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Food Safety Risk of Food Trucks Compared with Restaurants

ABSTRACT

Food trucks have become popular among consumers. However, regulators across the United States have concerns about their safety. This paper compares the health inspection performance of mobile food vendors and restaurants within seven major cities in the United States—Boston, Las Vegas, Los Angeles, Louisville, Miami, Seattle, and Washington, D.C. Health inspection regimes vary, but within each city the same inspection criteria are used for both restaurants and mobile vendors (food trucks and carts). The study analyzes health inspection scores received by 34,396 food service establishments across all of these cities (194,687 total inspections) between 2008 and July 2013, with dates varying by city. By use of Poisson regression analysis, the number of violations or demerits is modeled as a function of establishment type and other explanatory variables. A separate model was run for each city. Additionally, in Boston, Miami, and Washington, D.C., the analysis was run using just the data on critical violations. Mobile food vendors averaged fewer violations than restaurants in Boston, Las Vegas, Los Angeles, Louisville, Miami, and Washington, D.C. ($P < 0.01$). In Seattle, mobile vendors and restaurants were equally likely to receive violations. The results suggest that food from mobile vendors is as safe as food from restaurants.

INTRODUCTION

Mobile food vendors are an increasingly popular fixture in urban centers across the United States. Typically operating from motorized food trucks or non-motorized carts, vendors serve everything from hot dogs and ice cream to pho and cupcakes. The rapid growth of the industry has given policy makers occasion to revisit food vending rules, which are now in flux in small towns and large cities across the country *(27)*.

Although the resulting rulemaking is no doubt motivated in part by a desire to protect public health and safety, many regulators and elected officials have imposed strict limitations on when and where vendors may operate, which may be designed to protect restaurants from competition rather than

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to protect the public from unsafe food *(40)*. In Los Angeles, Louisville, Seattle, and Washington, D.C., for instance, vendors are limited in where they may sell, setting off-limits a specific number of feet outside an open food business, entire neighborhoods, or all public property *(32)*. Mobile vendors in Las Vegas, Louisville, Miami, and other cities are required to be movable at all times and to move at least every half hour *(32)*.

In 2008, a "food truck war" erupted in Los Angeles after officials started enforcing parking regulations in response to anti-vendor pressure from restaurant owners *(17)*. The county even passed a law threatening jail time for food truck owners who did not move every half hour *(27)*. Ultimately, the courts struck down Los Angeles' regulations because they had nothing to do with public safety *(17)*, but similar fights over restrictive regulations are occurring all over the country, from Chicago and Atlanta to Cranston, R.I., and Akron, Ohio *(1, 34, 46)*.

Nonetheless, health authorities and the general public do have sincere concerns about sanitation aboard mobile food providers. For example, in 2013 the *Boston Globe* published an article stating that it is common for food trucks to receive health code violations that put consumers at risk for food poisoning *(24)*, and, in a television newscast on Louisville's WAVE3, the city's chief health inspector laughed at the idea of eating from a food truck, claiming, "We feel you can operate safer from an actual building" *(13)*.

Such assertions, often devoid of systematic evidence, contribute to (mis)beliefs about the potential risks of mobile food. A 2013 study found that consumers' risk and benefit perceptions toward street food were most heavily influenced by perceived health and safety risks, which determine their purchasing behavior *(5)*. After the Louisville news report, for instance, many potential customers demanded refunds for tickets they had purchased for an upcoming food truck rally *(18)*.

Restaurant food safety is regulated by state and local governments, which have their own retail food codes based on the U.S. Food and Drug Administration's (FDA) model food code *(29)*. Every locality has a unique standardized inspection form based on the FDA's 44-item scale *(22)* and the Centers for Disease Control and Prevention's five food risk factors—food from unsafe sources, inadequate cooking, improper holding temperatures, contaminated equipment, and poor personal hygiene *(42)*.

An understanding of the risks associated with mobile food is important to regulators' ability to protect public health and safety. However, little research has been conducted on the cleanliness of street food vendors in the United States. Two previous studies that looked at mobile food vendors in the United States used health department food safety violations as an indicator of the safety of food from an establishment. Researchers in the first study observed 10 mobile food vendors in New York City for 20 minutes each and found that each vendor violated the city code of health at least once during the observation; these violations included touching food with bare hands and "foods stored at inappropriate temperatures" *(3)*. This study did not compare vendors to other types of food establishments. The second study compared the inspection results of different types of Philadelphia establishments with and without a certified food handler (CFH), using a Generalized Estimation Equation-based approach. Mobile vendors averaged fewer critical violations and had a lower odds ratio of critical violations than the other establishment types. The author suggests that vendors perform better because they "are small and have only a handful of employees, making the CFH's job of conducting food safety easier compared to Take-Out and Eat-In establishments" *(25)*.

Numerous international studies on mobile food have been performed, but few have compared it with restaurants. The Street Food Project, a decade-long project analyzing street food internationally, conducted comprehensive studies of street food in seven provincial cities in Asia and Africa. Researchers observed food handling and sanitary conditions and sampled the food for pathogens. Results indicated that "food handling practices of vendors generally reflect prevailing local standards." Additionally, a comparison of the level of contamination of food from street vendors and restaurants found restaurants were no better than vendors *(41)*.

The objective of this study was to compare the inspection performance of mobile vendors and restaurants in seven U.S. cities, testing the hypothesis that mobile vendors are less sanitary, or more likely to violate health department standards of food safety and cleanliness, than brick-and-mortar restaurants.

MATERIALS AND METHODS

Inspection regimes

To examine whether there is a statistically significant difference between the food inspection outcomes (the number of reported food safety violations) of mobile food vendors and brick-and-mortar restaurants, this study used food inspection reports from seven cities—Boston, Las Vegas, Los Angeles, Louisville, Miami, Seattle, and Washington, D.C. These cities were chosen from the 50 largest U.S. cities because they had accessible data for restaurants and mobile vendors, the data were disaggregated by establishment type, and the same food safety standards (e.g., holding temperatures, food sources, etc.) are applied to mobile vendors and to brick-and-mortar restaurants. The reports were obtained from the following agencies: Boston Inspectional Services Department, Southern Nevada Health District, Los Angeles County Department of Public Health, Metro Health and Wellness Department of Louisville, Florida Department of Business and Professional Regulation, Seattle and King County Board of Health, and Washington, D.C. Department of Health.

In the cities studied, all food establishments, including mobile vendors, must pass the local regimes' health inspections. Moreover, each city in this study requires mobile

Table 1. Inspection Regimes for Mobile Food Vendors and Restaurants in Seven U.S. Cities

	Boston	Las Vegas	Los Angeles	Louisville	Miami	Seattle	Washington, D.C.
Freq. of yearly routine inspections	Risk-based[a] (max two times)	One time	Risk-based[a] (max four times)	Two times	Three times	Risk-based[a] (Max two times)	Risk-based[a]
Possible violations	88	34	71	38	55	50	54
Possible violations by category (demerit values for violations)[b]							
Foodborne[c]	33	10 (5)	17 (6)				
Critical[d]	9	13 (3)	18 (4)	36 (3–5)	43	27 (5–30)	27
Non-critical[e]	46	11 (1)	36 (1)	17 (1–2)	12	23 (2–5)	27

Sources: *6, 7, 8, 9, 10, 12, 14, 15, 30, 35, 39, 43, 44*

[a]Risk-based routine inspections are conducted as frequently as the department deems necessary based on the risk factors associated with the establishment.

[b]Depending on how violations are counted, each violation may be given a demerit, a value based on the public safety risk of the violation.

[c]Foodborne violations are likely to cause illness.

[d]Critical violations are serious problems that if not corrected could lead to illness.

[e]Non-critical violations relate to best practices but are not immediate threats.

vendors to operate out of a commissary, a shared kitchen, which must also pass inspection. Routine inspections are required at least once a year, unannounced. Several localities use a risk-based schedule, sending inspectors more frequently to establishments that handle raw ingredients than to those that only sell pre-packaged or limited-preparation foods *(Table 1)*.

Each locality's inspection regime has a unique list of violations, method for counting violations, and schedule for routine inspections. Therefore, inspection scores cannot be compared across cities. *Table 1* identifies the differences between the regimes with regard to (1) the frequency of routine inspections, (2) the number of possible violations during an inspection, (3) the number of violations in each category (critical foodborne, critical, and non-critical violations), and (4) the grade system used, which is either a total number of violations by violation category or a total number of demerits based on the violation risk level *(6, 7, 8, 9, 10, 12, 14, 15, 30, 35, 39, 43, 44)*. For example in Louisville, one critical violation may count as three, four, or five demerits.

Analysis of data set

The inspection timeframe varies depending on data availability and accounts for at least two years of inspections in each city *(Table 2)*. Inspection reports for these seven cities all included the establishment type, inspection score (either number of violations by type or total demerits), and date of the inspection. Establishment types are categorized as mobile vendors and restaurants. All other types, such as hotels and grocery stores, are excluded from this analysis. Mobile vendors consist of food trucks (motorized vehicles that sell from the road) and carts (non-motorized stands or carts that vend on sidewalks). Restaurants are brick-and-mortar establishments that serve food prepared on site. In Seattle and Washington, D.C., the health departments also provided the department designated risk rank for the food establishment.

In all, 194,687 inspection reports across all seven cities were reviewed—11,585 of mobile vendors and 183,102 of restaurants. The total number of food establishments inspected was 34,396—3,365 mobile vendors and 31,031 restaurants.

Poisson regression analysis

All analyses were conducted using Stata, release 12.1. Because sanitation scores are a count of the number of violations during an inspection and most inspections have few violations, the analysis is done using a Poisson regression *(45)*. The model used is:

$$\ln(Y) = a + \beta(\text{establishment type}) + \Theta(\text{day of week}) + X(\text{month}) + \Omega(\text{year}) + \Psi(\text{risk rank})$$

Table 2. Descriptive Statistics of Food Safety Violations of Mobile Food Vendors and Restaurants for Seven U.S. Cities

	Boston	Las Vegas	Los Angeles	Louisville	Miami	Seattle	Washington, D.C.
	2011–	2009–	2009–	2010–	2008–	2009–	2011–
Years	July 2013	July 2012	July 2012	July 2013	July 2012	July 2012	2012
Mobile vendors							
Percentage of sample	9.0	5.5	8.3	3.7	6.4	3.4	1.7
No. of establishments	573	751	953	117	730	139	102
No. of inspections	1,743	2,487	3,804	648	1,627	1,143	133
Mean no. of violations	1.26	2.29[b]	3.27[b]	1.87[b]	3.71	13.59[b]	1.81
SD of violations	1.95	3.93[b]	6.21[b]	3.11[b]	3.62	21.05[b]	1.31
Mean no. of foodborne violations[c]	0.45						
SD of foodborne violations[c]	0.88						
Mean no. of critical violations[d]	0.05				3.31		0.12
SD of critical violations[d]	0.24				3.15		0.41
Restaurants							
Percentage of sample	91.0	94.5	91.7	96.3	93.6	96.6	98.3
No. of establishments	2,813	8,659	7,542	2,540	3,959	2,762	2,756
No. of inspections	17,634	42,611	42,091	16,958	23,836	32,229	7,743
Mean no. of violations	4.56	6.99[b]	7.82[b]	4.39[b]	8.15	16.91[b]	4.27
SD of violations	4.46	6.78[b]	5.25[b]	4.51[b]	7.97	20.37[b]	4.74
Mean no. of foodborne violations[c]	0.84						
SD of foodborne violations[c]	1.33						
Mean no. of critical violations[d]	0.30				5.43		1.80
SD of critical violations[d]	0.55				5.39		1.97

[b]Based on demerits, a value assigned to individual violations based on the public safety risk of the violation.

[c]Foodborne violations are a subset of violations that are likely to cause illness.

[d]Critical violations are a subset of violations that if not corrected could lead to illness.

The dependent variable is inspection score (Y) received, which is either the number of violations or the number of demerits. Las Vegas and Los Angeles provided grades equal to 100 minus demerits. These grades were transposed to obtain the demerits in a scale similar to the other cities'. Independent variables are establishment type (β) and dummy variables—a binary variable of 1 if true or 0 if false—representing day of the week (Θ), month (X), and year (Ω). The date dummy variables are included to account for weekly and seasonal fluctuations in traffic and weather. Standard errors are clustered by each establishment to account for multiple inspections per business. The model was also run as a fit population-averaged model to control for the larger number of restaurants than of food trucks. The results from this model indicated little to no difference in the outcomes and can be provided upon request.

Additionally, the Seattle and Washington, D.C. models include a risk rank (Ψ) dummy as another control. Health departments use a risk rank to identify the potential risk associated with an establishment depending on the manner in which it prepares and serves food. High-risk categories (Seattle 3 and D.C. 4 or 5) include establishments that handle raw ingredients extensively, such as most sit-down restaurants. Moderate-risk categories (Seattle 2 and D.C. 2 or 3) include establishments that do limited preparation, such as delis or coffee shops. Low-risk categories (ranked 1 in both Seattle and D.C.) include establishments such as hot dog stands and convenience stores that primarily serve prepackaged or limited-preparation foods.

Critical violations, such as not posting consumer advisories, improper labeling of ingredients, unclean food contact surfaces, and improper sewage and waste-water disposal, are distinct from non-critical violations, because these food safety violations are typically linked to foodborne illnesses *(11, 19, 33, 42)*. In Boston, Miami, and Washington, D.C., the data disaggregated critical and non-critical violations. The results for critical violations in those cities are provided separately as an additional analysis.

RESULTS

Table 2 provides a summary of information by city, including timeframe of data, the number of establishments and inspections, and the descriptive statistics. As the means indicate, food trucks do not perform worse than restaurants as hypothesized. As indicated in *Table 2*, the mean number of violations or demerits is smaller for mobile vendors (between 1.26 and 13.59) than for restaurants (between 4.27 and 16.91). Mobile vendors also averaged fewer critical violations (between 0.05 and 3.31) than restaurants (between 0.30 and 5.43) in those cities that designate them separately. Notably, mobile vendors account for a small portion of the sample, from 1.7% in Washington, D.C., to 9% in Boston.

Table 3 provides the Poisson regression coefficients, robust standard errors, and significance levels but excludes the day of week and month dummy variable coefficient. The Poisson regression analysis shows that mobile vendors do not perform worse during food safety inspections as hypothesized; they perform as well as, and often better than, restaurants. With the exception of Seattle, the coefficients of restaurants are positive and significant ($P < 0.01$), indicating that restaurants are more likely to violate health department food safety standards than mobile food vendors. The coefficient of Seattle restaurants is positive but not significant, indicating that, in that city, there is no significant difference between the demerits received by restaurants and mobile vendors.

The coefficients of the restaurants taken in their anti-log form can be interpreted as a measure of how many times more or fewer violations or demerits restaurants received than mobile food vendors. In Boston, restaurants received 3.5 times more food safety violations than mobile food vendors; in Las Vegas, three times more in Los Angeles and Louisville, 2.4 times more; in Miami, 2.2 times more; and in Washington, D.C., 1.9 times more.

The results from *Table 3* include every violation type. However, critical food safety violations are more closely linked to foodborne illness *(11, 19, 33, 42)* and may therefore be of particular concern to policy makers. *Table 4* shows that mobile food vendors are less likely to violate critical food safety violations than restaurants in Boston, Miami, and Washington, D.C., falsifying the hypothesis that street vendors are more likely to violate health department food safety standards. The coefficients of restaurants in *Table 4* are statistically significant and positive ($P < 0.01$). When the coefficients in their anti-log form are interpreted, it is seen that Boston restaurants received 1.8 times more foodborne critical violations and 5.3 times more critical violations than Boston mobile food vendors. In Miami, restaurants averaged 1.6 times more, and in Washington, D.C., restaurants 11.5 times more critical violations than mobile food vendors.

DISCUSSION

Contrary to the hypothesis, mobile vendors in Boston, Las Vegas, Los Angeles, Louisville, Miami, and Washington, D.C., received fewer violations than restaurants on average. In Seattle, mobile vendors and restaurants did not differ statistically in the number of demerits received during inspections. Additionally, in cities where critical violations can be distinguished from less dangerous violations—Boston, Miami, and Washington, D.C.—mobile vendors had fewer critical violations than brick-and-mortar restaurants. These results imply that general concerns that food trucks and carts are unsafe are misleading. The findings are consistent with a review of international studies on street food that found that vendor practices match local cultural standards and that street food is just as safe as food sold in restaurants *(41)*.

In 2008, food trucks increasingly began attracting "foodies" in major cities across the U.S. and became a popular business venture for entrepreneurs during the recession *(27)*. Because

Table 3. Poisson Regression Results of Food Safety Violations for Mobile Food Vendors and Restaurants from Seven U.S. Cities[a]

	Boston Coefficient (se)	Las Vegas Coefficient (se)	Los Angeles Coefficient (se)	Louisville Coefficient (se)	Miami Coefficient (se)	Seattle Coefficient (se)	Washington, D.C. Coefficient (se)
Constant	-0.300[x]	0.669[z]	1.091[z]	0.794[z]	0.761[z]	2.216[z]	0.229
	(0.171)	(0.084)	(0.089)	(0.110)	(0.112)	(0.289)	(0.356)
Restaurants	1.251[z]	1.097[z]	0.882[z]	0.857[z]	0.773[z]	0.012	0.618[z]
	(0.066)	(0.049)	(0.045)	(0.080)	(0.032)	(0.110)	(0.067)
2009					-0.154[z]		
					(0.017)		
2010		0.037[z]	-0.050[z]		-0.175[z]	0.000	
		(0.010)	(0.009)		(0.017)	(0.057)	
2011		0.121[z]	-0.084[z]	0.176[z]	-0.435[z]	-0.017	
		(0.011)	(0.010)	(0.018)	(0.019)	(0.054)	
2012	0.230[z]	0.264[z]	-0.098[z]	0.122[z]	-0.466[z]	0.051	-0.146[z]
	(0.023)	(0.013)	(0.013)	(0.020)	(0.027)	(0.060)	(0.022)
2013	0.224[z]			0.056[y]			
	(0.026)			(0.025)			
Risk Rank 2[b]						-0.605[z]	0.351[z]
						(0.140)	(0.085)
Risk Rank 3[b]						0.461[z]	0.566[z]
						(0.104)	(0.083)
Risk Rank 4[b]							0.704[z]
							(0.092)
Risk Rank 5[b]							0.010
							(0.092)
Wald χ^2	572.04	1,146.17	536.18	287.57	1,517.85	243.07	408.65
Clusters	3,386	9,410	8,495	2,657	4,689	2,901	2858
Observations	19,377	45,098	45,895	17,606	25,463	33,372	7876

[a]All specifications include day of week and month dummies.

[b]Risk-rank identifies the risk associated with an establishment, based on the manner in which it prepares and serves food. One is low risk and five, high risk.

[x]$P < .10$

[y]$P < .05$

[z]$P < .01$

vending involves low start-up costs, entrepreneurs without access to significant capital could start their own businesses, offering a path out of unemployment or simply a way to achieve upward mobility *(2)*. As mobile vendors have become more prominent on the food scene, policy makers and consumers have expressed concerns about their food safety record *(13, 24, 38)*. The results of this study provide evidence that when mobile vendors are held to the same

Table 4. Poisson Regression Results of Critical Violations for Boston, Miami, and Washington, D.C.[a]

	Boston foodborne violations Coefficient (se)	Boston critical violations Coefficient (se)	Miami critical violations Coefficient (se)	Washington, D.C. critical violations Coefficient (se)
Constant	-1.278[z]	-3.731[z]	0.707[z]	-2.781[z]
	(0.257)	(0.504)	(0.109)	(0.440)
Restaurants	0.597[z]	1.669[z]	0.480[z]	2.444[z]
	(0.081)	(0.167)	(0.031)	(0.280)
Risk rank 2[b]				0.382[z]
				(0.104)
Risk rank 3[b]				0.622[z]
				(0.101)
Risk rank 4[b]				0.776[z]
				(0.110)
Risk rank 5[b]				-0.038
				(0.230)
Wald Chi^2	161.39	225.21	969.89	294.46
Clusters	3,386	3,386	4,689	2,858
Observations	19,377	19,377	25,463	7,876

[a]All specifications include day of week, month, and year dummies. Foodborne violations are a subset of violations that are likely to cause illness. Critical violations are a subset of violations that if not corrected could lead to illness. Miami and Washington, D.C., do not use the term foodborne violations. These violations are included in their critical violations.

[b]Risk rank identifies the risk associated with an establishment based on the manner in which it prepares and serves food. One is low risk and five, high risk.

[z]$P < .01$

health department food safety standards as brick-and-mortar restaurants, mobile vendors perform just as well as, if not better than, restaurants on inspections.

There are several possible explanations for why mobile vendors do at least as well as restaurants on inspections. Like ratings and reviews of restaurants, those of food trucks can be found on national websites, local websites, and mobile apps *(28)*. The ubiquity of these ratings may compel food truck owners and restaurants to maintain high standards of service in order to keep ratings high and customers buying, particularly in highly competitive marketplaces. Additionally, unlike consumers in most restaurants, consumers can watch as their food is prepared and can visually inspect the cleanliness of the cart or truck. If the food establishment looks dirty, people are less likely to stop *(5, 16)*. Reviews and proximity to food preparation create market accountability similar to grade cards or the reputational effects of chains *(20, 21, 22)*.

In addition to market-driven ratings systems, city health departments sometimes produce sanitation grade cards, which must be displayed conspicuously. Research on the use of grade cards in Los Angeles found that providing this information for consumers created an incentive for restaurants to maintain higher health standards than before the program was in place *(20, 37)*. In late 2010, following Los Angeles' "food truck wars," the county extended the letter-grade cards, previously required only in restaurants, to food trucks as well. Louisville also extended this system to mobile vendors in late 2013.

Research on restaurants may also shed light on mobile vendors' strong inspection record. Three studies find that having a certified food handler (CFH) present improves inspection results at restaurants *(4, 23, 31)*. This is likely also the case for mobile food preparers, and indeed each city in this study except for Las Vegas requires CFHs. Given the small number of people who can work at a cart or food truck at the same time, a CFH can oversee every aspect of food preparation. Additionally, because of space constraints, mobile vendors typically have smaller menus and serve fewer customers than restaurants, further reducing the likelihood of violations during inspection *(4, 36)*.

The results herein suggest that food from food trucks and carts is as safe as, if not safer than, food from restaurants. Consequently, absent systematic evidence to the contrary, arguments that mobile vendors are unsafe should not be used to justify time and place restrictions. Instead, the best way to protect consumers is for regulators to incorporate mobile vendors into existing health inspection regimes. The limitation of this study is that the findings are from seven cities and may not be applicable to other locations. Additionally, the Los Angeles data does not account for all the food trucks in the city. Although the health department is required to do at least two routine inspections a year, it appears many Los Angeles food vendors have never been inspected *(26)*.

Additional research on mobile food vendors in other cities and environments is needed. Similar research could also include controlling for the individual inspectors and linking the inspections of commissaries to the vendors who use them. To learn more about the differences between restaurants and mobile vendors, research could track the frequency of types of violations by establishment to see what, if any, violations are more prevalent for mobile vendors. This would allow health departments to focus on the prevalent violation issues with the mobile vending community. Studies could also explore foodborne illness outbreaks, their causes, and risk of outbreak between consumers patronizing food trucks and restaurants. Finally, a more in-depth study might measure and compare the microbial safety of food from brick-and-mortar restaurants and mobile vendors.

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