54)

For this group, we split CSA participants up into groups defined by high and low pre-CSA medical expenditure patterns. We used a combination of Jenks Optimization and general descriptive statistics to identify a cut-off point between high and low expenditure participants. Jenks Optimization is a common approach in spatial statistics for clustering a set of observations into classes. This approach maximizes

[1] We took the average of two 6-month periods for each individual to generate a pre- and post-CSA expenditure amount. The cut-off between high- and low-expenditure CSA participants was based on the mean pre-CSA billed amounts for all individuals. The cutoff for the high expenditure category for this cohort was >$350 per 6-months for diet related expenses and >$100 for pharmacy expenses.

the distance between class means while minimizing variance of component observations around their class means (Stefanidis and Stathis 2013). See page 12 for the specific methods we used to categorize participants. Table 2 has a breakdown of the descriptive statistics of this group.

2016 Program

Following the initial pilot, UK Health and Wellness agreed to expand and fund the program. For 2016, they conducted a larger pilot, but with a combination of first time shareholders, returning participants from the 2015 program, and other employees who had experience with CSA. They operated a separate sign-up window for previous participants. They also used biometric criteria from their wellness check-ins to recruit new individuals from higher health risk categories. Finally, to allocate the rest of the vouchers, they offered unclaimed lots to employees without target restrictions. The total number of participants who gave consent to use claims were 132. For the comparison group, we used the records of all UK employees who gave consent to H&W to use medical claims during a Wellness Check-in. This group was approximately 4600 individuals. Descriptive statistics of the 2016 pilot are shown in table 3.

Table 3. 2016 Pilot Employee Descriptive Statistics [2]

	CSA	Full Comparison
Employee Characteristics	132	3651
Male: N, (%)	31, (23)	1040, (28)
Age: average	47	45
Pre-6 month avg diet-related medical ($/6 mo.)	$211	$216
Post-6 month avg diet-related medical ($/6 mo.)	$254	$209
High expenditure class medical: N, (%)	21, (16)	1658, (34)
Low expenditure class medical: N, (%)	111, (84)	3225, (66)
Pre-6 month avg diet-related pharmacy ($/6 mo.)	$126	$120
Post-6 month avg diet-related pharmacy ($/6 mo.)	$88	$126
High expenditure class pharmacy: N, (%)	21, (16)	1833, (37)
Low expenditure class pharmacy: N, (%)	111, (84)	3112, (62)

Claims

We collected all medical claims and pharmacy expenditure data from participants in the CSA program for each year as long as they had given consent during the 'Wellness Check-in' to have their anonymized medical history data included in aggregate analyses. As H&W handled the recruitment of voucher participants in each year, they submitted requests to the Center for Clinical & Translational Science – an organization that handles access to medical claims data at our University. These data are collected as

[2] We took the average of two 6-month periods for each individual to generate a pre- and post-CSA expenditure amount. The cut-off between high- and low-expenditure CSA participants was based on the mean pre-CSA billed amounts for all individuals. The cutoff for the high expenditure category for this cohort was >$500 per 6-months for diet related expenses and >$140 for pharmacy expenses.

part of the University's self-funded medical insurance plans. Given that one insurance organization handles all of these claims, medical claims costs should be commensurate across this large dataset.

We requested two years of medical claims prior to an individual enrolling in the CSA voucher program and at least one year following the start of the CSA. While we collected data from the 2017 cohort, we exclude this from our current analysis because the dataset was incomplete[3]. We ensured anonymity of employees by requesting de-identified claims. In addition to the cost of services rendered (office visits, hospital stays, surgeries, prescription drugs), we collected information to classify employees: age, sex, and employment periods. The employment period data was binary – employed/not employed at some point during the specific billing period. The Center for Clinical & Translational Science is not permitted to give specific dates of employment due to confidentiality concerns. To avoid including claim periods where the employee started at the middle or end of that 6-month range, we removed claims from all individuals in their first period of employment.

For this current analysis, we only include the claims of year prior to and a year following an employee's first CSA subscription. The periods of analysis considered are as follows. Yellow and green durations match the pre- and post-CSA date range respectively. We have two comparison groups for the 2015 since the small comparison group was selected to match the CSA participants for a separate project. The rows at the bottom indicate the date range for each billing period.

Figure 2. Date Ranges of Claims Used for Each Test and Comparison Group[4]

CSA Year	Group	6 Month Billing Period										N
		1	2	3	4	5	6	7	8	9	10	
2015	1 Year 2015			X	X	Z	Z					81
	Full Comparison			X	X	Z	Z					3117
	Small Comparison			X	X	Z	Z					76
2016	1 Year 2016					X	X	Z	Z			135
	Full Comparison					X	X	Z	Z			3645

Billing Period	1	2	3	4	5	6	7	8	9	10
Start	5/13	11/13	5/14	11/14	5/15	11/15	5/16	11/16	5/17	11/17
End	10/13	4/14	10/14	4/15	10/15	4/16	10/16	4/17	10/17	4/18

[3] These is a lag in reporting and processing of claims between the medical service providers and the insurance company. We will analyze these data once we can verify that all medical claims have been reported.

[4] 'X' in yellow spaces indicates the pre-CSA period. 'Z' in the green space indicates the period starting with the CSA intervention. The CSA that typically lasts about 22-24 weeks. We include that duration as part of the post-CSA range. The 6-month billing periods (1-10) span from May 2013 – April 2018. The specific date ranges for each period are shown at the bottom of the figure.

Methods and Analysis

Our general approach was to compare how billed amounts for diet-related medical services differed before and after joining a CSA. For CSA shareholders, we averaged total billed medical services in the two 6-month periods prior to joining the CSA to get a 6 month mean. We repeated this for the two 6-month periods following the start of the CSA intervention. We chose 6-month periods in order to include employees who may have only been employed for a full 6 months but not a full year prior to intervention. We then subtracted the 6-month pre-CSA mean from the post-CSA mean to determine the change for each individual after starting a CSA.

We repeated this procedure for the comparison group. We placed the starting point of the post-intervention to match the particular CSA group for which we wanted a comparison. For instance, we designated the pre-intervention for the comparison group as periods 3 and 4 when comparing to the 2015 CSA group. For the 2016 CSA group, we considered periods 5 and 6 as the pre-intervention period for the comparison group. In this way, the pre- and post-billing periods were the same for both the comparison and test groups within a specific program year. Additionally, we had a second comparison group for the 2015 CSA since it was a special pilot program with a small pilot comparison group selected in the same manner as the CSA participants. We considered the most expensive 1% of billed amounts outliers and removed them from the analysis[5] prior to generating pre-/post-CSA differences.

Once the pre- and post-CSA differences were generated for each individual, we used these differences to calculate overall group mean differences for the comparison and CSA groups. Additionally, we split the CSA test groups into two subgroups based on the degree of expenditures prior to CSA intervention. We discuss our method for this split below. The intent here was to see if CSA participation had a differential impact on higher- and lower-cost employees.

Next, we ran ordinary least squares (OLS) regressions on post-/pre-CSA differences with the following independent variables: age, sex, and group (i.e. test/comparison). The group variable had three categorical values: comparison, high expenditure test, and low expenditure test. In other words, the comparison group was the base value and the regressions indicated whether CSA participation had a significant impact on changes in billed diet-related medical expenditures. We repeated this analysis on diet-related pharmacy expenses.

[5] For each billed period in both the pre- and post-CSA range, we removed expenditures that were extremely expensive and the result of high-cost events or some congenital cause. Our approach was to code billed amounts that were severe outliers for each billing period as non-observations. The threshold needed to qualify as an outlier was set using the Jenks' Optimization method. Using Stata software, we ran the 'group1d[5]' command which iteratively creates classes up to a specified number. We set the maximum at 8 classes. Generally at around 5-7 iterations, we see clusters of one or two classes that comprise 99% of the observations (N=~4000) and a few more classes with fewer than 30 observations per class. Once these clusters are defined, we code the 1% of excessively high observations into non-observations (not zeros) to prevent them from skewing pre-post differences. For instance, for billing period six, we have 3991 observations between $0 and $2735, 86 between $2735 and $10,214, and 37 observations in 5 separate classes that range between $11,000 and $178,000. In this case, we would drop the final 5 classes.

Diet-Related Codes

Medical Claims

Using ICD-9 and ICD-10 codes, we coded all medical claims on whether they were diet-related. We were relatively selective in what we considered diet-related, and generally restricted our focus to diagnosis codes related to hypertension, obesity, and diabetes. All clinic and hospital visits that were related to these conditions were coded as diet-related. The medical claims that we received split each visit up into a number of different codes that indicated 1) the diagnosis given by the clinician during the visit and 2) the corresponding treatments/diagnostics/procedures. In other words, the billing for the visit was itemized by different procedures. The coding of each line item generally had a hierarchy of 3 diagnosis codes (ICD-9 or ICD-10) to justify the billed amount. If either of the first two diagnosis codes of each line item had a diet-related code, we included the amount billed into our calculations. Generally, if the first two diagnosis codes were not diet-related, neither was the third. This approach allowed us to exclude non-diet related claims within a visit where the patient had multiple, yet unrelated conditions observed. Additionally, by using second level in addition to first level diagnosis codes, we captured claims that were primarily coded as an office visit, but also coded for a diet-related diagnosis/treatment. Table 4 has the list of codes we considered to be diet-related. This list was created by referencing the following articles and in consultation with public health and wellness specialists (Beckman 2014; Boeing 2012; ICD10data 2018).

Table 4. Diet-Related Claims Codes

ICD9	ICD10	Condition
250.00	E11	Type-2 Diabetes
274	M10	Gout
278	E66	Obesity
280 - 281	D50 - D53	Anemia
401 - 403	I10, I11, I12	Hypertension
410, 413-414, 428	I20, I21, I25, I50	Heart Diseases
440	I70	Atherosclerosis
564, 579	K58, K59, K90	Digestive Disorders
585	N18	Kidney Disease
733	M81	Osteoporosis
790	R73	Elevated Blood Glucose

Pharmacy Claims

Diet-related pharmacy claims were more straightforward to code. Each claim had a number of different potential codes to categorize its therapeutic effect, but we chose to use the AHFS Pharmacologic-Therapeutic Classification. This classification system groups drugs by common effect and bypasses the proprietary naming conventions of the drug company. We coded pharmacy billed amounts as diet-related if the primary use of a claimed drug was to lower cholesterol, treat diabetes, or manage hypertension. The relevant drug categories for these expenses follow those from Davison's 2017 dissertation which examined the impact of a diet-related wellness intervention on pharmaceutical use.

Table 5. Diet-Related Pharmacy Codes

Category	Indication	AHFS Code
bile acid sequestrants	Cholesterol	240604
cholesterol absorption inhibitors	Cholesterol	240605
fibric acid derivatives	Cholesterol	240606
HMG-CoA reductase inhibitors	Cholesterol	240608
miscellaneous antihyperlipidemic agents	Cholesterol	240692
antidiabetic combinations	Diabetes	682
glucose elevating agents	Diabetes	6820
alpha-glucosidase inhibitors	Diabetes	682002
miscellaneous antidiabetic agents	Diabetes	682003
amylin analogs	Diabetes	682003
biguanides	Diabetes	682004
dipeptidyl peptidase 4 inhibitors	Diabetes	682005
incretin mimetics	Diabetes	682006
insulin	Diabetes	682008
meglitinides	Diabetes	682016
sulfonylureas	Diabetes	682020
thiazolidinediones	Diabetes	682028
emergency glucose	Diabetes	682212
cardioselective beta blockers	Hypertension	1216
alpha blocker	Hypertension	2420
betablocker	Hypertension	2424
calcium channel blocking agents	Hypertension	2428
central alpha agonists	Hypertension	240816
vasodilators	Hypertension	240820
angiotensin converting enzyme inhibitors	Hypertension	243204
angiotensin II inhibitors	Hypertension	243208
renin inhibitors	Hypertension	243240
potassium-sparing diuretics	Hypertension	24082416
thiazide and thiazide-like diuretics	Hypertension	24082420

High- and Low-Expenditure Shareholders

We split each test group (2015 & 2016 CSA groups) into two sets of individuals – those with statistically higher and lower pre-CSA medical expenditures. We set the point between these categories using two methods. The first approach we used was to use the mean billed amounts of all individuals (test + comparison) in the two 6-month periods prior to CSA intervention as the cutoff point. The second strategy was to use the Jenks approach on billed amounts for all individuals to identify one cluster/class with significantly lower expenditures and then use a value slightly above the high end of that class range to define the starting point of the higher expenditure group. After comparing this value to the mean billed amounts of all individuals, we chose a value between the two. Generally, these values were within $100 of each other, and we chose to interpolate the cutoff point based on these two values. The high and low expenditure groups (along with the comparison groups) were identified using a dummy variable with the comparison as the base in regressions.

Modelling Changes in Expenditures

For this analysis, we generated differences in expenditures for each individual and classified these observations according to one of three groups: comparison, high expenditure, and low expenditure groups. Using this group classification as a dummy variable (with the comparison as the base), we regressed the average 6-month difference in post- versus pre-CSA billed amounts against age, gender, and group. As discussed above, we analyzed each year's participants separately and used the same pre-/post-CSA date range for the comparison group.

2015 Pilot

We present data from the 2015 pilot CSA program in Tables 6-9. The first set of results (table 6) concerns diet-related medical claims regressed with our small pilot comparison group. This small pilot comparison was comprised of individuals recruited in the same manner as the CSA participants for a pilot project. All individuals in this comparison group had no experience with CSA, just like the test group. As indicated in table 2, the average age, sex, and percentage of individuals in the low versus high expenditure group are similar for test and the small pilot comparison group. As such, the differences in billed amounts in table 6 (and table 7 for the pharmacy expenditures) have the unique distinction of coming from a population specifically chosen to understand the impact of CSA on first-year shareholders versus individuals with no previous or current CSA experience[6].

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[6] This pilot test and comparison group from 2015 was selected to conduct pre- and post-CSA surveys on participants' food lifestyle behaviors. This methodology was supported by grant funds which directly subsidized the CSA voucher for this specific purpose. In following years, the voucher funds came directly from UK Benefits. As such, they had conditions on who was permitted to receive the voucher – and this was a more general population of UK employees, some of whom had experience with CSA. To make 2016 results more comparable, we drew from a larger population for the control group as discussed above.

We use an OLS model to explore the determinants of the pre/post intervention differences in both diet-related medical expenditures and diet-related pharmacy expenditures using the following approach:

$$\Delta Exp_{i,t} = F(CSA_{highexpend_{i,t}}, CSA_{lowexpend_{i,t}}, Male_{i,t}, Age_{i,t})$$

with the reference groups being non-CSA participants and female as categorical variables and age continuous based on the age observed at the time of the intervention.

Results

Based on the regression model, diet-related medical claims decreased for individuals who were in a higher expenditure category prior to the CSA intervention. This group showed an average decrease of $434 for each six-month period in the year following the start of their CSA compared to the small pilot comparison group. This decrease is statistically significant at a 95% confidence level. These data only refer to diet-related codes as discussed above, yet at $800-900 decrease in billed expenses in the year following the intervention, the CSA provided a return on the initial $200 voucher investment for this group. Additionally, this data only includes the individuals employed by UK and using the CSA voucher, not his/her family, so this return can be considered a conservative estimate.

Table 6. 2015 Diet-Related Medical Expenditure Differences – Regression with Small Comparison

	Coefficient	Standard Error	t	p>t
High Expend**	-$434	212	-2.05	0.04
Low Expend	$51	129	0.39	0.69
Male	-$100	134	-.75	.45
Age	$9	6	1.57	.12
Constant	-$263	308	-0.85	0.39
N = 150		Prob>F = .092		R^2 = .053
N(HE)=16		N(LE)=63		N(C)=72

Note: Non-CSA voucher employees in the pilot (small) comparison group serve as the reference group in this regression analysis. The data above represent average change per six-month period for the year immediately following intervention.

Participants with lower initial expenditures did not exhibit a statistically significant change in their billed expenses. As such, the $51 increase per six-month period is statistically the same as zero. While there were no observable cost savings for this group, these individuals appear to be maintaining their already good health.

When observing diet-related pharmacy expenditures, we notice the same general pattern. High-expenditure participants registered a decrease of $92 per 6 months on average for the year following initial CSA participation. Low-expenditure participants had a cost decrease, but again this was not statistically significant. We treat this as $0 change in billed expenses. However, it is important to note that age and gender do have an effect on billed expenses.

Table 7. 2015 Diet-Related Pharmacy Expenditure Differences – Regression with Small Comparison

	Coefficient	Standard Error	t	p>t
High Expend**	-$92	39	-2.38	0.02
Low Expend	-$21	26	-0.80	0.42
Male***	$71	26	2.68	0.01
Age***	$3	1	2.83	0.01
Constant **	-$142	62	-2.3	0.02
N = 148		Prob>F = .002		R^2 = .11
N(HE)=18		N(LE)=58		N(C)=72

Note: Non-CSA voucher employees in the pilot (small) comparison group serve as the reference group in this regression analysis. The data above represent average change per period for the year following intervention.

When pharmacy and medical billed amounts are considered together, the high expenditure group had a decrease of approximately $1052[7] in these expenses for the 12 months following CSA participation. The low expenditure group had no statistically significant change in billed amounts on average for the year after entering the voucher program. Using these values and considering all CSA participants, the decrease in expenses per person (regardless of expenditure status) is ~$213[8] according to these regression models.

Using the same test group, we ran regressions using the same independent variables, but changed the composition of our comparison group. We had access to medical claims from ~4600 UK employees, which represents the general employee population. This comparison group, then, may include CSA subscribers who are NOT part of the CSA voucher program and others with varying levels of health. Therefore, while this comparison group is not a cohort selected in the same way as the CSA participants, it does give us a sense of how the CSA program compares to the general employee population.

Table 8. 2015 Diet-Related Medical Expenditure Differences – Regression with Full Comparison[9]

	Coefficient	Standard Error	t	p>t
High Expend**	-$490	197	-2.49	0.01
Low Expend	$-41	100	-0.42	0.68
Male	-$48	40	-1.20	0.24
Age*	$1.5	1	2.400	0.05
Constant	-$244	64	3.77	0.00
N = 1789		Prob>F = .02		R^2 = .01
N(HE)=16		N(LE)=60		N(C)=1713

Note: Non-CSA voucher employees in the large comparison group serve as the reference group in this regression analysis. The data above represent average change per six-month period for the year following intervention.

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7 ((-$434+ -$93)/6-month period)* (2 6-month periods)

8 (($1054decrease x 16 high expenditure individuals) + ($0 change x 63 low exp. individuals))/79 total participants

9 This dataset may include employees in the comparison group who were only employed for part of billing period 3. We are in the process of gathering data from periods 1 and 2 for the large comparison group in order to ascertain and include only the employees employed for the entire duration of each billing period.

As with the small pilot comparison group, we see a similar pattern when using the full comparison. High expenditure participants showed a statistical decrease of $490 in billed amounts compared to the comparison group. The LE group did not have a statistically significant change. Pharmacy expenditures (table 9) however did not show any significant changes in either direction for both groups, while sex and age were more important to understanding expenditure patterns. When considering tables 6-9 together, six-month decreases for the high expenditure group in the 2015 program are similar in magnitude when compared to both comparison groups.

Table 9. Diet-Related Pharmacy Expenditure Differences – Regression with Full Comparison

	Coefficient	Standard Error	t	p>t
High Expend	-$127	87	-1.46	0.14
Low Expend	-$109	82	-1.32	0.19
Male**	-$54	22	-2.48	0.01
Age***	$6	1	7.25	0.00
Constant	-$27	61	-0.45	0.65
N = 1403		Prob>F = .000		R^2 = .05
N(HE)=18		N(LE)=58		N(C)=1327

Note: Non-CSA voucher employees in the large comparison group serve as the reference group in this regression analysis. The data above represent average change per six-month period for the year following intervention.

2016 Program

Next, we analyze participants from the 2016 program's claims. This program's cohorts are unique and do not overlap with those in the 2015 pilot. Additionally, for the 2016 program, we do not have a small comparison group. Instead, we use the full comparison group of UK employees who agreed to allow their anonymized records for data analysis. This is the same larger comparison group used for the 2015 data with the caveat that we used a different cutoff point for the pre-/post-CSA period to match the date range of the 2016 CSA group.

Table 10. 2016 Diet-Related Medical Expenditure Differences – Regression with Full Comparison

	Coefficient	Standard Error	T	p>t
High Expend***	-$673	164	-4.11	0.00
Low Expend	$57	70	0.81	0.41
Male	$32	26	1.23	0.22
Age	$0.1	1	.05	0.96
Constant	-$2.9	47	-.06	0.95
N = 3817		Prob>F = .000		R^2 = .01
N(HE)=20		N(LE)=112		N(C)=3685

Note: Non-CSA voucher employees in the large comparison group serve as the reference group in this regression analysis. The data above represent average change per six-month period for the year following intervention.

High expenditure and low expenditure groups exhibit the same pattern in this year as the previous (table 10). For diet-related medical billed amounts, the high expenditure group had a significant average decrease of $673 per 6 months for the year following CSA entry compared to the comparison group. The low expenditure group had no statistically significant change in either direction.

For pharmacy expenditures, the high expenditure group's billed amounts decreased by $116 on average for each six-month period in the year following intervention (table 11). The low expenditure group's change was statistically the same as $0.

Table 11. 2016 Diet-Related Pharmacy Expenditure Differences – Regression with Full Comparison

	Coefficient	Standard Error	t	p>t
High Expend***	-$116	40	-2.89	0.01
Low Expend	-$17	17	-0.99	0.32
Male	$7	7	1.02	0.31
Age***	$1	0	4.88	0
Constant***	-$40	12	-3.40	0.001
N = 3776		Prob>F = .000		R^2 = .01
N(HE)=20		N(LE)=111		N(C)=3645

Note: Non-CSA voucher employees in the large comparison group serve as the reference group in this regression analysis. The data above represent average change per six-month period for the year following intervention.

Taken together, these regressions suggest that in the year following initial participation in the CSA voucher program in 2016, medical expenses decrease by $1346[10] and pharmacy expenses decrease by $232 for high-expenditure CSA participants. Low expenditure participants had a change statistically similar to $0. When considering all participants and combining medical and pharmacy claims, the decrease in billed amounts was $204 per person for the entire 2016 cohort[11].

Discussion

The CSA voucher program appears to have most financial impact on those who have relatively higher medical/pharmacy claims, but the potential impacts go beyond reducing specific claims categories. While both cohorts had fewer individuals in the high expenditure category, this trend is not surprising. CSA historically has appealed to those who were in good health, or at least on the path to cultivate better health. From this analysis, we see that those in the low-expenditure category (the highest proportion of individuals) are maintaining low expenditure levels throughout the program. So while there is a statistically measurable decrease for higher-spending/riskier employees, the CSA program can act as a mechanism for reinforcing the positive health outcomes as well.

Claims benefits are only one of the overall possible benefits from a CSA incentive program. In our analysis, we do not consider any changes in the household of the CSA subscriber. As this ends up being a household benefit, the potential changes may be more significant. Additionally, we do not examine

[10] (-$673/6-month period)* (2 6-month periods)
[11] (($1346 decrease x 20 high expenditure individuals) + ($0 change x 112 low expenditure individuals))/131 total participants

the impacts of this program on absenteeism, presenteeism, employee morale, loyalty to the employer, and other associated benefits that might accrue. While we recognize that these potential benefits go beyond what is analyzable with our claims data, we are tracking CSA participant attitudes toward their workplace through an on-going survey and some focus groups. While these data are tangential to this current paper, we include mention to savings on health claims are not the only area of workplace wellness that this program may affect.

Finally, we use ordinary least squares regressions as a foundational approach to explore the first year impact of a CSA program. While this approach is appropriate for analyzing billing differences over a uniform period, we intend to further analyze data to understand the long-term impact of participation 1) for employees who join for multiple consecutive years and 2) to identify specific employee segments that would disproportionally benefit from a program participation. More complex analytic models will be required for these projects, especially when attempting to account for inflation of medical costs over a multiyear period. As indicated in figure 1 and table 1, costs are increasing rapidly across the US and in Kentucky, so controlling for these systemic changes will be critical.

Descriptively, we find statistically significant decreases in diet-related medical and pharmacy expenditures that are large in magnitude relative to baseline expenditures; this result is present for higher-risk CSA participants in both 2015 and 2016. The drops in average expenditures for the test groups are large relative to those observed in the comparison groups. Additional analysis with subsequent years of data can help us establish whether observed differential changes are causal impacts of the CSA program.

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