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### **Abstract**

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## **1 Introduction**

## **2 Data**

### **2.1 Description of Study**

We implemented a randomized control trial to examine the effects of shutting down indoor dining services on restaurant performance. Survey methodology was used to measure these effects against a valid comparison group consisting of restaurants operating at regular capacity. In this report, we will refer to the systematic closure of indoor dining services and simultaneously switch to take-out or delivery only services as the intervention. The control group will refer to restaurants whose services remained fully operational for the duration of the study and who were invited to complete a survey regarding their restaurant’s performance after the intervention period ended.

A sample size of 400 was selected for the experiment based on funding availability (see Appendix for funding details), with 200 restaurants randomly assigned to receive the intervention and 200 restaurants randomly assigned to be in the control group. While these sample sizes indicate the number of restaurants we reached out, the number of respondents who consented to participate in the study differed slightly. A total of 150 restaurants received the intervention and responded to the survey, while 180 restaurants assigned to the control condition completed the survey.

Restaurants randomly assigned to receive the intervention were asked to close their indoor dining services so their food was only available to customers for take-out or delivery. There were no restrictions as to how restaurants carried out their take-out and delivery orders, meaning they could use any type and number of food courier services, including their own in-house delivery services. Take-out included orders from individuals who called ahead or placed an order for pick-up through a food courier, as well as individuals who entered the store and made an order for take-out on the spot at the entrance. The only restriction was that seating areas in the restaurants were closed and customers had to leave with their food.

The duration of the intervention was three months, beginning on October 1st and ending on December 31st, 2020. While we understand that three months might be considered a long time to ask restaurants to partially shut down some of their services, we felt this length was necessary to ensure the intervention had time to stabilize and take effect. Since restaurant performance may fluctuate on a month-to-month basis due to a variety of external factors, we felt that measuring performance over a longer period of time would be a better indicator of the effects of the intervention and reduce the impacts of these fluctuations. The three month time period also gave restaurant owners and employees sufficient time to adjust and adapt to the new business model and make any changes where necessary. Finally, the duration of the intervention lined up with the third quarter of the fiscal year so revenue performance

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\*Code and data are available at: <https://github.com/bonjwow/covid-shut-down>

could be compared to the previous quarter. This was done purposefully under the assumption that many restaurants would already be calculating their quarterly earnings, and this would simplify their process of comparing performance before and after the intervention.

After 200 restaurants were randomly assigned to receive the intervention, the owners of each restaurant were contacted via telephone by members of the team at Petit Poll and invited to participate in the experiment. Restaurant owners were informed of the purpose of the intervention, the details and expected length of the intervention, and the compensation for participating. Restaurant owners were encouraged to ask questions and to ask for clarification when necessary to ensure transparency regarding the intervention process. On our end, this included making it clear that the restaurant may end up operating at a loss for the duration of the intervention, and that some employees may have to be put on a temporary leave of absence. In addition to this, restaurant owners were informed that they were under no obligation to participate in the experiment if they did not wish to do so, and that if they consented to participate, they were allowed to opt-out and revert to their standard business practice at any point during the intervention. Finally, while only the restaurant owner's consent was necessary to participate in the experiment, they were strongly encouraged to discuss the intervention and its potential implications with their employees as well before deciding to participate. Restaurants were contacted 6 weeks before the starting date of the intervention to ensure an adequate amount of time to prepare for the transition. Informed consent forms signed by each restaurant owner were collected two weeks before the start date of the intervention. A total of 150 restaurants consented to participate in the intervention.

During the intervention period, members of the team at Petit Poll performed monthly check up calls with each restaurant in the intervention group. This was done to get a sense of how the intervention was going and allow restaurant owners to voice any concerns. This also allowed us to confirm if restaurants were still following the requirements of the intervention. Restaurant owners were once again reminded during these calls that they had the option to opt-out of the intervention at any time if they felt their business was at serious financial risk and did not wish to continue.

Restaurants in the intervention condition received \$1200.00 CAD for participating. This amount was determined based on funding allocations for this study. We acknowledged that participating in the intervention may result in some financial losses and put some businesses at risk and wanted to provide some form of compensation to help alleviate those concerns as well as incentivize restaurants to participate. However, we also understand that this amount of money carries different weight for different types of restaurants. We provided resources and encouraged restaurants to look into external relief funding to support their businesses throughout and after the intervention period.

200 restaurants selected to be in the control condition were called or contacted via email after the end of the intervention and invited to complete a brief survey regarding various aspects of their restaurant's performance, employees, and take-out and delivery practices. Restaurant owners were told the purpose of the study and invited to ask any questions they had. Like the intervention condition, restaurant owners were informed that their participation was voluntary, and their responses to the survey would be completely anonymized. A total of 180 restaurants assigned to the control condition completed the surveys within two weeks of the end of the intervention.

## 2.2 Survey Details

A short survey<sup>1</sup> hosted on Google Forms was created to assess the effects of the intervention. Screenshots of the questions can be found in the Appendix. The survey contained 16 questions, the majority of which were in categorical multiple choice format. Questions 1-4 in the survey were designed to gather basic demographic questions about the restaurants to characterize the sample, such as the restaurant's location, scale, segmentation (e.g. fine dining, casual dining, or quick service), and the number of years the restaurant has been in operation. The rest of the questions were related to the intervention, and intended to measure a range of potential effects of the intervention on the restaurant. These included questions about the number of employees working at the restaurant before and after the intervention period, questions about whether or not any changes were made to menu prices, changes to hours or days of operation, and questions about the restaurants' performance in terms of revenue. To avoid situations where respondents may be uncomfortable or not willing to share their exact revenue, questions were asked in relative terms to the last quarter. For example, question 7 asked restaurants to indicate whether their quarterly revenue was higher, lower, or around the same compared to the last quarter. Similarly, question 8 asked respondents' to report how much

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<sup>1</sup>Survey available here: <https://forms.gle/hLPNhyjBCXxGiDPz5>

their revenue declined compared to the last quarter in terms of percentages. These questions were both adapted from a survey conducted by Restaurants Canada on impacts of COVID-19 on businesses (Restaurants Canada 202AD).

Restaurants in the intervention and control groups received the exact same questions to ensure a fair comparison between groups. Two identical copies of the survey with separate links were created on Google Forms to differentiate between restaurants in the intervention group who completed the survey and those in the control group. To respect respondents' privacy, restaurant owners within each group all received the same URL. Respondents were required to sign in with a Google account to complete the survey to ensure only one response per restaurant, however their addresses were not saved or connected to their responses in any way to ensure complete anonymity. Only general demographic characteristics about the restaurant such as location and restaurant type were asked.

## 2.3 Sampling Methodology

The restaurants included in the study were selected using stratified random sampling from a list of registered business licenses in Toronto issued by the Municipal Licensing and Standards Division. This dataset was obtained from the Toronto Open Data Portal (City of Toronto 2021) and contains information regarding the different types of licenses and permits issued to businesses in Toronto, their contact information, and location. Since all restaurants in Toronto need a license to operate, this dataset provides excellent coverage of all restaurants currently in the city. Additionally, since the dataset refreshes on a daily basis, all information including when businesses cancel their licenses is up to date. The data were filtered to keep only businesses categorized as eating establishments which had not cancelled their license at the time the dataset was accessed. Restaurants which had been identified as take-out only or had no seating accommodations in the dataset were also filtered out during the sampling process. This was done to help ensure any effects found after the experiment could be attributed to our intervention which required restaurants to operate on a take-out only basis. The inclusion of restaurants which have already been tailored as take-out only businesses before the start of the experiment might influence the results in unknown ways. This is due to the fact that these restaurants most likely already had strategies in place to optimize their business performance while only providing take-out.

Since we are interested in the effects of switching to a take-out only business model for all restaurants in the city of Toronto, we needed to make sure our sample was representative of restaurants all across the city and not just those clustered in certain areas. Similarly, we needed to ensure that there were no major regional differences between the restaurants who received the intervention and the restaurants in the control group. For example, if most of the restaurants who were selected to receive the intervention ended up being clustered in significantly different areas than those in the control group, a number of extraneous factors related to location could influence the results irrespective of the effects of the intervention. In order to mitigate these effects, the number of restaurants coming from each area in Toronto should be roughly equal between the intervention and control groups. Therefore, to ensure restaurants in each area of Toronto are accurately represented in the experiment and that the distribution of restaurants in the intervention and control groups, a stratified sampling method was used.

The first three characters of the postal codes provided for each restaurant in the dataset were used to stratify each restaurant into boroughs assigned by Canada Post (Canada Post 2014). Figure 1 displays the percentage distribution of restaurants located in each borough. As expected, a large proportion of restaurants were located in Downtown Toronto, followed by North York and Scarborough. After assigning each restaurant to an individual strata, a stratified random sampling method was implemented in R (R Core Team 2020) to randomly select a number of restaurants from each borough in proportion to the number of restaurants clustered in each area. For example, since our total sample size is 400 and approximately 28% of restaurants in the total list of restaurants we are sampling from are located in Downtown Toronto, we randomly selected 28% of 400 (112 restaurants) from the Downtown Toronto area to be in our sample. After restaurants were selected from each borough, R was used to randomly assign each restaurant to either the intervention group or the control group. The random assignment was done by borough, so half of the restaurants selected from each borough were assigned to the intervention group and the other half were assigned to the control. This sampling process ensured the restaurants we randomly selected were representative of all areas in Toronto, and that there were no major differences between restaurants assigned to the intervention group and those assigned to the control group in terms of their locations.

## Proportion of Restaurants in Toronto by Borough

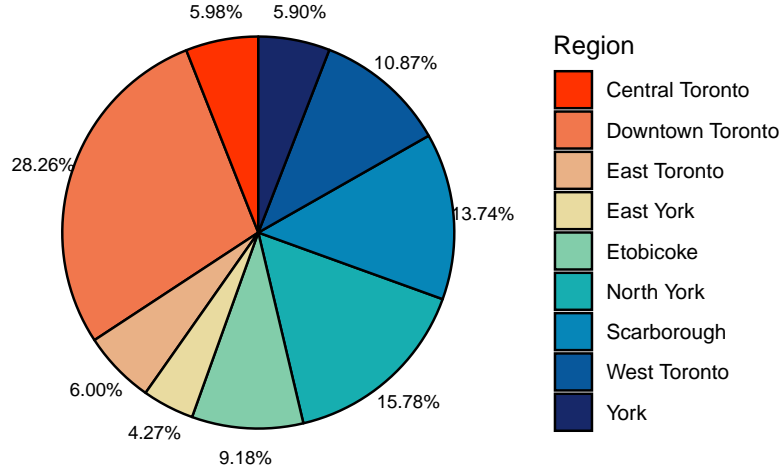


Figure 1: Distribution of Restaurants in Toronto by Canada Post FSA

In order for us to make causal inferences about the effects of our intervention, steps had to be taken to ensure we had a valid comparison group to compare the effects of the intervention to. One characteristic of a valid comparison group is that it has roughly the same characteristics as the intervention group (Gertler et al. 2016). The Toronto restaurant scene is extremely diverse in terms of the size of the restaurants, the type of food served, and the target populations. While we wanted to cover a wide range of restaurant types, it was difficult to control for all these factors given the number of restaurants in Toronto. We relied on the process of randomized sampling and random assignment to ensure, at the very least, there were no systematic differences between groups since every restaurant had an equal chance of being assigned to either condition. Similarly, using stratification to control for location helped to ensure the groups were similar based on the number of restaurants picked from each borough. However, while the sampling method was selected to reduce differences between the groups, there may be significant differences between restaurants who choose to participate in the intervention versus those who do not which need to be addressed when discussing the effects of the intervention.

Finally, to make a valid comparison between the intervention and control groups, restaurants in each group needed to be unaffected by one another (Gertler et al. 2016). To illustrate, consider a situation where one restaurant was selected to shut-down their indoor dining services and the restaurant located next door was part of the control group and stays open. If a customer wanted to dine indoors at the first restaurant, sees that the restaurant is closed for indoor dining, and instead decides to eat at the restaurant next door because it is open, our results might be affected by the fact that the closure of one restaurant directly impacted the sales of another restaurant in the control group. Again, we relied on the random sampling methodology and the sample size in relation to the total number of restaurants in each area to circumvent this issue. Given the large number of restaurants we were sampling from, it is statistically unlikely that restaurants in the intervention and control groups would be so close together and impact each other in such a way.

## 2.4 Results

Survey questions pertaining to the characteristics of the restaurants, such as location, size, type, and age of restaurants Figure 2 show us that:

- The largest concentration (nearly 60%) of restaurants in the Greater Toronto Area are centralized in downtown Toronto (28.26%), North York (15.78%), and Scarborough (13.74%);

- Most restaurants are of medium or large scale<sup>2</sup>;
- The majority of restaurants who responded are relatively new (Have been operating for 3 years or less);
- Fast-food/quick service restaurants were the most common types, followed by casual dining, and then fine dining;
- UberEats was the most popular food courier service that restaurants received orders from. (MOVE)

## Warning: Removed 130 rows containing non-finite values (stat\_count).

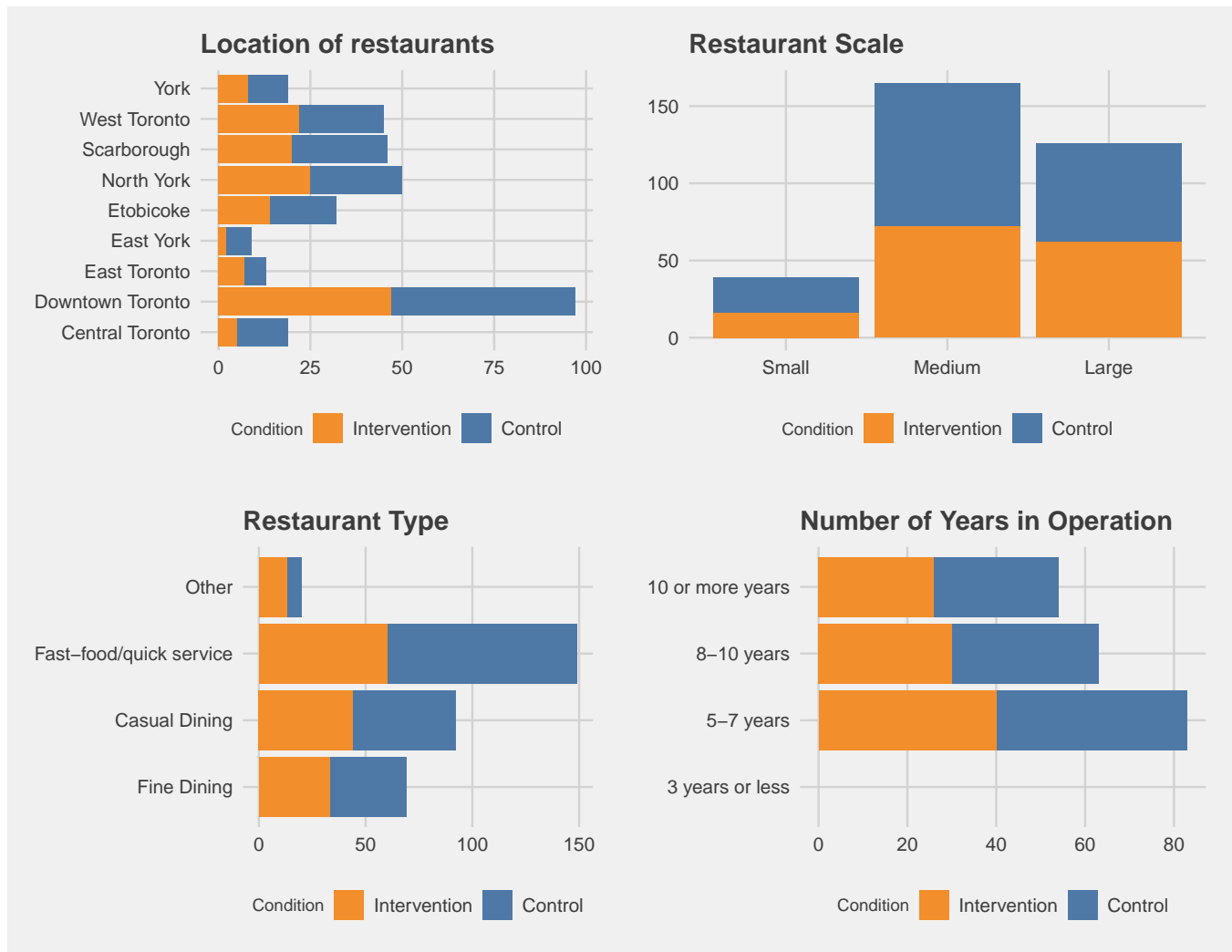


Figure 2: Sample Characteristics of Restaurants by Condition

Table 1 displays changes in the numbers of employees working at restaurants in the sample prior to the intervention period (Oct 1) and following the intervention period (Dec 31). This shows us that initially, both the control and treatment group had a very similar number of employees on average. Following the intervention period, however, the treatment group appears to have 10.26 fewer employees on average. Two-tailed Welch's t-tests comparing the two groups' mean employees shows that the difference prior to the intervention period is not a significant finding (  $t(330) = -8.56, p > .05$  ), but the difference in employee numbers between the two groups post-intervention is significant (  $t(330) = 19.46, p < .05$  ).

<sup>2</sup>The survey asked respondents to consider their restaurant scale in terms of space and seating capacity, however the perceptions of scale may be subjective

Table 1: Welch’s T-test to examine effects of intervention on the number of employees

Mean Difference	Control	Treated	t	p	df
	Mean (Pre-Intervention)	Mean (Post-Intervention)			
0.428	30.761	30.333	0.754	0.452	315.856
9.572	29.272	19.700	18.981	0.000	327.114

In terms of effects on revenue and/or overall sales for restaurants during the intervention period, Figure 5 shows us that more restaurants within the treatment group saw decreases in revenue compared to the prior quarter (July 1 - Sep 30), while the control group’s revenue largely remained the same. In addition to this, Figure 6 shows that of those restaurants that saw a decrease in revenue, the treatment group saw the harshest declines in revenue during the intervention period. A Chi-Square test for whether the restaurant saw a decrease in revenue showed that restaurants in the treatment group were more likely to report a decrease in revenue  $X^2(2, N = 330) = 220.73, p < 2.2e-16$ . The percentage decrease in revenues also showed a significant relationship, where restaurants in the treatment group are most likely to report higher loss of revenue during the intervention period  $X^2(3, N = 330) = 178.33, p < 2.2e-16$ . Prior to the intervention period, it appears as though both groups had similar breakdowns of revenue coming from take-out and/or delivery (Figure 7).

Questions related to the adjustments of the restaurants during the intervention, such as a menu price, and hours and days of operation (Figures 8-12) show us that:

- Most of the restaurants in the control group did not make any alterations to their menu prices, while most restaurants in the intervention group either lowered or raised the menu price;
- Most of the restaurants in the control group did not adjust their hours our days of operation, while most of the ones in the intervention group reduced their operating schedules.

Pearson’s Chi-squared ( $X^2$ ) test was used to see if there is a statistically significant difference between the intervention and the adjustments of the restaurants. The test results show that the p-value of each of those adjustments is less than 0.001, meaning that there is a high correlation between those variables. Consequently, it is expected that restaurants will most likely adjust the menu price and reduce their operating schedule if they operate on a delivery and take-out only basis.

## 2.5 Figures

### 2.5.1 Sample Characteristics

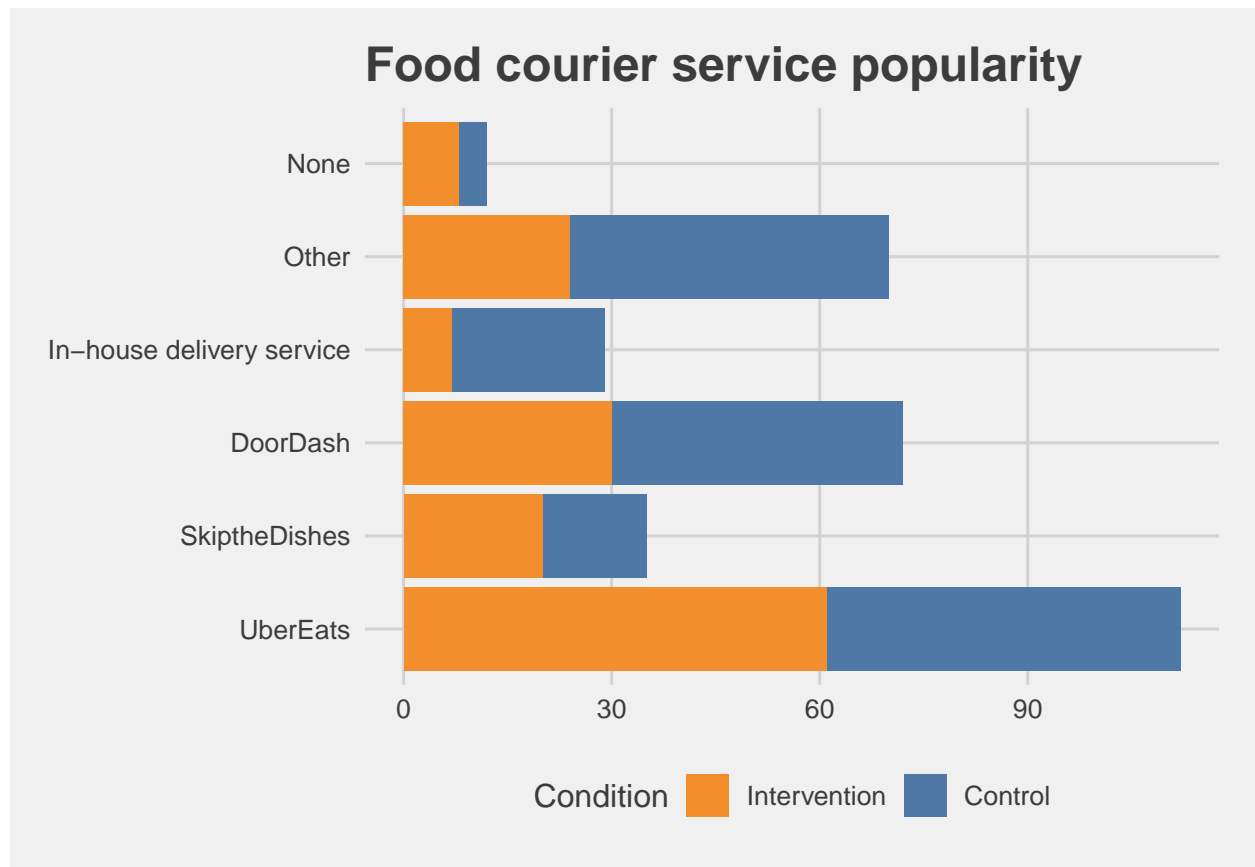


Figure 3: The most used food courier service

### 2.5.2 Effects of Intervention on Number of Employees

Table 2: Pearson's Chi-squared test to examine the possibility of an association between the intervention and the total sales

	X-squared	df	p-value
<b>X-squared</b>	176.875	2	0.000 ***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

### 2.5.3 Effects of Intervention on Revenue

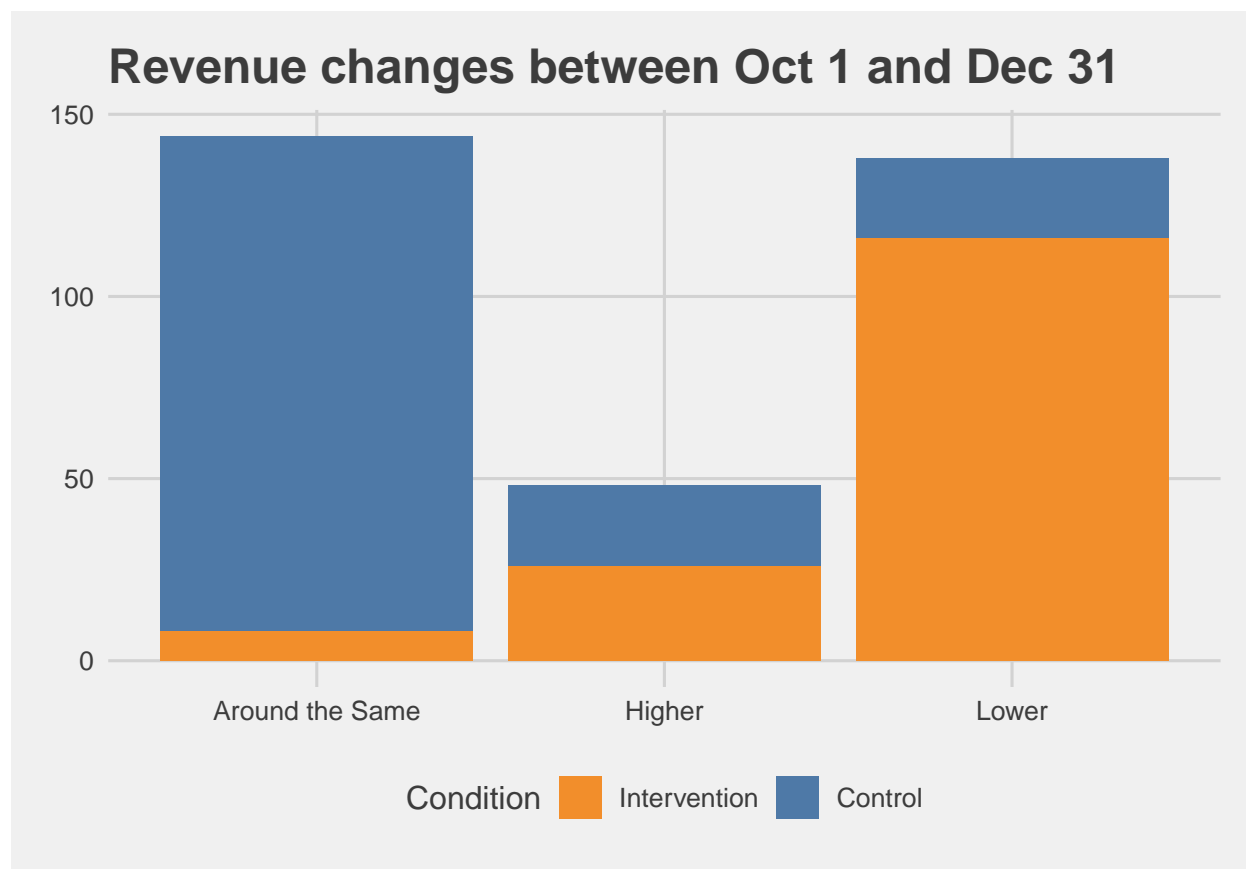
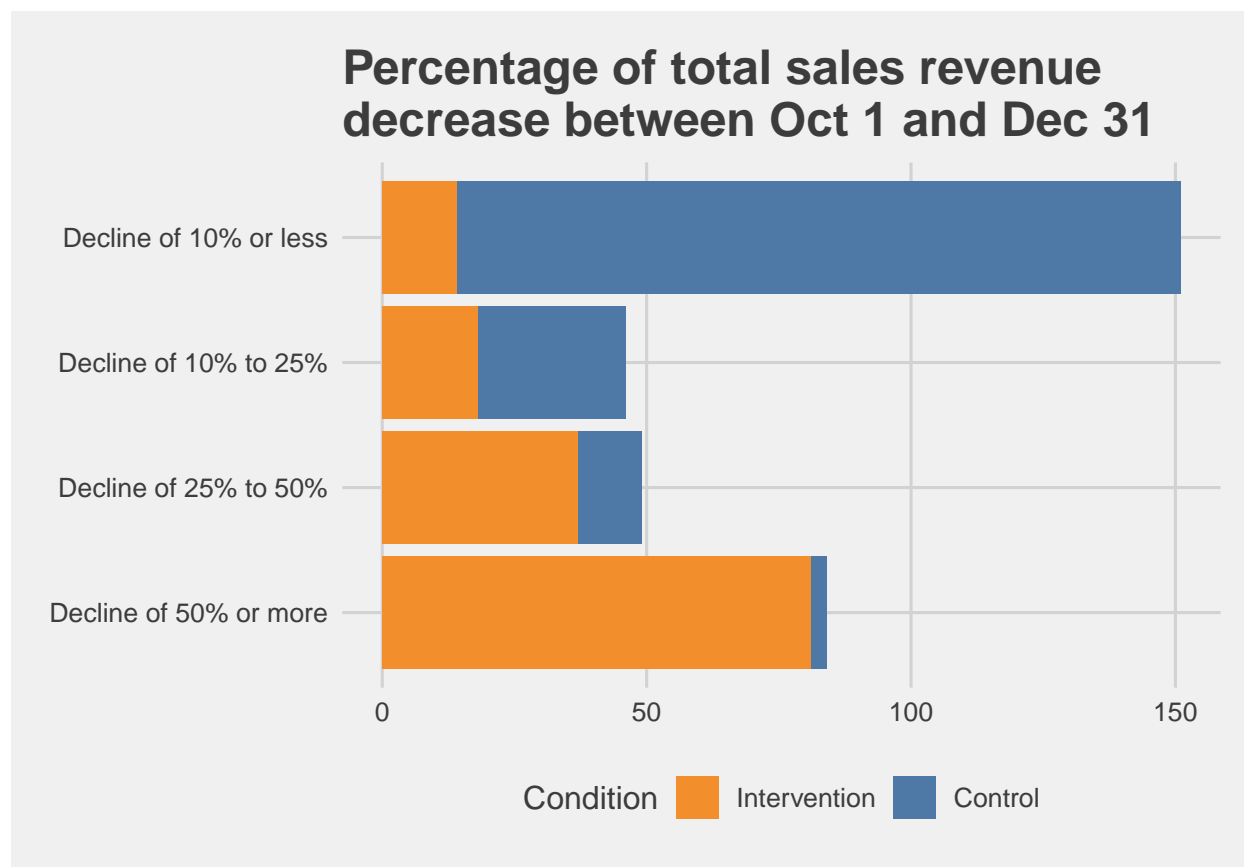




Table 3: Pearson's Chi-squared test to examine the relation between the intervention and the total sales and a decline in revenue

	X-squared	df	p-value
<b>X-squared</b>	186.363	3	0.000 ***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$



## Total revenue from takeout or delivery prior to Oct 1

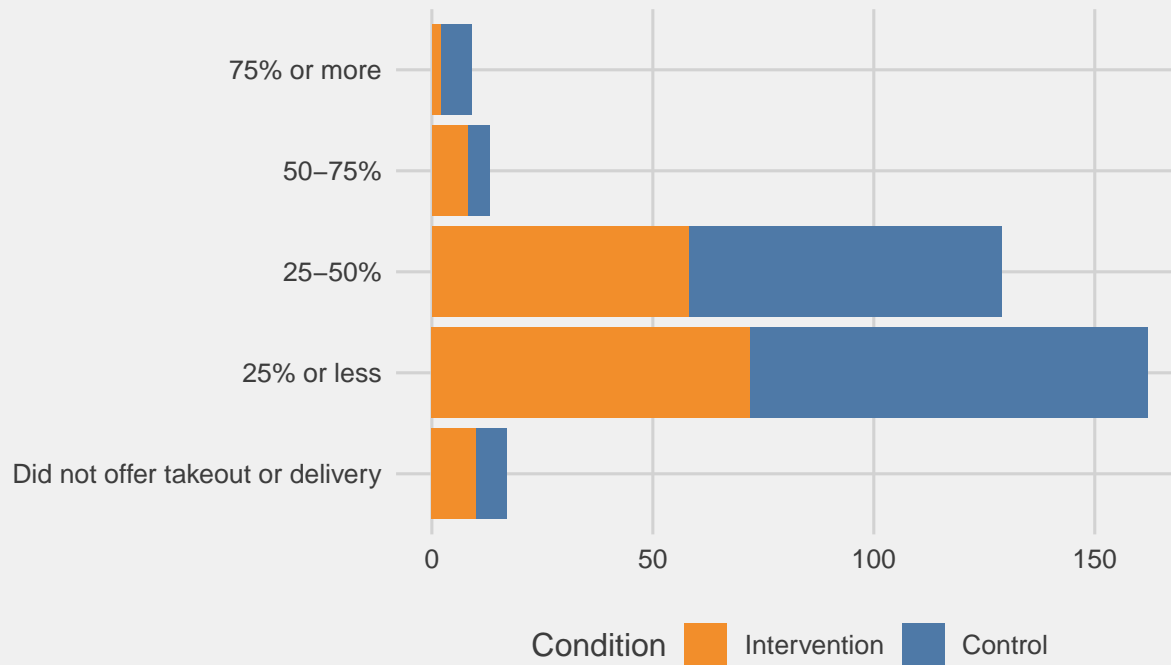


Table 4: Pearson's Chi-squared test to examine the association of the intervention with price adjustments

	X-squared	df	p-value
<b>X-squared</b>	17.027	5	0.004 **

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

## 2.6 Effects of Intervention on Menu Prices

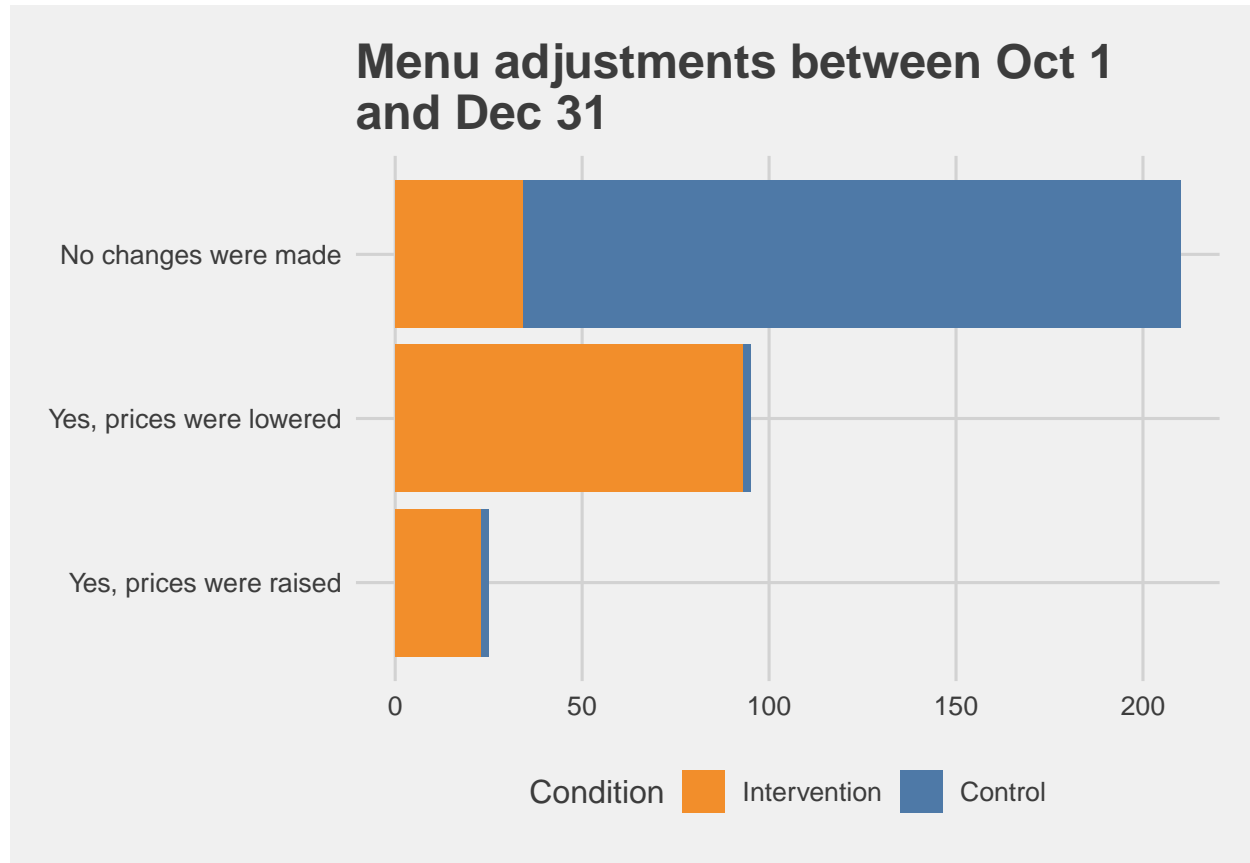
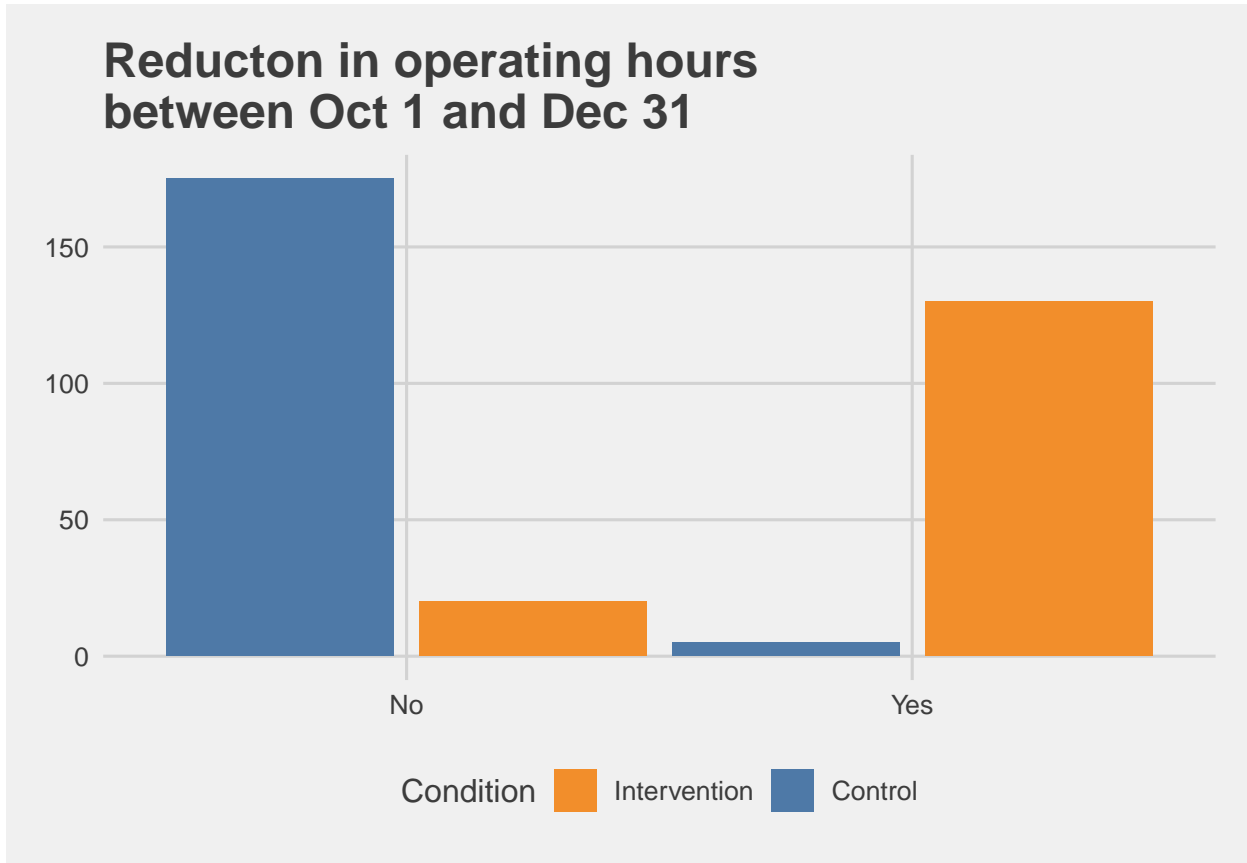


Table 5: Pearson's Chi-squared Test for Q12

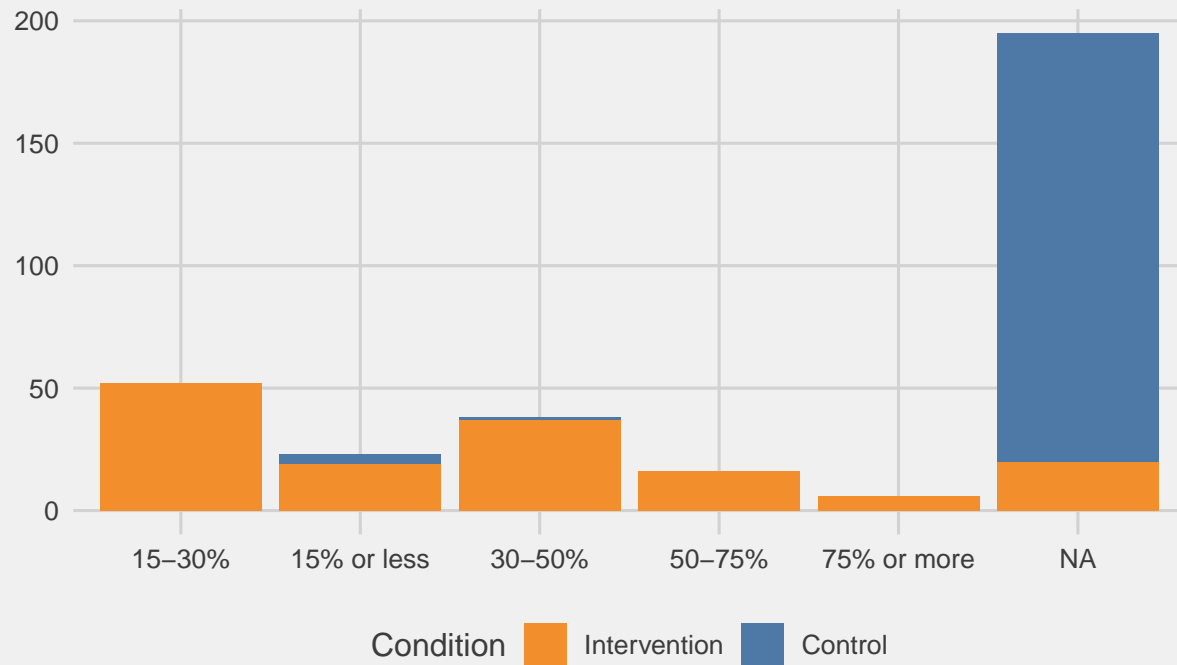
	X-squared	df	p-value
<b>X-squared</b>	234.729	1	0.000 ***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

## 2.7 Effects of Intervention on Hours/Days of Operation



## Percentage of hours reduced between Oct 1 and Dec 31



## Reduction of operating days between Oct 1 and Dec 31

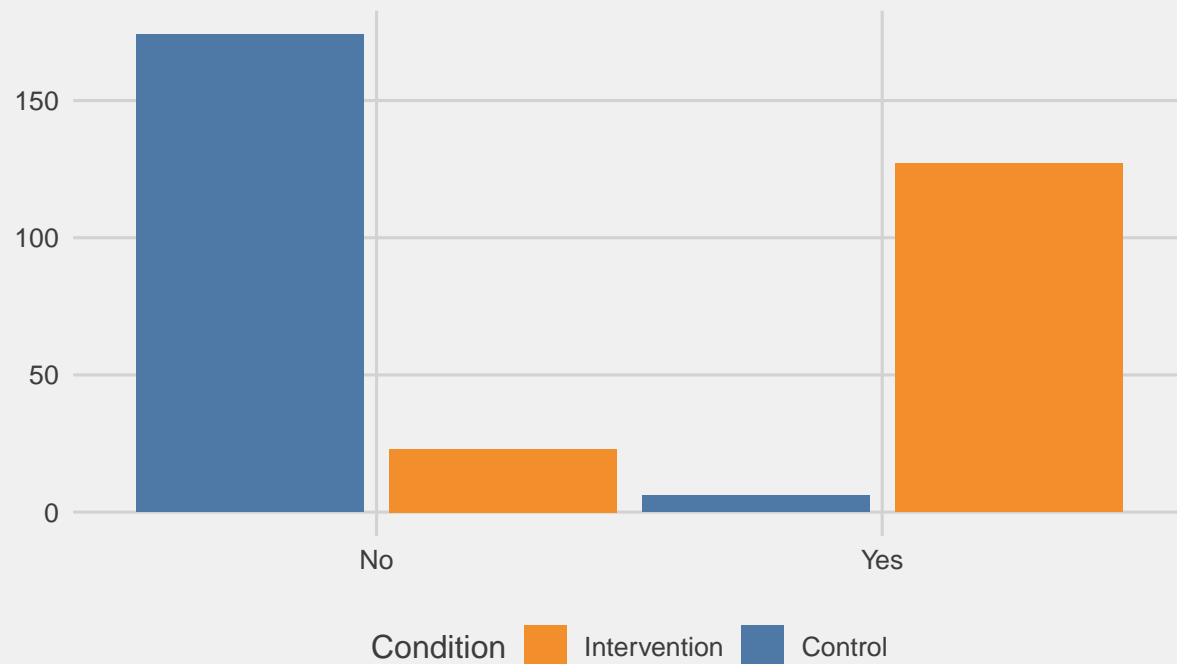
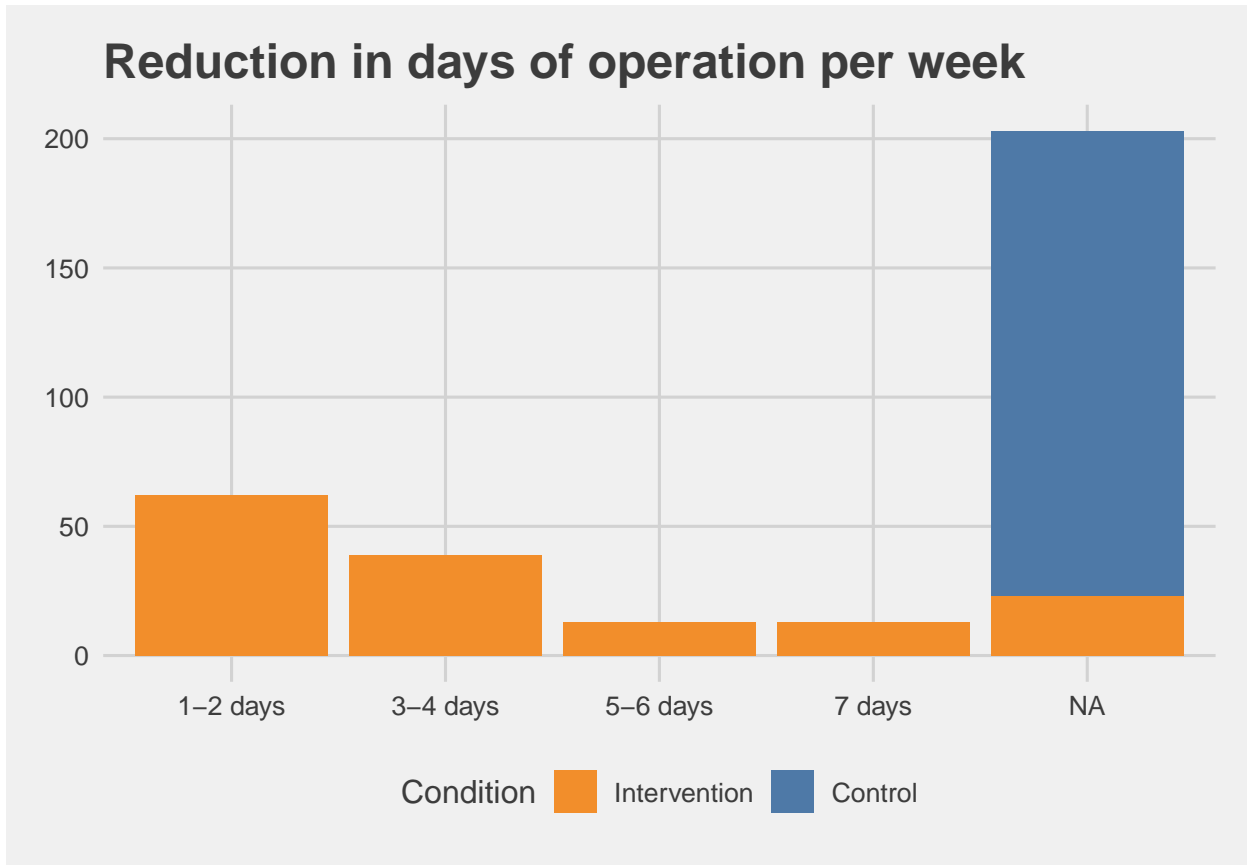


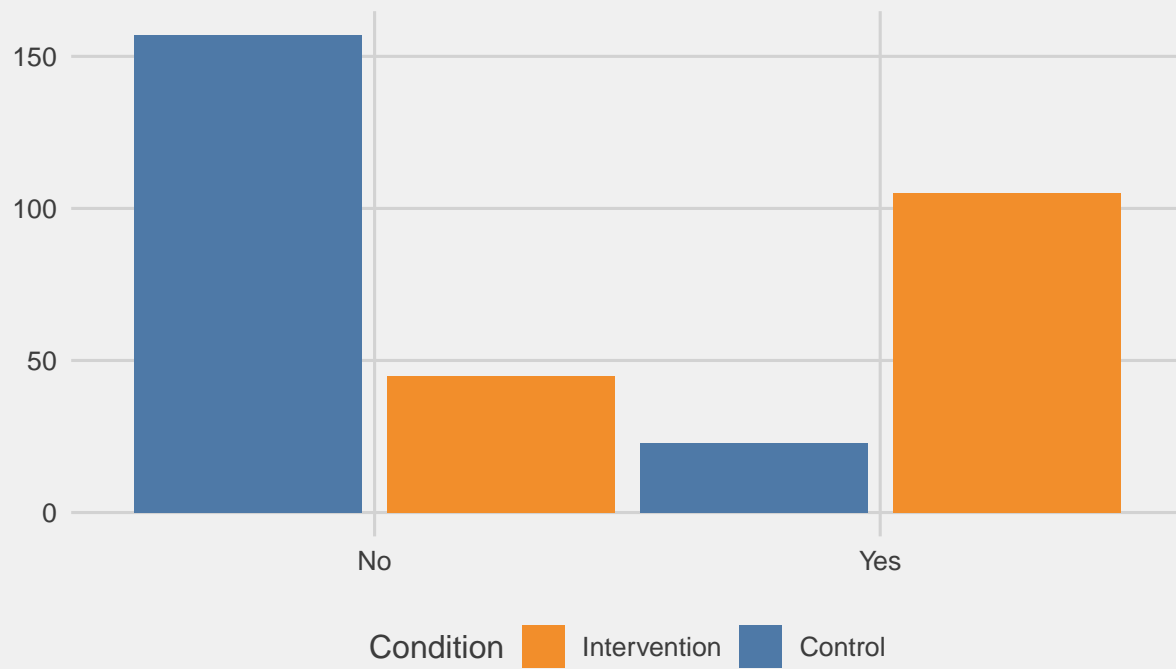
Table 6: Pearson's Chi-squared Test for Q14

	X-squared	df	p-value
<b>X-squared</b>	221.588	1	0.000 ***

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$



## Funding Applications between Oct 1 and Dec 31



## **3 Discussion**

### **3.1 Overview of Findings**

### **3.2 Limitations and Future Directions**



# Appendix

## 3.3 Survey

### Effects of COVID-19 Indoor Dining Shutdowns on Restaurants

This survey is part of a study conducted by Petit Poll on behalf of the Ontario Government to examine the effects of shutting down indoor dining services on restaurants.

You will be asked a number of questions about your restaurant's demographic characteristics, as well as changes in revenue, employee count, menu prices, and operational hours during the study period which took place between October 1st 2020 and December 31st 2020. There are 16 questions in total, and the survey should not take more than 15 minutes to complete.

By proceeding to complete this survey, you understand your de-identified responses will be recorded and analyzed by Petit Poll and shared with the Ontario Government. No personally identifying information will be collected aside from general questions about your restaurant's characteristics. Your participation is entirely voluntary, meaning you may skip any questions you do not wish to answer, or leave the survey entirely at any point in time. The results from this survey will be compiled in a final report and shared with the Ontario government, and may also be shared publicly. However, we will only be reporting group-based responses, not individual responses from any specific restaurants.

If you have any questions or concerns about this survey, or are interested in receiving a copy of the results in the future, please don't hesitate to e-mail us at: [restaurant.study@petitpoll.ca](mailto:restaurant.study@petitpoll.ca)

1. What region is your restaurant located in?

☐ Downtown Toronto

☐ North York

☐ Scarborough

☐ West Toronto

☐ Etobicoke

☐ York

☐ Central Toronto

☐ East Toronto

☐ East York

☐ Other

2. How would you best describe the scale of your restaurant? (in terms of space and seating capacity)

☐ Small

☐ Medium

☐ Large

3. What best describes your restaurant segmentation?

☐ Fast-food/quick service

☐ Casual Dining

☐ Fine Dining

☐ Other

4. How many years has your restaurant been in operation?

☐ 3 years or less

☐ 4-6 years

☐ 7-10 years

☐ More than 10 years

5. Prior to October 1st 2020, how many people did you employ at your restaurant?

Your answer \_\_\_\_\_

6. How many people do you currently employ at your restaurant?

Your answer \_\_\_\_\_

7. Between October 1st and December 31st of 2020, was your total sales revenue higher, lower, or about the same as it was during the previous quarter (July 1st to September 30th 2020)?

☐ Higher

☐ Lower

☐ Around the Same

8. If your restaurant experienced a decrease in revenue compared to last quarter, what was the approximate percentage decrease?

☐ Decline of 50% or more

☐ Decline of 25% to 50%

☐ Decline of 10% to 25%

☐ Decline of 10% or less

Figure 4: Screenshot of Google Forms Survey Questions 1-8

9. Before October 1st 2020, approximately how much of your total monthly sales revenue came from takeout or delivery?

☐ Did not offer takeout or delivery

☐ 15% or less

☐ 15-30%

☐ 30-50%

☐ 50-75%

☐ 75% or more

10. Between October 1st and December 31st of 2020, which food courier service did you receive the most orders from?

☐ UberEats

☐ SkiptheDishes

☐ DoorDash

☐ Other Food Courier Service

☐ In-house delivery service

☐ None

11. Between October 1st and December 31st of 2020, did you make any adjustments to your menu prices?

☐ Yes, prices were raised

☐ Yes, prices were lowered

☐ No changes were made

12. Between October 1st and December 31st of 2020, did you reduce your restaurant's hours of operation?

☐ Yes

☐ No

13. If you reduced your restaurant's hours of operation, approximately how many hours per week did you reduce by?

☐ 15% or less

☐ 15-30%

☐ 30-50%

☐ 50-75%

☐ 75% or more

14. Between October 1st and December 31st of 2020, did you reduce the number of days your restaurant was open to the public?

☐ Yes

☐ No

15. If you reduced the number of days your restaurant was open, how many days per week did you reduce by?

☐ 1-2 days

☐ 3-4 days

☐ 5-6 days

☐ 7 days

☐ Not Applicable

16. Have you applied for and received any external funding or grants for your restaurant since October 1st, 2020?

☐ Yes

☐ No

Submit

## Effects of COVID-19 Indoor Dining Shutdowns on Restaurants

Thank you for taking the time to complete the survey. Please e-mail us at [restaurant.study@petitpoll.ca](mailto:restaurant.study@petitpoll.ca) if you have any further questions.

Figure 5: Screenshot of Google Forms Survey Questions 9-16

## 3.4 Funding Acknowledgement

We would like to thank the Ontario Government for generously providing Petit Poll with \$240,000 CAD in funding to carry out this study. The funding was used to provide compensation to restaurants for participating in the intervention. A sample size of 200 for the intervention condition was selected based on this amount, in which each restaurant who participated in the intervention received \$1200. A total of 150 restaurants participated in the intervention and received payment, making the total amount of funding spent during the study \$180,000 CAD

## 3.5 Packages

The subsection lists the R packages used in the making of this report.

### 3.5.1 General data cleaning and analysis

- `tidyverse` (Wickham et al. 2019)
- `dplyr` (Wickham et al. 2021)
- `janitor` (Firke 2021)
- `purrr` (Henry and Wickham 2020)
- `broom` (Robinson, Hayes, and Couch 2020)

### 3.5.2 Figures

- `ggplot2` (Wickham 2016)
- `ggthemes` - Themes and colour palettes used in Figure 2 onwards (Arnold 2021)
- `LaCroixColor` - Colour palette used for Figure 1 (Bjork 2021)

### 3.5.3 Tables

- `kableExtra` (Zhu 2020)

### 3.5.4 RMarkdown Report

- `knitr` (Xie 2021a)
- `bookdown` (Xie 2020)
- `tinytex` (Xie 2021b)

### 3.5.5 Other

- `opendatatoronto` (Gelfand 2020)
- We attempted to use this package to obtain the business licensing dataset used for sampling, however due to an unknown error on the publisher's end, we were unable to access it via the package.

## References

- Arnold, Jeffrey B. 2021. *Ggthemes: Extra Themes, Scales and Geoms for 'Ggplot2'*. <https://CRAN.R-project.org/package=ggthemes>.
- Bjork, Johannes. 2021. *LaCroixColor: LaCroix Water Color Palettes*.
- Canada Post. 2014. *Listing of Forward Sortation Area Codes (Fsa)*. [https://www.canadapost.ca/cpo/mc/assets/pdf/business/nps/machineable\\_presort\\_fsalist\\_february2014.pdf](https://www.canadapost.ca/cpo/mc/assets/pdf/business/nps/machineable_presort_fsalist_february2014.pdf).
- City of Toronto. 2021. *Toronto Open Data Portal*. Toronto, Canada. <https://open.toronto.ca/dataset/municipal-licensing-and-standards-business-licences-and-permits/>.
- Firke, Sam. 2021. *Janitor: Simple Tools for Examining and Cleaning Dirty Data*. <https://CRAN.R-project.org/package=janitor>.
- Gelfand, Sharla. 2020. *Opendatatoronto: Access the City of Toronto Open Data Portal*. <https://CRAN.R-project.org/package=opendatatoronto>.
- Gertler, Paul J, Sebastian Martinez, Patrick Premand, Laura B Rawlings, and Christel MJ Vermeersch. 2016. *Impact Evaluation in Practice*. The World Bank.
- Henry, Lionel, and Hadley Wickham. 2020. *Purrr: Functional Programming Tools*. <https://CRAN.R-project.org/package=purrr>.
- R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- Restaurants Canada. 2021. *COVID-19 Having Devastating Impact on Restaurant Operators*. Ontario, Canada: Restaurants Canada. <https://www.restaurantscanada.org/resources/covid-19-having-devastating-impact-on-restaurant-operators/>.
- Robinson, David, Alex Hayes, and Simon Couch. 2020. *Broom: Convert Statistical Objects into Tidy Tibbles*. <https://CRAN.R-project.org/package=broom>.
- Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.
- Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Golemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. <https://doi.org/10.21105/joss.01686>.
- Wickham, Hadley, Romain François, Lionel Henry, and Kirill Müller. 2021. *Dplyr: A Grammar of Data Manipulation*. <https://CRAN.R-project.org/package=dplyr>.
- Xie, Yihui. 2020. *Bookdown: Authoring Books and Technical Documents with R Markdown*. <https://github.com/rstudio/bookdown>.
- . 2021a. *Knitr: A General-Purpose Package for Dynamic Report Generation in R*. <https://yihui.org/knitr/>.
- . 2021b. *Tinytex: Helper Functions to Install and Maintain Tex Live, and Compile Latex Documents*. <https://github.com/yihui/tinytex>.
- Zhu, Hao. 2020. *KableExtra: Construct Complex Table with 'Kable' and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>.