Delivering Disease: Assessing the Potential for Time/Temperature Abuse in Online Food Delivery Services

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Abstract

Background and Purpose: Online food delivery services are third party entities that deliver foods from restaurants to consumers. These services are exploding in popularity around the world. The lack of regulation in this industry creates a scenario for time temperature abuse to occur. This study specifically investigates the efficacy of thermally insulated delivery bags used ubiquitously by these online food services.

Methods: 30 samples of Janes Pub-Style Chicken Nuggets were cooked for 30 minutes to an internal temperature of 74°C. The nuggets were then inserted with a SmartButton temperature data logger. The nuggets were then placed into a High-Density Polyethylene take-out container. The whole set-up was then placed into a Winco Thermally Insulated Delivery Bag for a one hour period. Time and temperature of the chicken nuggets was recorded over a one hour period to reflect realistic delivery times.

Results: A correlation/regression analysis was performed which showed that as the time increased so too did the temperature. Correlational coefficient, $r = -0.9363$, coefficient of determination, $r^2 = 0.8766$, ($p = 0.000$). The equation of the line was Temperature = (67.9996) + [(-0.6828) × Time]. Temperature of the chicken nuggets fell below 60°C after 12 minutes in the delivery bag. The median temperature of chicken nuggets after a one hour period was 44.5°C. This was found to be statistically different from the standard of 60°C with a p-value of 0.0000

Conclusion: The median temperature of chicken nuggets after the one hour sampling period did not reach the food safety standard of 60°C. Foods kept at a temperature below 60°C and above 4°C are considered in the temperature danger zone. In this range, pathogenic bacteria grow at their optimal rate. Therefore, it was determined that thermally insulated bags were unable to maintain foods at temperatures hot enough to be considered safe.

Key Words: Online, Food Delivery, Skip the Dishes, Chicken Nuggets, Winco

Introduction

Foodborne illness has an enormous impact on Canadian society. Approximately one in eight Canadians are affected by food borne illness every year, totalling almost four million Canadians (Canada, 2015). Ten leading factors associated with foodborne illness have been identified as: improper cooling, advance preparation, food handling by infected persons, inadequate reheating for hot-holding, contaminated raw food or ingredient(s), unsafe food source(s), use of leftovers, cross-contamination and inadequate cooking (Bryan, 1988). However, one important potential source that could lead to illness is missing from the list: food delivery services, in particular, the recent explosion of online delivery services, which has increased even more during the 2020 Covid-19 pandemic. Current research fails to address the possibility for one of these leading causes of food borne illness to be exacerbated by the delivery service. This research project explored time-temperature abuse during the delivery process. Changes in temperature over time for frozen breaded chicken products was measured. The author of this research project wondered if foodborne outbreaks previously attributed to mishandling at the restaurant level could be instead caused by mishandling during delivery.

Contamination

Bacteria may naturally occur in foods or be introduced during the preparation process. If consumed immediately the risk is minimal. However, given enough time in the temperature danger zone bacteria may multiply in food to a point that is risky to consume (Thiel, 1999). As transit time increases, the potential for time- temperature abuse increases. The literature also fails to explore the possibility of new contamination during the delivery process. Online food service couriers are untrained workers and may introduce contamination unintentionally. Using legislation, Environmental Health Officers (EHO) conduct inspections of restaurants to eliminate the potential for mishandling to occur. However, food delivery services are unregulated in Canada, thus do not receive inspection from an EHO. Untrained delivery drivers may be unaware of the dangers associated with the foods they are delivering.

Salmonella

The research project examined frozen breaded chicken products. They pose a high risk due to their potential for contamination by the bacteria *salmonella spp.* *Salmonella*

spp. ranks high in the list of pathogens causing illness and death in the United States and Canada (Canada, 2015). Across Canada, outbreaks of *salmonella* have been attributed to frozen chicken products, such as pub style chicken nuggets. Several recalls have been issued by the Canadian Food Inspection Agency (CFIA) due to *salmonella* contamination, most recently coming in May of 2019 (Public Health Agency of Canada, 2019). Characterization studies of bacterium species *salmonella spp.* found the bacteria grow in a range of 5-45 °C with an optimum growth temperature between 35-37°C (Tajkarimi, 2007). Other models of *salmonella* growth factor the range to be between 7-50°C (Yabo Peng, Xiaoting Li, Ting Fang, et al., 2019). Thus, all thermal packaging used by online food delivery services must be able to maintain cooked chicken products above 50°C in order to inhibit Salmonella growth. However, studies conducted on similar thermal retention devices have found they are characteristically unable to maintain temperatures over time (Wang 2015) (Wu 2014). There is a need to examine the ability of thermal packaging used by online food services to maintain adequate food safety temperatures.

Online Food Services

Online food delivery services can entail a wide range of services; however, for the purposes of this study the focus was on services in which a customer can order food from a restaurant to be delivered by a party independent of the restaurant. Becoming an independent courier for one such service, *Skip the Dishes,* requires no formal training in Food Safety, despite their involvement in the food handling process. Currently, in BC there are no regulations directed towards 3rd party food delivery systems. This means there is no supervision or inspection by an EHO. Currently, the onus is on food premises to ensure their food is being handled safely according to the Food Premise Regulation under the Public Health Act (Public Health Act [SBC 2008]). However, once the food leaves the restaurant, restaurants have no control over what happens to it. Legislative requirements for online food delivery service workers may reduce the potential for mishandling. Customers using online food delivery services may not understand the risks associated with the service.

Surveys have been conducted on the attitudes of customer towards online food delivery systems. A survey by Hong Qin and Victor R. Prybutok in 2009 questioned participants about their perceived value,

service, and attitudes towards food quality (2009). Similarly, Sharma and Waheed surveyed college students regarding the amount of money they spend, their satisfaction with food delivery apps and what type of food they order (2018). Both studies focused on consumer habits and fail to investigate consumer's perception of food safety. However, a focus group conducted in West Texas surveyed consumers about desired features in take-out containers and their perceptions regarding food safety practices (Boyce, J., Broz, C. C., & Binkley, M., 2008). They found that most consumers placed more emphasis on time or convenience. When asked about food safety most respondents knew the food needed to be hot but admitted they were less knowledgeable about food safety than they would like (2008). Currently, the majority of the literature and surveys are focused on the type of food products consumed and the perceived levels of satisfaction by the consumer. More research is required to investigate customer's perception and knowledge of food safety of online food services.

Thermal Packaging

Independent couriers for *Skip the Dishes* are required to purchase an insulated thermal bag during the application process. These bags are designed to retain heat, theoretically maintaining foods inside at temperatures that inhibit pathogen growth. However, there are two unaddressed problems with this system. First, there is no way to ensure that drivers are using these thermal bags. Since there is no legislation or legal requirements, there is no authority to ensure that drivers are using these bags. Second, there is a gap in the literature on whether these bags are effective at retaining enough heat to maintain proper temperatures.

Skip the Dishes recommends that drivers purchase the *Winco* 22"x22"x13" insulated delivery bag. The outer shell is made of polyester while the insulation is composed of expanded polyethylene (EPE). *Winco* claims their products are able to retain items at 75°C (165°F) for two hours and 55°C (131°F) for four hours.

Past Environmental Health student projects investigated the ability to maintain adequate food safety temperatures of other thermal retaining products. Wu (2015) investigated the ability of Thermos containers to maintain milk at a temperature of 4°C or less at coffee shops. Milk is a potentially hazardous food that must be maintained below 4°C; however, she found that after four hours all milk samples entered the

danger zone ≥ 4°C. This demonstrates the inability for potentially hazardous dairy products to stored at adequate temperatures in Thermoses. Specifically looking at soft thermal containers similar to ones used by online service delivery personnel, Wong (2014) investigated a different thermal packaging, fitness lunch bags, to see if they could maintain cooked chicken products below 4°C for 8 hours. The author found after one hour, all samples were above 4°C and ultimately fitness lunch bags were unable to keep cold foods out of the danger zone. A concern with this study is that fitness lunch bags are primarily for private use, thus the public health significance is low. In the above studies it is clear that various thermal packaging techniques are unable to maintain adequate safe food handling temperatures, yet similar packaging is still being used for online food service delivery workers. A study conducted by Wang (2015) directly tested the ability for take-out containers to maintain temperatures of hot foods. The authors tested broth from take-out Vietnamese food to see if the polypropylene take-out soup containers were able to maintain the broth above 70°C, as required to pasteurize raw beef products in the soup. However, they found after approximately 30 minutes of transit time the mean temperature had dropped almost ten degrees. Take-out containers were unable to maintain the broth at temperatures necessary for food safety. This study did not utilize additional thermal packaging to assist the take-out containers. It is possible that with additional thermal packaging the soup would be able to maintain temperatures adequate for food safety. Thus, additional research is required. The research project combined aspects from past student project by testing the ability for thermal packaging to retain heat.

Independent couriers at Skip the Dishes and other online food services are not obligated to use a car as the primary method of delivery. During the application process they are given the option to use a bike or deliver on foot. In this case, insulated thermal bags would be subjected to outside temperatures. It is unknown in the literature if a cold winter's day would have a negative impact on the ability for a thermal bag to maintain adequate hot temperatures. Conversely, it is unknown if a hot summer's day would impact the ability for an insulated thermal bag to maintain adequate cold temperatures. In this research project, the author maintained the thermal bags at room temperature. This mimicked the conditions of a courier in their vehicle.

Purpose of the Study

The purpose of this research project was to determine if thermal packaging used by online food delivery services was able to maintain potentially hazardous foods at temperatures adequate to ensure food safety. The results of this study may influence the creation of guidelines for online food delivery services.

Methods and Materials

The researcher placed Janes® Pub Style Chicken Nuggets into a microwave to soften the nuggets. Once softened, an incision was made into the nuggets for future placement of the Smart Button. Chicken nuggets were then placed onto a baking sheet and cooked in the oven at 425°F for 30 minutes. After the 30 minute period, the Smart Button was inserted into the nuggets and placed into a High-Density Polyethylene (HDPE) take-out container. The entire set-up was then placed into a Winco insulated delivery bag for at least one hour (Figure 1).

Figure 1: Winco thermally insulated delivery bag

After the temperature recording period, the delivery bag was opened and the Smart Button® was removed for data collection. The Smart Button® Thermometer is factory calibrated to an accuracy of ±1.0°C from -30°C to 45°C (± 1.8°F from -22°F to 113°F) (ACR Systems Inc., 2017).

Results

The temperature of the pub style chicken nuggets in the takeout containers was logged against time in each trial. The null and alternative hypothesis are as follows:

Hypothesis 1: Correlation

Null Hypothesis: slope =0

There is no correlation between time and temperature of cooked chicken nuggets placed in a HDPE take out container and stored in an insulated thermal bag for 60 minutes

Alternative Hypothesis: slope ≠ 0

There is a correlation between time and temperature of cooked chicken nuggets placed in a HDPE take out container and stored in an insulated thermal bag for 60 minutes

Hypothesis 2: One-Sided T-Test

Null Hypothesis: The mean temperature of chicken nuggets over a one hour collection period will be > 60°C

Alternative Hypothesis: The mean temperature of chicken nuggets over a one hour collection period will be < 60°C

The first null hypothesis of this experiment suggests that there is no correlation in mean chicken nugget temperature as the holding time increases from 0-60mins. Whereas, the alternative hypothesis suggests that the there is a correlation in mean chicken nugget temperature as the holding time increases from 0-60mins, i.e. the slope is not 0. The alternative hypothesis suggests the more time the food spends in the delivery bag, the more the temperature will decrease. Thus, at some point, it may decrease sufficiently to enter the danger zone. In contrast, if the null hypothesis is true then the length of transit time for delivery drivers is not a limiting factor influencing food safety. The second null hypothesis of the experiment is that the mean temperature of chicken nuggets over a one hour period will be greater than or equal to 60°C, i.e. out of the upper limit of the danger zone. On the other hand, the alternative hypothesis is that the mean temperature will be less than 60°C, or in the danger zone, over a one hour period. If the alternative hypothesis is accepted, then it is possible the delivery bags are insufficient in maintaining chicken nugget temperature at a food safety standard over a one hour period.

This study collected continuous numerical interval data as temperature is on a continuum (Heacock, H., Chen, D. 2019). The recorded temperature of 30 chicken nuggets samples was analyzed for correlation and regression. The obtained mean temperatures from 30 trials of cooking and holding chicken nuggets were analyzed for statistical significance.

Collected Data

Table 1(See Appendix) illustrates the change in temperature of chicken nuggets in a thermally insulated delivery bag over time. Descriptive statistics was generated using data from table one.

Descriptive Statistics

NCSS (NCSS 2019 Statistical Software, 2019) was used to generate descriptive statistics for the 390 counts of data collected

Mean	47.51666667
Standard Error	0.691710294
Median	44.5
Mode	38.5
Standard Deviation	13.66018379
Sample Variance	186.6006213
Kurtosis	-0.657512574
Skewness	0.58035545
Range	55.5
Minimum	24.5
Maximum	80
Sum	18531.5
Count	390
Confidence Level(95.0%)	1.359958512

Table 2: Descriptive Statistics for Correlation Analysis.

during the 30 trials used in the correlation and regression analysis (See Table 2). The *R*-value was -0.9363 and the R-squared value was 0.8766. \

Microsoft Excel (Microsoft Corporation, 2019) was used to generate descriptive statistics for the 390 counts of data points collected during the 30 trials (See Table 3). The descriptive statistics illustrate the mean temperature to be 47.5°C with a standard deviation of 13.6°C. The median temperature was 44.5°C, while the mode was 38.5°C.

Parameter	Value	Parameter	Value
Dependent Variable	C2	Rows Processed	390
Independent Variable	C1	Rows Used in Estimation	390
Frequency Variable	None	Rows with X Missing	0
Weight Variable	None	Rows with Freq Missing	0
Intercept	67.9996	Rows Prediction Only	0
Slope	-0.6828	Sum of Frequencies	390
R-Squared	0.8766	Sum of Weights	390.0000
Correlation	-0.9363	Coefficient of Variation	0.1011
Mean Square Error	23.08144	Square Root of MSE	4.804315

Table 3: Descriptive Statistics for T-Test Analysis

Inferential Statistics

In this research project, two hypotheses were tested, both utilizing the analytic software NCSS. The temperature change of chicken nuggets was collected over one hour at five minute intervals (0min, 5min, 10min, etc.). Linear correlation and regression were performed to determine the correlation between time and temperature for hypothesis one. The temperatures were then used to determine when and for how long the chicken nuggets reached the "danger zone" (4-60°C). In addition, a one-sample T-test was performed to determine if the mean temperature of chicken nuggets in an insulated delivery bag remains above 60°C. If the average temperature remains above 60°C, then we can conclude that the bags are working as intended and the food is at less risk.

Research Findings- Correlation Analysis

The research project found a negative linear correlation between time and mean chicken nugget temperature. As the holding time in the delivery bag increased, the mean temperature decreased. The change in temperature can be predicted by the change in time with the use of the slope and intercept, the equation of the line was

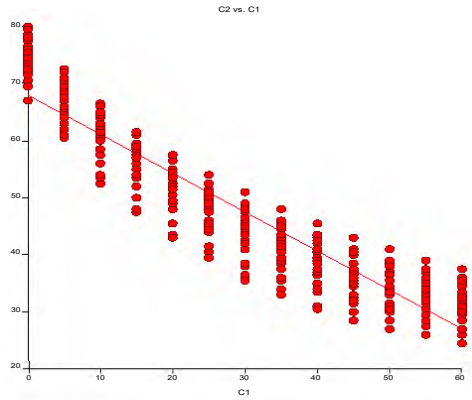

Figure 3: The relationship between Time and Temperature (°C) of chicken nuggets in an insulated delivery bag.

estimated to be: Temperature = (67.9996) + [(-0.6828) ×Time] (See Figure 3).

This regression equation is useful to make predictions based on the data collected in our sample. After approximately 12 minutes the chicken nuggets entered the temperature danger zone of 60°C-4°C. After 12 minutes, the nuggets remained in the danger zone for the entire duration of data collection. The nuggets were placed into the bag for one hour because, on average, *Skip the Dishes* limits their delivery time to 60-70 minutes (2020, retrieved from https://www.skipthedishes.com/langley-city/restaurants). An R-Value of -0.93 suggests a very good to excellent strength of relationship between time and temperature (Heacock, H., Chen, D. 2019). The R^2 value measured in this study was 0.86. This measures the proportion of the dependent variable (Temperature) that is attributed to the independent variable (Time) (Heacock, H., Chen, D. 2019). Therefore, we can conclude that time spent in the delivery bag has a great effect on the temperature of the chicken nuggets. The p-value was 0.0000, therefore we can reject the hypothesis that the slope is 0 and conclude there is statistically significant correlation between time and temperature. On average, foods entered the bacterial growth danger zone at approximately 12 minutes. As a result, online food delivery services drivers should limit their transit time to below this mark or utilize bags with greater insulation capabilities. The author determined the Winco insulated delivery bag was not able to retain products at 74°C for one hour despite the claim made on their website ("Insulated Delivery Bag", 2018). Once the correlation relationship was established, the researcher then investigated if the mean temperature of the chicken nuggets was different from the food safety standard of 60°C.

Research Findings- One-Sample T-Test

A one-sample T-test was performed on the mean final temperatures of chicken nuggets placed in delivery bags. The T-Test analyzed whether the food was held above 60°C. This temperature (60°C) was chosen because it is the temperature required by legislation that

Wilcoxon Signed-Rank Test

Sum of Ranks (W)	Mean of W	Std Dev of W	Number of Zeros	Number Sets of Ties	Multiplicity Factor
8386	38122	2227.508	1	63	23280

Test Type	Alternative Hypothesis	Z-Value	Prob Level	Reject H0 at α = 0.050?
Exact*	Median ≠ 60			
Exact*	Median < 60			
Exact*	Median > 60			
Normal Approximation	Median ≠ 60	13.3494	0.00000	Yes
Normal Approximation	Median < 60	-13.3494	0.00000	Yes
Normal Approximation	Median > 60	-13.3494	1.00000	No
Normal Approx. with C.C.	Median ≠ 60	13.3492	0.00000	Yes
Normal Approx. with C.C.	Median < 60	-13.3492	0.00000	Yes
Normal Approx. with C.C.	Median > 60	-13.3497	1.00000	No

* The Exact Test is provided only when there are no ties

Tests of Assumptions

Assumption	Value	Prob Level	Decision (α = 0.050)
Shapiro-Wilk Normality	0.9446	0.000000	Reject normality
Skewness Normality	4.4347	0.000009	Reject normality
Kurtosis Normality	-3.9492	0.000078	Reject normality
Omnibus Normality	35.2628	0.000000	Reject normality

Figure 4: NCSS print-out of the One-Sample T-Test

hot foods must be held above to ensure they remain fit for consumption by public (Public Health Act, 2008). The Wilcoxon Signed-Rank T-test indicated that the median temperatures were less than 60°C with a probability level of 0.00. Therefore, the null hypothesis that the mean temperature of chicken nuggets will be greater to or equal to 60°C was rejected. Therefore, the mean temperature of chicken nuggets is significantly less than the standard of 60°C, the temperature necessary for safe hot-holding.

Discussion

Online food delivery has exploded in popularity and is the convenient choice in a busy world where many do not have time to cook. This new service raises concerns due to the lack of training of the delivery driver and the potential for time-temperature abuse to occur. The potential for time-temperature abuse arises with the effectiveness of the Winco Insulated Delivery Bag, the recommended choice for one online food delivery service, Skip the Dishes. Winco claims their bags are able to retain items at 75°C (165°F) for two hours and 55°C (131°F) for four hours. This study investigated this claim as well as the relationship between time spent in the delivery bag and temperature of food item. The researcher found a strong degree of correlation between time and temperature, R= -.93. It was also determined that after 12 minutes the temperature dropped below 60°C, the legislated threshold for food safety and far below the claim of 75°C.

Food safety experts endorse the 2hr/4hr rule which outlines how long a potentially hazardous food (chicken nuggets) can be left at temperatures in the danger zone 4°C-60°C (2hr/4hr Rule, 2019). Foods may be kept in the danger zone for less than two hours before they must be refrigerated. This is based on the logarithmic nature of bacterial growth. In less than two hours, it is assumed that bacterial populations will not grow to levels considered dangerous for infection. Since the majority of deliveries are under one hour, this need not apply to online food services. However, an issue arises with vulnerable populations such as the very young, very old, pregnant, or immunocompromised who may be susceptible to a much lower bacterial infectious dose (Lund B.M, 2015). In some cases, it has been recorded that *salmonella spp.* may achieve infection with as little as 10cfu/g (Greig et al, 2010). For these populations, more consumer information is required for them to make an informed

decision about the risk of the service they are using. The government of Australia has employed guidelines for consumers so that both vulnerable populations and the general public are more informed on how to reduce the risk associated with take-out foods. In these guidelines, it is suggested that consumers always re-heat food to above 75°C as soon as possible, to kill any bacteria that may be present (Government of Western Australia, 2015). According to the results of this research project, similar guidelines would be beneficial in Canada as well. For the general public, there is still an inherent risk to using these services if the bags are incapable of maintaining food temperatures above 60°C. In order to combat this, transit times should be held to under 12 minutes either by the service itself or legislative requirements. Alternatively, carriers used to transit food products can be made more efficient. This can be done using alternate products such as the Rubbermaid PROSERVE® top load insulated carrier or the HUBERT® black nylon insulated takeout delivery bag. Other methods can be employed such as adding heating packs to the insulated bags or utilizing delivery bags with built in heaters. One such bag was invented in 1989 by John Schirico, after he saw the growth of the pizza delivery industry. Despite the revolutionary idea, the idea never proliferated in the industry. However, it would make a brilliant solution to the problems we know face. Ultimately take-out foods present a food safety risk, and the increase in accessibility to these foods by online food delivery services is proliferating this risk without the proper legislated safeguards in place.

Research into the efficacy of temperature retention during food delivery is limited. However, the results from this study are consistent with other environmental health student projects. As mentioned in the literature review, other student projects tested the efficacy of a variety of temperature retention devices such as Thermos', Fitness Lunch Bags and polypropylene take-out containers holding Vietnamese soup broths. In all cases they found the temperature change over time to be unsatisfactory for food safety (Wu, 2015) (Wong, 2014) (Wang, 2015) (Chu 2013).

Limitations

The research project conducted by the researcher is a term project done for an Environmental Health class at BCIT, thus it faces some inherent limitations. The study was limited by the limited amount of resources, i.e. time and money. Since, there

was a limited time frame for data collection, only 30 samples were collected and analysed. With more time, different food samples could have been investigated. Having an increased variety of food samples would increase the external validity and generalizability of the results. Due to the resource limitation, the equipment used in the study were limited. Future research could utilize ovens with standardized temperatures and thermometers that are more accurate. An oven with standardized and exact temperatures would help to better narrow down the exact time at which temperatures dip below food safety standards (<60°C). More accurate instrumentation would increase the internal validity of the study.

Knowledge Translation

The results from this study indicate there is a risk to online food service. However, this risk is not addressed in any form, there are no legislative requirements placed on online food delivery services and no guidance documents to inform the public. As discussed in the literature review, often consumers are self-admittedly unaware about the food safety risks of online food services (Boyce, J., Broz, C. C., & Binkley, M., 2008). The results from this study can be used to gap this lack of risk communication and inform consumers about the risks associated with online food delivery services. The National Collaborating Center of Environmental Health (NCCEH) creates guidance documents for a variety of topics including food safety. The results from this study may influence a guidance document about the microbial risks associated with online food delivery services. The BCCDC also creates guidance documents for the general public and food service establishment operators. The preliminary research conducted in this study could be the foundation for future research done by the BCCDC which could support the creation of online documentation. Finally, this preliminary research may spark further research into the area of safety during food delivery. With more evidence, legislation may be created and imposed on services such as Skip the Dishes and their drivers. The imposition of legislation on online food delivery services would ensure that drivers are trained, educated and equipment is standardized across all services to ensure that the potential for time-temperature abuse is minimized. In all cases, more future research must be done into the risks of online food delivery services.

Future Research

1. A time-temperature experiment using the same methodology but with another food type, for example beef or fish.
2. An experiment using the same methodology but with a second or third food item in the delivery bag. For example, the addition of a frozen or cold item in a separate take-out container but in the same Winco bag.
3. An experiment testing the microbial difference (microbial load) of the chicken nuggets after they have been incubated in the delivery bag for 1hour, 2 hours, 3 hours, etc. This would provide evidence that bacterial growth is occurring and the severity of this growth.

Conclusion

The results of the study show that Winco Insulated Delivery Bags are unable to maintain chicken nuggets at a temperature satisfactory for food safety (i.e. > 60°C) over a one hour period. Temperature is a limiting factor of bacterial growth, this study showed that there is a strong correlation between time and temperature as the chicken nuggets are stored in delivery bags. After 12 minutes in the delivery bag, the chicken nuggets fell into the temperature danger zone. This is where bacteria may multiply at their optimal growth rate, increasing the chance of infection, especially among vulnerable populations. This study highlights the need for change in the online food service industry. It emphasizes the need for innovation in the materials used to transport food as well as the industry's need for legislation. Online take out delivery will not diminish, as evidenced by the rapid proliferation of all delivery services during the current Covid-19 pandemic. By utilizing the recommendations in this paper, the risk to anyone who uses online food delivery services will be minimized.

Competing Interests

The author declares they have no competing interests.

Appendix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Time (min)																														
0	76	77.5	76.50	67.00	75.5	75	76	70.5	73	80	80	79.5	74	75	69.5	71.5	72.5	71.5	73.5	72	73	74.5	79.5	72.5	71.5	72.5	75.5	78.5	78	79.5
5	68.5	71	69.5	62.00	67	65	68	65	64	71	72.5	70.5	67	70.5	60.5	61	63	64.5	67	66	67	70	69.5	68.5	62	67.5	64	70.5	71	72
10	63	65	64	57.50	62	61	63	60.5	57.5	64	66.5	64	62.5	66	52.5	53.5	56	58.5	61	60.5	61.5	62	61.5	62.5	54	60	56	63	64.5	65
15	58	59.5	59	53.50	57.5	57	58.5	56	52	58	61	58.5	58.5	61.5	47.5	47.5	50	53.5	56	56	56	56	55	57	48	54	50	57	59	59
20	54	55	54	50.50	53.5	53.5	54.5	52.5	48	53.5	56.5	54	54.5	57.5	43.5	43	45.5	49	51.5	51.5	52	50.5	49.5	52	43	49.5	45.5	51.5	53.5	53.5
25	50	51.5	51	47.50	50.5	50.5	50.5	49	44	49.5	52.5	50	51	54	40.5	39.5	41.5	45	47.5	48	48.5	46	44.5	48	39.5	45.5	41.5	47.5	49	49
30	47.5	48	48	44.50	47.5	47.5	47.5	46	41	46	49	46.5	48	51	38	36.5	38.5	42	44	44.5	45	42.5	41	44.5	35.5	42	38.5	43.5	45.5	45
35	45	45.5	45	42.50	44.5	45	44.5	43	38.5	43	46	43.5	45	48	36	34	35.5	39	41	42.5	42	39.5	37.5	41	33	39.5	36	40.5	42	41.5
40	42.5	43	42.5	40.50	42.5	42.5	42	40.5	36.5	40.5	43.5	41	42.5	45.5	34	31	33.5	36.5	38.5	39.5	39.5	37	35	38.5	30.5	37	34	37.5	39	38.5
45	40.5	41	40.5	38.50	40.5	40.5	40	38.5	34.5	38.5	41	38.5	40.5	43	32.5	30	31.5	34.5	36.5	37	37.5	34.5	33	36	28.5	35	32	35.5	36.5	36
50	38.5	39	39	37.00	38.5	38.5	38	36.5	33	36.5	39	36.5	38	41	31.5	28.5	30	33	34.5	35.5	35.5	33	31	34	27	33.5	30.5	33.5	34.5	33.5
55	37	37.5	37	32.00	37	37	36	34.5	31.5	34.5	37	35	37.5	39	30.5	27.5	28.5	31.5	33	33.5	34	31.5	29.5	32	26	32	29.5	31.5	32.5	32
60	35.5	36	35.5	27	35	35.5	34.5	33	30.5	26	35.5	33.5	35.5	37.5	29.5	26	27	30	31.5	32	32.5	30	27	30.5	24.5	30.5	28.5	30	31	30

Table 1: Temperature of chicken nuggets over 5 minute intervals.

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