

**An Examination of the Geographical Correlation Between  
Commercial Motor Vehicle Drivers**

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**Prepared for:**

**The Alliance for Driver Safety and Security**

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## EXECUTIVE SUMMARY

Roadway safety is of paramount importance to the trucking industry and the travelling public. In an effort to improve roadway safety, Federal Motor Carrier Safety Administration (FMCSA) regulation §382.301 requires commercial motor vehicle drivers to undergo pre-employment testing for controlled substances before engaging in safety-sensitive functions. FMCSA only recognizes urinalysis for pre-employment screenings. Some members of the trucking industry and The Alliance for Driver Safety and Security (i.e. "The Trucking Alliance") advocate for FMCSA recognition of hair testing.

To support the need for hair testing recognition, The Trucking Alliance gathered 151,662 paired pre-employment urine and hair drug screenings from fifteen (15) different trucking companies. Their results indicate a discrepancy in the number of drivers who could successfully pass a pre-employment urinalysis drug screen and those who could pass a hair test. While 949 (0.6%) applicants failed the urine test, 12,824 (8.5%) failed or refused the hair test. FMCSA classifies refusal to submit to a drug or alcohol screening as a failure. **This yields a hair test failure rate 14.2 times larger than urine.**

The Trucking Alliance believes its results should be generalized to the national U.S. driver population, which would indicate almost 300,000 current drivers are unable to pass a hair test assuming a driver population of 3,500,000. However, The Trucking Alliance lacks statistical evidence to support whether or not the sample is representative of the nation's drivers.

The Trucking Alliance asked Joe Cangelosi, Ph.D. and Doug Voss, Ph.D. ("Researchers") to determine whether their sample is representative and whether it is appropriate to generalize their results across the national driver population.

To determine whether the sample is representative of the overall driver population, Researchers requested the fifteen (15) participating companies provide information on the state of licensure for drivers in The Trucking Alliance sample. Researchers utilized correlation analysis to determine the extent to which the Trucking Alliance sample is geographically similar to the national truck driver population as provided by the Bureau of Labor Statistics (BLS). **Results revealed a high degree of similarity between the Trucking Alliance sample and the national driver population. A perfect, direct correlation = 1.0. The Trucking Alliance sample shared a .880 correlation with drivers in BLS SOC Code 533032, which is most analogous to drivers in the Trucking Alliance sample.**

Researchers also calculated the sample size necessary to draw inferences to the national driver population. Given a margin of error = 1%, and a confidence level = 99%, a sample size of 16,641 is required. The Trucking Alliance's original sample (n = 151,662) and the sample used in this report (n = 41,922) both exceed this threshold.

**Based on this information and other analyses contained herein, Researchers conclude:**

- 1) The Trucking Alliance sample is large enough to draw inferences to the national driver population at a confidence level = 99% and a margin of error = 1%.**
- 2) The Trucking Alliance sample is representative of the national driver population.**
- 3) The Trucking Alliance urine vs. hair test results can be generalized across the national driver population.**

## INTRODUCTION

Roadway safety is of paramount importance to the trucking industry and the travelling public. In an effort to improve roadway safety, Federal Motor Carrier Safety Administration (FMCSA) regulation §382.301 requires commercial motor vehicle drivers to undergo pre-employment testing for controlled substances before engaging in safety-sensitive functions. FMCSA only recognizes urinalysis for pre-employment screenings. Some members of the trucking industry and The Alliance for Driver Safety and Security (i.e. “The Trucking Alliance”) advocate for FMCSA recognition of hair testing.

To support the need for hair testing recognition, The Trucking Alliance gathered 151,662 paired pre-employment urine and hair drug screenings from fifteen (15) different trucking companies. Their results indicate a discrepancy in the number of drivers who could successfully pass a pre-employment urinalysis drug screen and those who could pass a hair test. While 949 (0.6%) applicants failed the urine test, 12,824 (8.5%) failed or refused the hair test. FMCSA classifies refusal to submit to a drug or alcohol screening as a failure. **This yields a hair test failure rate 14.2 times larger than urine.**

The Trucking Alliance believes its results should be generalized to the overall U.S. driver population, which would indicate almost 300,000 current drivers are unable to pass a hair test assuming a driver population of 3,500,000. However, The Trucking Alliance lacks statistical evidence to support whether or not the sample is representative of the nation’s drivers.

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## DATA ANALYSIS

Researchers requested driver state of licensure information from the fifteen (15) participating Trucking Alliance companies. Six (6) carriers provided usable data with location information for 56,491 of the 151,622 drivers (37.25%). Driver location information is provided in Table 1.

**TABLE 1**  
**TRUCKING ALLIANCE<sup>1</sup> DRIVER LOCATION INFORMATION**

<b>CDL State</b>	<b>TA Carriers 2017</b>	<b>TA Carriers 2018</b>	<b>TA Carriers Total</b>
AK	0	1	1
AL	389	441	830
AR	417	655	1,072
AZ	143	1,671	1,814
CA	1,666	4,536	6,202
CO	72	514	586
CT	236	342	578
D.C.	8	10	18
DE	62	116	178
FL	305	1,343	1,648
GA	1,156	3,887	5,043
HI	0	0	0
IA	100	133	233
ID	11	381	392
IL	942	2,259	3,201
IN	347	553	900
KS	78	633	711
KY	260	291	551
LA	255	381	636
MA	108	184	292
MD	288	320	608
ME	8	10	18
MI	302	820	1,122
MN	90	687	777
MO	349	551	900

<sup>1</sup> The Trucking Alliance is abbreviated as TA in various tables throughout the report.

<b>CDL State</b>	<b>TA Carriers 2017</b>	<b>TA Carriers 2018</b>	<b>TA Carriers Total</b>
<b>MS</b>	307	1,124	1,431
<b>MT</b>	6	5	11
<b>NC</b>	756	1,308	2,064
<b>ND</b>	5	9	14
<b>NE</b>	14	17	31
<b>NH</b>	15	31	46
<b>NJ</b>	384	474	858
<b>NM</b>	47	138	185
<b>NV</b>	54	204	258
<b>NY</b>	307	986	1,293
<b>OH</b>	402	1,616	2,018
<b>OK</b>	232	408	640
<b>OR</b>	61	251	312
<b>PA</b>	999	1,860	2,859
<b>RI</b>	14	26	40
<b>SC</b>	288	936	1,224
<b>SD</b>	7	15	22
<b>TN</b>	322	2,538	2,860
<b>TX</b>	1,783	5,654	7,437
<b>UT</b>	54	1,377	1,431
<b>VA</b>	422	1,282	1,704
<b>VT</b>	4	15	19
<b>WA</b>	206	372	578
<b>WI</b>	203	436	639
<b>WV</b>	84	113	197
<b>WY</b>	1	8	9
<b>TOTAL</b>	14,569	41,922	56,491

Researchers then gathered **2018** state-level driver employment data from The U.S. Bureau of Labor Statistics (BLS) Occupational Employment Statistics Query System.<sup>2</sup> BLS classifies drivers into three Standard Occupational Classification (SOC) codes. These codes and their BLS descriptions are provided below:

- **Light Truck or Delivery Services Drivers (SOC Code 533033):** Drive a light vehicle, such as a truck or van, with a capacity of less than 26,000 pounds Gross Vehicle Weight (GVW), primarily to deliver or pick up merchandise or to deliver packages. May load and unload vehicle. Excludes "Couriers and Messengers" (43-5021) and "Driver/Sales Workers" (53-3031).<sup>3</sup>
- **Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032):** Drive a tractor-trailer combination or a truck with a capacity of at least 26,000 pounds Gross Vehicle Weight (GVW). May be required to unload truck. Requires commercial drivers' license.<sup>4</sup>
- **Industrial Truck and Tractor Operators (SOC Code 537051):** Operate industrial trucks or tractors equipped to move materials around a warehouse, storage yard, factory, construction site, or similar location. Excludes "Logging Equipment Operators" (45-4022).<sup>5</sup>

State-level BLS data for each SOC code is provided in Table 2:

**TABLE 2**  
**2018 STATE-LEVEL BLS DATA BY SOC CODE**

State	Light Truck or Delivery Services Drivers (SOC Code 533033)	Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)	Industrial Truck and Tractor Operators (SOC Code 537051)	BLS Total
AK	1,840	2,380	450	4,670
AL	14,650	32,170	9,010	55,830
AR	7,080	34,700	7,470	49,250
AZ	15,300	25,450	10,730	51,480
CA	111,100	138,380	62,460	311,940
CO	17,610	22,880	10,400	50,890
CT	11,580	12,560	2,820	26,960
DC	1,340	530	100	1,970
DE	2,620	4,370	2,010	9,000
FL	55,230	87,960	22,640	165,830
GA	27,890	62,500	39,400	129,790
HI	4,830	3,300	830	8,960
IA	9,580	38,470	7,810	55,860

<sup>2</sup> <https://data.bls.gov/oes/#/home> (accessed August 29, 2019)

<sup>3</sup> <https://www.bls.gov/oes/current/oes533033.htm> (accessed August 29, 2019)

<sup>4</sup> <https://www.bls.gov/oes/current/oes533032.htm> (accessed August 29, 2019)

<sup>5</sup> <https://www.bls.gov/oes/current/oes537051.htm> (accessed August 29, 2019)

<b>State</b>	<b>Light Truck or Delivery Services Drivers (SOC Code 533033)</b>	<b>Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)</b>	<b>Industrial Truck and Tractor Operators (SOC Code 537051)</b>	<b>BLS Total</b>
<b>ID</b>	4,520	11,940	2,120	18,580
<b>IL</b>	49,140	70,380	30,080	149,600
<b>IN</b>	18,820	54,560	17,620	91,000
<b>KS</b>	8,400	20,370	5,460	34,230
<b>KY</b>	15,680	24,850	14,040	54,570
<b>LA</b>	15,950	21,070	7,010	44,030
<b>MA</b>	22,800	27,650	5,530	55,980
<b>MD</b>	21,180	23,320	6,280	50,780
<b>ME</b>	4,310	8,830	3,150	16,290
<b>MI</b>	28,860	55,940	20,360	105,160
<b>MN</b>	16,070	34,860	6,450	57,380
<b>MO</b>	16,840	44,470	12,490	73,800
<b>MS</b>	7,990	22,710	8,460	39,160
<b>MT</b>	3,690	6,440	1,080	11,210
<b>NC</b>	27,370	58,110	22,800	108,280
<b>ND</b>	2,060	10,560	1,280	13,900
<b>NE</b>	4,610	26,360	3,880	34,850
<b>NH</b>	4,030	6,870	1,250	12,150
<b>NJ</b>	32,310	48,760	17,990	99,060
<b>NM</b>	4,660	10,970	1,090	16,720
<b>NV</b>	6,680	11,760	3,110	21,550
<b>NY</b>	46,030	62,360	16,010	124,400
<b>OH</b>	39,310	74,090	30,850	144,250
<b>OK</b>	8,730	25,750	7,070	41,550
<b>OR</b>	10,940	23,300	9,120	43,360
<b>PA</b>	37,140	82,330	31,070	150,540
<b>RI</b>	4,080	3,200	760	8,040
<b>SC</b>	13,570	29,620	7,670	50,860
<b>SD</b>	3,130	7,880	1,500	12,510
<b>TN</b>	18,250	63,030	16,720	98,000
<b>TX</b>	65,960	191,490	68,370	325,820
<b>UT</b>	8,190	24,760	4,380	37,330
<b>VA</b>	21,470	42,820	13,550	77,840
<b>VT</b>	2,190	3,440	780	6,410
<b>WA</b>	17,740	31,610	11,260	60,610
<b>WI</b>	15,360	49,760	13,800	78,920

State	Light Truck or Delivery Services Drivers (SOC Code 533033)	Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)	Industrial Truck and Tractor Operators (SOC Code 537051)	BLS Total
WV	5,130	12,110	2,460	19,700
WY	1,480	6,340	1,070	8,890
<b>Total</b>	915,320	1,800,320	604,100	3,319,740

Researchers utilized correlation analysis to determine the relationship between Trucking Alliance driver locations and national driver locations drawn from the BLS data. The year 2018 represented the most recent BLS data available. The analysis compares the 2018 Trucking Alliance driver sample (**n = 41,922**) to the 2018 national BLS data.

### The Required Sample Size:

A sample of **n = 41,922** greatly exceeds that required to make inferences about the national truck driver population. Given a margin of error of 1% (which would require a much larger sample size than a margin of error of 5%), and a confidence level of 99% (which greatly exceeds the industry standard of 95%), the sample size required would be **16,641**. The formula to get the result is below:<sup>6</sup>

$$n = Z^2 * p(1-p) / e^2$$

where,

p = .5 (probability of a positive or negative outcome to a hair or urine test);

e = .01 or 1% (the margin of error or level of tolerable error; sample results should be within 1% of the true population proportion);

Z = 2.58 (the level of confidence desired; 99% in our sample results).

If p=.5 and e=.01, Z<sup>2</sup> for 99% confidence = 2.58, required sample size (n) = **16,641**.

To further clarify, the sample results involved two possibilities: a **positive** hair or urine test or a **negative** hair or urine test. Hence, **p** = the probability of the occurrence of an event in the sample (n), i.e. a positive or negative outcome of the urine or hair test; because the value of the event is **unknown (50-50)** before the test is administered, a value of .5 or 50% is utilized to yield the largest possible sample required to produce a representative sample. **The numbers produced by the sample size formula indicate that the size of the sample taken exceeds the size of the sample required by over 2.5 times (41,992/16,641 = 2.52).**

The sample size issue is satisfied by the number of sample units in this analysis.

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<sup>6</sup> The SurveyMonkey formula applies a correction factor which would increase the sample size by a little over a half of a percent (.00513).



### The Correlation Between Trucking Alliance Drivers and the National Driver Population:

Discussion then turns to whether sufficient evidence exists that the distribution by state of Trucking Alliance drivers is representative of the distribution by state of drivers in the national population.

**SOC Code 533032 (Heavy and Tractor-Trailer Truck Drivers) is the only SOC Code whose members must possess a Commercial Driver’s License (CDL) and is the most analogous to drivers in The Trucking Alliance sample.** However, all three SOC codes were included in our analysis.

Results are presented below in Table 3:

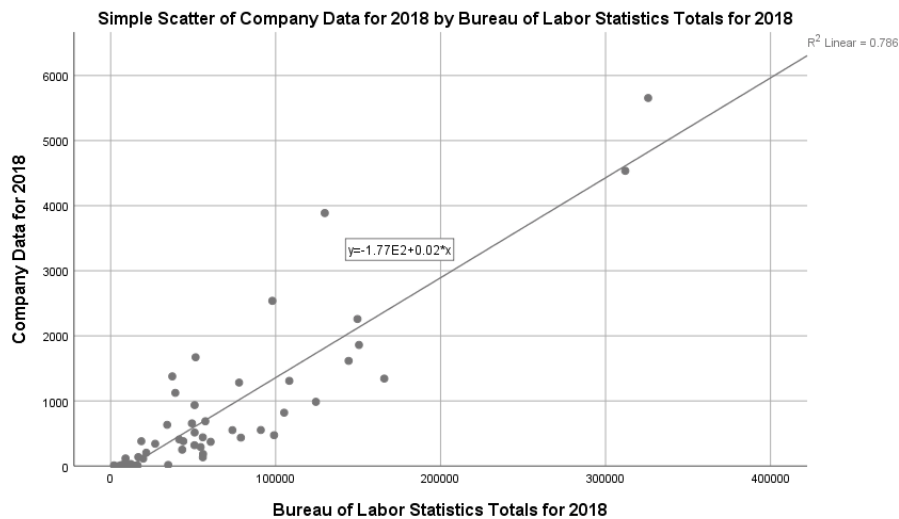
**TABLE 3  
CORRELATION ANALYSIS**

		Light Truck or Delivery Services Drivers (SOC 533033)	Heavy and Tractor-Trailer Truck Drivers (SOC 533032)	Industrial Truck and Tractor Operators (SOC 537051)	BLS Total
TA Carriers 2018	R	.784**	.880**	.923**	.886**
	p-value	.000	.000	.000	.000
	N	51	51	51	51

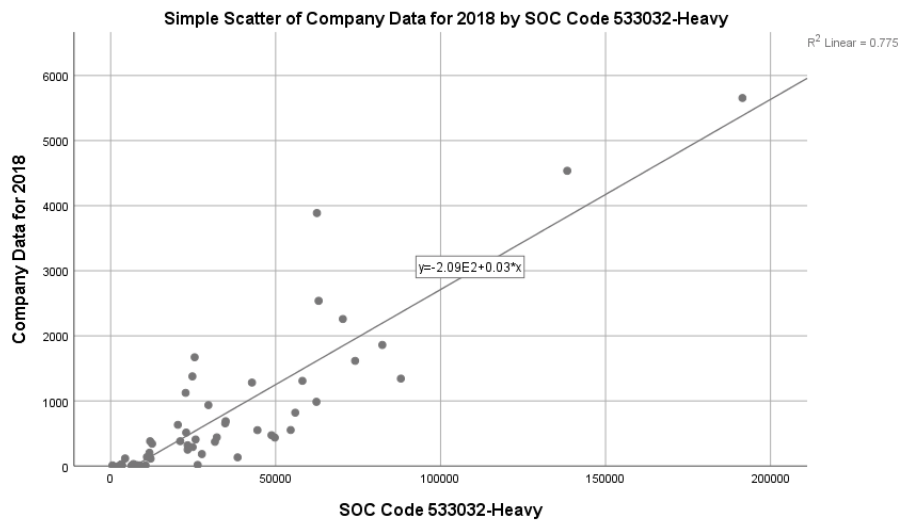
\*\*Correlation is significant at the 0.01 level (2-tailed)

Data visualization graphs are provided below and depict how closely the BLS and Trucking Alliance data points are correlated. Regression lines, which minimize the squared distance between the regression line and each data point, are plotted through the data.

**FIGURE 1  
SCATTER PLOT: TA CARRIERS 2018 AND BLS TOTAL**



**FIGURE 2**  
**SCATTER PLOT: TA CARRIERS 2018 AND SOC CODE 533032**



Such findings indicate a very strong and positive relationship between the BLS and Trucking Alliance data in question.

**CONCLUSIONS**

Results indicate significant correlations between the BLS data and The Trucking Alliance sample across all three SOC codes individually and the combination of all three SOC codes. Each correlation coefficient was significant at  $p < 0.01$ . The p-value estimates the likelihood that an examined relationship is due to chance or error. Lower p-values indicate higher confidence in the relationship between the two variables and, therefore, greater evidence that variables are significantly correlated. Another way to view the p-value is  $1 - p$  is the level of confidence that a statistically significant relationship exists between the two variables in question.<sup>7</sup> Researchers can be nearly 100% confident that the relationship between the two variables is statistically significant.

With an  $R^2 = 0.786$ , Figure 1 indicates that almost 79% of the variation in the total number of drivers by state across all three SOC codes can be explained by the variation in the number of drivers by state in The Trucking Alliance sample. Figure 2 focuses on SOC Code 533032, the only SOC code requiring a CDL, which is most analogous to the drivers in The Trucking Alliance sample. Figure 2 indicates an  $R^2 = 0.775$ , meaning almost 78% of the variation in the total number of drivers by state for SOC code 533032 can be explained by the variation in the number of drivers by state in the Trucking Alliance sample.

**Based on this information and other analyses contained herein, Researchers conclude:**

- 1) The Trucking Alliance sample is large enough to draw inferences to the national driver population at a confidence level = 99% and a margin of error = 1%.**

<sup>7</sup> Please reference the Appendix for further discussion of p-values.

- 2) **The Trucking Alliance sample is representative of the national driver population.**
- 3) **The Trucking Alliance urine vs. hair test results can be generalized across the national driver population.**

## APPENDIX

Correlation analysis is a relative measure of the strength (R) and direction (-/+ ) of the relationship between two datasets. The bivariate correlation analysis produces a statistic, the correlation coefficient (R) that describes the degree to which the two variables co-vary together, either directly or inversely. The correlation coefficient (R) can vary from -1.0 to +1.0. Values close to -1.0 or +1.0 would indicate a strong, statistically significant relationship. Values close to zero (0) would indicate a weak, statistically insignificant relationship. In an inverse correlation, high values for one variable are consistently associated with low values of the other variable. In a **direct correlation**, high values of one variable are consistently associated with high values of the other variable with which it is being correlated, and vice-versa. As indicated earlier, regardless of whether they are positive or negative, small R-values indicate a weaker relationship between the two variables being correlated.

**TABLE 4**  
**CORRELATION ANALYSIS**

		Light Truck or Delivery Services Drivers (SOC 533033)	Heavy and Tractor- Trailer Truck Drivers (SOC 533032)	Industrial Truck and Tractor Operators (SOC 537051)	BLS Total
TA Carriers 2018	R	.784**	.880**	.923**	.886**
	p-value	.000	.000	.000	.000
	N	51	51	51	51

\*\*Correlation is significant at the 0.01 level (2-tailed)

In the correlation analysis above, **R=.880** for SOC Code 533032 indicates a very strong positive/direct relationship between the total number of CDL drivers in the 50 states and D.C., and the number of drivers in The Trucking Alliance sample. Recalling that R=1.0 would indicate a perfectly correlated relationship, R=.880 indicates an extremely close relationship between the two datasets. Hence, states that had more CDL drivers were sampled more heavily and states that had fewer CDL drivers were sampled less. A critical additional measure in the correlation analysis is the p-value, which indicates the probability that the relationship between the two correlated variables is insignificant or an estimate of the likelihood that an examined relationship is due to chance or error. In the correlation analysis between BLS data and The Trucking Alliance sample, the probability of insignificance is ZERO (0); in other words, Researchers can be nearly 100% confident that the relationship between the two variables is statistically significant.

**CORRELATION TABLE**

		TA Carriers 2017	TA Carriers 2018	TA Carriers Total	Light Truck or Delivery Services Drivers (SOC533033)	Heavy and Tractor-Trailer Truck Drivers (SOC533032)	Industrial Truck and Tractor Operators (SOC537051)	BLS Total
TA Carriers 2017	R	1	.911**	.949**	.834**	.891**	.951**	.913**
	p-value		0.000	0.000	0.000	0.000	0.000	0.000
	N	51	51	51	51	51	51	51
TA Carriers 2018	R		1	.994**	.784**	.880**	.923**	.886**
	p-value			0.000	0.000	0.000	0.000	0.000
	N		51	51	51	51	51	51
TA Carriers Total	R			1	.810**	.898**	.946**	.908**
	p-value				0.000	0.000	0.000	0.000
	N			51	51	51	51	51
SOC 533033 Light	R				1	.885**	.896**	.946**
	p-value					0.000	0.000	0.000
	N				51	51	51	51
SOC 533032 Heavy	R					1	.957**	.985**
	p-value						0.000	0.000
	N					51	51	51
SOC 537051 Industrial	R						1	.975**
	p-value							0.000
	N						51	51
BLS Total	R							1
	p-value							
	N							51

\*\*Correlation is significant at the 0.01 level (2-tailed)

## How confident can we be of the representativeness of a sample of 41,992, given the correlation results above?

As indicated earlier, we determined that to be 99% confident with a margin of error of only 1%, we would need a sample size of 16,641. However, our testing results indicate a sample size of 41,992. Using the sample size formula but solving for Z, the level of confidence required, we invoke the following:

$$Z^2 = (n * e^2) / [p(1-p)], \text{ where}$$

Z = the value associated with the level of confidence

n = the sample size of 41,992 indicating the number of drivers tested in 2018 in the Trucking Alliance

e = margin of error as determined by the client and Researchers; industry standard is 5%

p = the probability of the occurrence of an event in the sample (n), i.e. a positive or negative outcome of the urine or hair test; because the value of the event is **unknown (50-50)** before the test is administered, a value of .5 or 50% is utilized to produce the largest sample required possible to produce a representative sample.

The highest Z-value found in most standard normal distribution tables is 3.49, which yields a confidence level of 99.98%. **Our calculated Z-value is 4.098, which is greater than 3.49, and therefore our confidence level is greater than 99.98%.**