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Statistical Analysis of Air Pollution Caused by Exhaust Gases Emitted from Gasoline Vehicles

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ABSTRACT

The purpose of this research is to measure vehicle exhaust emissions emitted from exhaust gases of gasoline vehicles in Irbid Directorate. One thousand gasoline vehicles were tested for emissions of Carbon Monoxide (CO), Carbon Dioxide (CO_2), Oxygen (O_2), and Hydrocarbons (HC).

The statistical results indicate that there are significant differences between emission rates based on vehicles characteristics, such as fuel type, model year, engine fuel supply system, and regular maintenance. In addition, these factors affect the test result of emission levels based on Jordanian standards of vehicles emissions.

KEYWORDS: Vehicle Exhaust Emissions, Air Pollution, Nonparametric Tests.

1. INTRODUCTION

Vehicle use is an enormous convenience to the individual, but society pays a very high price for it – especially in car-clogged cities, where there are more motor vehicles than minor cities.

Motor vehicles are the source of air pollution in cities which tend to suffer from different environmental problems. Air Pollution is becoming increasingly more international. Nowadays, most pollutants enter the atmosphere from the burning of fossil fuels in power plants and factories (stationary sources) and in motor vehicles (mobile sources). In modern cities, like Irbid directorate, motor vehicles can be a major source of air pollution.

The major pollutants emitted from gasoline cars are Carbon Monoxide (CO) and Hydrocarbons (HC). Carbon Monoxide (CO) which is a colorless, odorless, toxic gas produced by the incomplete combustion of organic compounds. The primary health effect of carbon monoxide is to reduce the oxygen carrying capacity of the blood. In ambient concentrations, CO can affect the functions of the brain, lungs, heart and the ability to exercise, all of which are sensitive to blood oxygen content. Exposure to high CO levels is also associated with low birth weights in infants. Hydrocarbons (HC), which results when unburned or partially burned fuel is emitted from the engine as exhaust, and also when fuel evaporates directly into the atmosphere. HC includes many toxic compounds that cause cancer and other adverse health effects. These emissions affect human health and the environment and are the primary cause of air pollution in many urban areas (EPA 2003, WHO 2003). Other emissions are Carbon Dioxide (CO_2), and Oxygen (O_2).

This study will concentrate on measuring vehicle exhaust emissions that emitted from exhaust gases of gasoline vehicles in Irbid Directorate. In order to determine whether the difference in mean of exhaust emissions from different groups of vehicles characteristics (such as model year (MY), manufacturer, engine capacity, fuel supply system injection / carburetor (I/C), test result of emission levels based on Jordanian Standards, maintenance and fuel type) is statistically significant.

2. METHODOLOGY

In this study, the exhaust emissions were measured using computerized exhaust gas analyzer for a random sample of (1000) gasoline vehicles. The exhaust gas emissions were measured based on the user guide of the

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computerized exhaust gas analyzer, the probe of the analyzer is put inside the vehicle's tail-pipe while at the idle speed, after a short period of time steady reading for (CO, CO_2, O_2, and HC) were taken.

The sample was taken from two private certified vehicle test stations in Irbid directorate. Those stations are equipped with modern devices to perform certain tests including emissions. The first station was (Visa Techno-test gas analyzer model Visa-4012, manufactured by Techno-test company - Italy), which is available at the Techno-star test center, it is located to the west of the industrial zone - Irbid. The second station was (Sun gas analyzer model Sun-SMP 4000, manufactured by Sun electric company - UK) which is available at Al-Azam Auto Care Center, it is located east of the industrial zone - Irbid. The sample was collected during the period of (May 2003 - October 2003).

3. STATISTICAL ANALYSIS

Emissions and characteristics data have been used to analyze pollution regulations and the possibility of implementing an environmental vehicle characterization. White (1982) and Kahn (1996) use cross-section data to investigate the evolution of manufacturers' compliance with pollution regulation in the United States. Under a different approach, Johnston and Karousakis (1998) use emissions and characteristics to study the possibility of implementing a vehicle characteristic tax. We build upon these previous studies in order to analyze both the evolution of compliance to the new regulation and the current relationship between characteristics and emissions for the Jordanian fleet.

The distributions of major emissions from large numbers of vehicles are high skewed. The majority of vehicles have relatively low emissions, while a relatively small number of malfunctioning vehicles have extremely high emissions. To overcome this difficulty, analysts have typically used the forms of the Log-normal (Stephens, 1994) and gamma (Zhang et al., 1994) distributions to model vehicle emissions data. One graphical tool for analyzing this kind of data is to plot emissions as a function of the cumulative fraction of vehicles (Wenzel and Slott, 2000).

As previously suggested, logarithmic transformation is frequently used to account for the non-normality of the data; yet this may not be the appropriate approach to take. Since the distribution of raw data significantly deviated from normality, see Figure (1), and Table (1). Nonparametric techniques are used in our analysis since such techniques do not require an assumption regarding the distribution of the underlying population. Consequently, the non-parametric Kruskal-Wallis (K-W) and the Mann- Whitney U test compared group mean values. Values of $p < 0.05$ were regarded as statistically significant. All analyses were performed with the SPSS 10.05 statistical software package.

3.1:Compliance Schedules and Emission Comparisons by Fuel Type

Divergence in emission levels among fuel-type vehicles can be observed in Table (2). As shown in Table (2), by 1986, the (HC and CO) emission levels from vehicles used normal gasoline exceeded those from vehicles used super or unleaded gasoline. However, the (HC and CO) emission levels in vehicles used super gasoline exceeded those from vehicles that used unleaded gasoline. This trend may explain why the technological efforts were concentrated on unleaded fuel and encourage using it.

In order to analyze these compliance schedules, we perform K-W test for each fuel type and for the four emissions. Our test included the vehicles Model Year (MY) after 1986, because all the vehicles of MY before 1986 never used unleaded fuel. Table (3) shows that there is no significant difference in the means of all emission levels for the most modern vehicles (MY > 2000), this is due to the fact that all of these modern vehicles, almost, used the same fuel systems. And there is statistical significance in the mean of CO_2 and HC emissions for all vehicles made before 1996. However, the statistical differences for the emission of O_2 appear only with the MY 1986-1990, while CO emissions appears only for the MY 1991-1995.

Because the test is significant for most emissions, among the vehicles Model Year (MY), pair wise comparisons (by using Mann-Whitney U Test) conducted (see Table 4). The results suggested that there are statistical differences between emission levels of CO_2 for vehicles models before 2000, and according to the mean ranks super fuel leads to better burning in the exhaust and also reduce the HC emissions. This conclusion also holds true for the Model Year (MY) after 1991 in comparing normal and unleaded fuel, which suggests that unleaded fuel decreases the HC emissions more than normal and introduced better burning for CO_2. Lastly, it appears that unleaded is better than super fuel in reducing emissions of CO for model year 1991-1995 and they have comparable results in HC emissions.

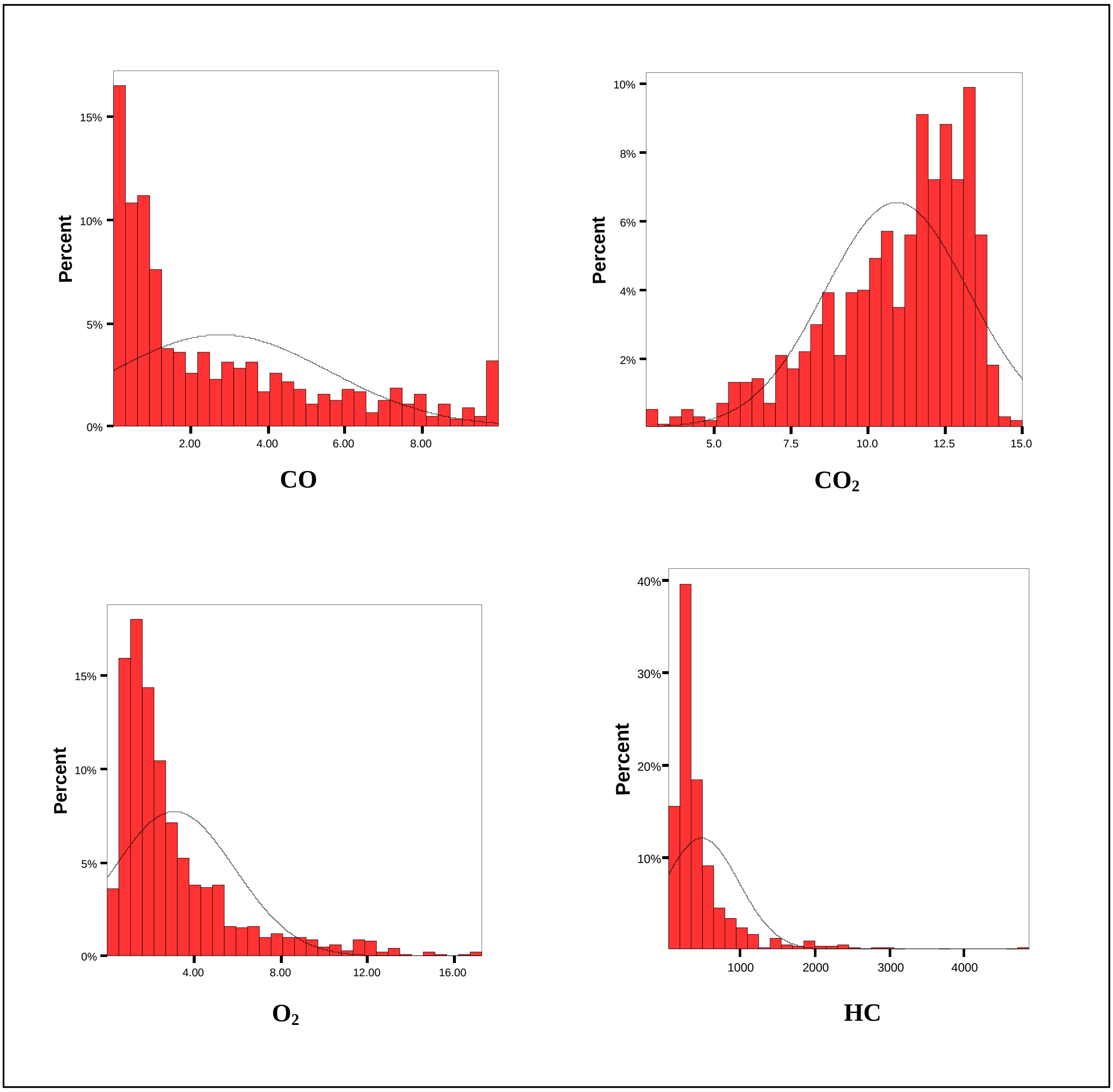

Figure (1): Distribution of Major Emissions.

Table (1): Kolmogorov-Smirnov test for normality distribution test of major emissions.

		CO_2	HC	O_2	CO
N		1000	1000	1000	1000
Normal Parameters [a,b]	Mean	10.905	487.65	3.0786	2.7681
	Std. Deviation	2.327	497.10	2.7939	2.8033
Most Extreme Differences	Absolute	.118	.228	.179	.170
	Positive	.087	.228	.179	.170
	Negative	-.118	-.221	-.159	-.162
Kolmogorov-Smirnov Z		3.747	7.218	5.666	5.381
Asymp. Sig. (2-tailed)		.000	.000	.000	.000

a. Test distribution is Normal.

b. Calculated from data.

Table (2): Summary statistics of fuel type for major emissions.

		Fuel Type					
		Normal		Super		Unleaded	
MY		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
1965-1970	CO2	8.740	3.417				
	HC	1023.33	445.64				
	O2	4.7233	5.0051				
	CO	5.3467	3.5720				
1971-1975	CO2	9.458	2.460				
	HC	913.00	794.04				
	O2	4.9925	3.8948				
	CO	3.3700	3.3821				
1976-1980	CO2	8.968	2.328	9.500	1.273		
	HC	637.86	477.43	287.00	28.28		
	O2	3.8968	3.5533	4.1100	.6930		
	CO	4.4738	3.0787	5.8050	2.8496		
1981-1985	CO2	10.009	2.188	10.657	2.208		
	HC	578.08	504.60	547.83	414.43		
	O2	2.8574	2.8366	2.8994	2.6431		
	CO	4.1157	2.8574	3.6778	3.2243		
1986-1990	CO2	10.415	2.187	11.625	1.972	12.000	1.414
	HC	550.57	451.60	370.91	380.29	232.50	10.61
	O2	3.2527	2.8556	2.9037	2.3507	3.1250	2.5102
	CO	3.3112	2.8661	2.3550	2.4079	.7500	.8485
1991-1995	CO2	11.151	2.168	11.783	2.069	13.829	.808
	HC	463.81	516.85	333.62	291.21	208.86	94.62
	O2	3.0490	2.6783	2.9176	2.7666	1.2400	.9844
	CO	2.2857	2.5609	1.8527	2.2486	.3486	.3569
1996-2000	CO2	10.891	2.501	12.245	1.731	13.675	.386
	HC	521.45	614.77	266.71	88.77	195.75	63.11
	O2	3.2546	2.9829	2.3910	1.9567	.9025	.1115
	CO	2.6205	2.9426	1.7459	1.9199	.6475	.4236
>2000	CO2	11.700	3.399	13.583	.531	15.000	.
	HC	348.20	207.99	207.67	73.77	82.00	.
	O2	1.9740	1.1367	1.7600	1.0708	2.8400	.
	CO	3.7660	4.8177	.5583	.5426	4.000E-02	.

Table (3): Chi-square statistics of K-W test for fuel type.

Model year (MY)	CO_2	HC	O_2	CO
1986-1990	16.306 (0.000)	24.9868 (0.000)	0.267 (0.000)	5.232 (0.073)
1991-1995	22.332 (0.000)	22.75 (0.000)	5.008 (0.082	9.911 (0.007)
1996-2000	20.975 (0.000)	13.189 (0.001)	8.12 (0.017)	2.647 (0.266)
> 2000	2.698 (0.256)	3.921 (0.141)	1.151 (0.562)	2.792 (0.248)

Note: p-value in parentheses;

Table (4): Z-statistics for fuel type comparisons using U-test.

Model year	Emissions	Normal vs. Super	Normal vs. Unleaded	Super vs. Unleaded
1986-1990	CO_2	-3.936 (0.000)	-1.09 (0.275)	-0.103 (0.918)
	HC	-4.719 (0.000)	-1.898 (0.058)	-0.464 (0.642)
1991-1995	CO_2	-2.961 (0.003)	-3.797 (0.000)	-3.278 (0.001)
	HC	-4.195 (0.000)	-2.575 (0.010)	-1.240 (0.215)
	CO	-0.916 (0.36)	-3.009 (0.003)	-2.923 (0.003)
1996-2000	CO_2	-3.598 (0.000)	-3.085 (0.002)	-2.097 (0.036)
	HC	-3.002 (0.003)	-2.236 (0.025)	-1.536 (0.125)
	O_2	-1.597 (0.110)	-2.545 (0.011)	-1.675 (0.094)

Note: p-value in parentheses;

Table (5): Summary statistics of injection – carburetor (I/C) for major emissions.

		I or C							
		Carburetor				injection			
MY		CO2	HC	O2	CO	CO2	HC	O2	CO
1965-1970	Mean	8.740	1023.33	4.7233	5.3467				
	Std. Deviation	3.417	445.64	5.0051	3.5720				
1971-1975	Mean	9.273	975.27	5.3427	3.3336	11.500	228.00	1.1400	3.7700
	Std. Deviation	2.491	801.48	3.8816	3.5447	.	.	.	.
1976-1980	Mean	8.865	635.72	3.7563	4.8013	9.933	537.33	5.0450	2.4067
	Std. Deviation	2.287	439.41	3.5845	2.9704	2.290	730.31	2.5390	3.1134
1981-1985	Mean	9.842	556.91	2.9123	4.3546	10.942	626.45	2.7093	3.0862
	Std. Deviation	2.220	459.85	2.9034	3.0212	1.910	584.20	2.4747	2.2866
1986-1990	Mean	10.210	556.57	3.0497	3.9043	11.198	459.92	3.3248	2.1876
	Std. Deviation	2.136	390.29	2.7960	2.9360	2.144	489.77	2.7037	2.3310
1991-1995	Mean	10.451	511.88	3.2657	3.1203	11.526	411.89	2.9313	1.9555
	Std. Deviation	2.314	364.61	3.4324	2.7659	2.095	489.78	2.5129	2.3803
1996-2000	Mean	10.683	626.53	3.4367	2.8439	11.474	399.17	2.8501	2.2127
	Std. Deviation	2.213	573.74	3.1685	2.9250	2.427	518.04	2.6331	2.6513
>2000	Mean	13.200	271.00	3.4700	1.6200	12.891	254.36	1.8000	1.8727
	Std. Deviation	.	.	.	.	2.489	169.35	.9672	3.5482

Table (6): Z-statistics of U-Test for I/C systems.

Model year	CO_2	HC	O_2	CO
1976-1980	-1.017 (0.309)	-2.291 (0.022)	-1.547 (0.122)	-1.633 (0.103)
1981-1985	-2.317 (0.021)	-0.458 (0.647)	-0.075 (0.939)	-1.866 (0.071)
1986-1990	-4.04 (0.000)	-4.024 (0.000)	-1.449 (0.147)	-4.593 (0.000)
1991-1995	-4.1 (0.000)	-4.163 (0.000)	-0.676 (0.499)	-2.827 (0.005)
1996-2000	-2.882 (0.004)	-3.11 (0.002)	-1.088 (0.277)	-0.86 (0.39)
> 2000	-0.731 (0.465)	-0.435 (0.833)	-1.593 (0.167)	-1.014 (0.311)

Note: p-value in parentheses;

Table (7): Chi-square statistics of K-W test for vehicles capacity.

Model year	CO_2	HC	O_2	CO
1976-1980	3.718 (0.156)	0.899 (0.638)	5.573 (0.062)	0.920 (0.631)
1981-1985	0.650 (0.721)	0.429 (0.807)	0.506 (0.777)	3.864 (0.145)
1986-1990	7.362 (0.025)	15.71 (0.000)	0.831 (0.660)	5.709 (0.508)
1991-1995	4.208 (0.122)	14.184 (0.001)	3.641 (0.162)	1.49 (0.475)
1996-2000	0.104 (0.949)	4.432 (0.109)	1.673 (0.433)	2.177 (0.337)

Note: p-value in parentheses;

Table (8): Summary statistics of capacity for major emissions.

		less than 1500cc		from 1500cc to 2500cc		more than 2500cc	
	MY	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
CO2	1965-1970			8.740	3.417		
	1971-1975			9.725	2.696	8.925	2.161
	1976-1980	8.135	1.873	9.317	2.267	7.788	2.765
	1981-1985	9.958	2.163	10.063	2.117	10.303	2.392
	1986-1990	10.410	2.145	11.128	2.025	10.271	2.665
	1991-1995	11.241	2.290	11.423	1.987	12.491	1.752
	1996-2000	11.251	2.444	11.372	2.369	11.077	2.470
	>2000	13.920	.701	12.200	2.928		
HC	1965-1970			1023.33	445.64		
	1971-1975			837.25	885.48	1064.50	660.64
	1976-1980	703.63	658.17	631.36	456.66	443.00	241.50
	1981-1985	575.76	477.63	543.57	487.04	622.91	518.22
	1986-1990	554.68	408.49	483.58	520.55	429.89	239.02
	1991-1995	477.49	566.71	364.90	291.87	320.18	229.90
	1996-2000	480.54	620.38	432.51	450.10	226.33	85.42
	>2000	160.20	79.62	324.00	174.85		
O2	1965-1970			4.7233	5.0051		
	1971-1975			3.5463	2.3020	7.8850	5.1500
	1976-1980	5.7313	3.5024	3.2362	2.9321	6.2000	5.8357
	1981-1985	3.0241	2.5217	2.7438	2.6551	2.9312	3.2932
	1986-1990	3.1979	2.8744	3.1911	2.6377	3.0754	2.7086
	1991-1995	3.0443	2.8482	2.9929	2.5013	1.6655	1.0523
	1996-2000	2.9345	2.9408	2.9474	2.5372	4.0017	3.1307
	>2000	2.0320	1.1115	1.8729	1.0721		
CO	1965-1970			5.3467	3.5720		
	1971-1975			4.5337	3.4516	1.0425	1.8187
	1976-1980	5.1537	2.9381	4.5074	2.9189	3.6560	4.6052
	1981-1985	4.1155	2.9793	4.4928	2.9393	3.2409	2.6841
	1986-1990	3.4454	2.9259	2.4870	2.4077	3.6643	3.1675
	1991-1995	2.1603	2.5156	2.1784	2.4639	1.5073	2.1817
	1996-2000	2.4910	2.6897	2.2677	2.8123	1.4717	1.9461
	>2000	.5820	.6192	2.7586	4.2935		

Figure (2): Major emission levels for fail/pass results by model year.

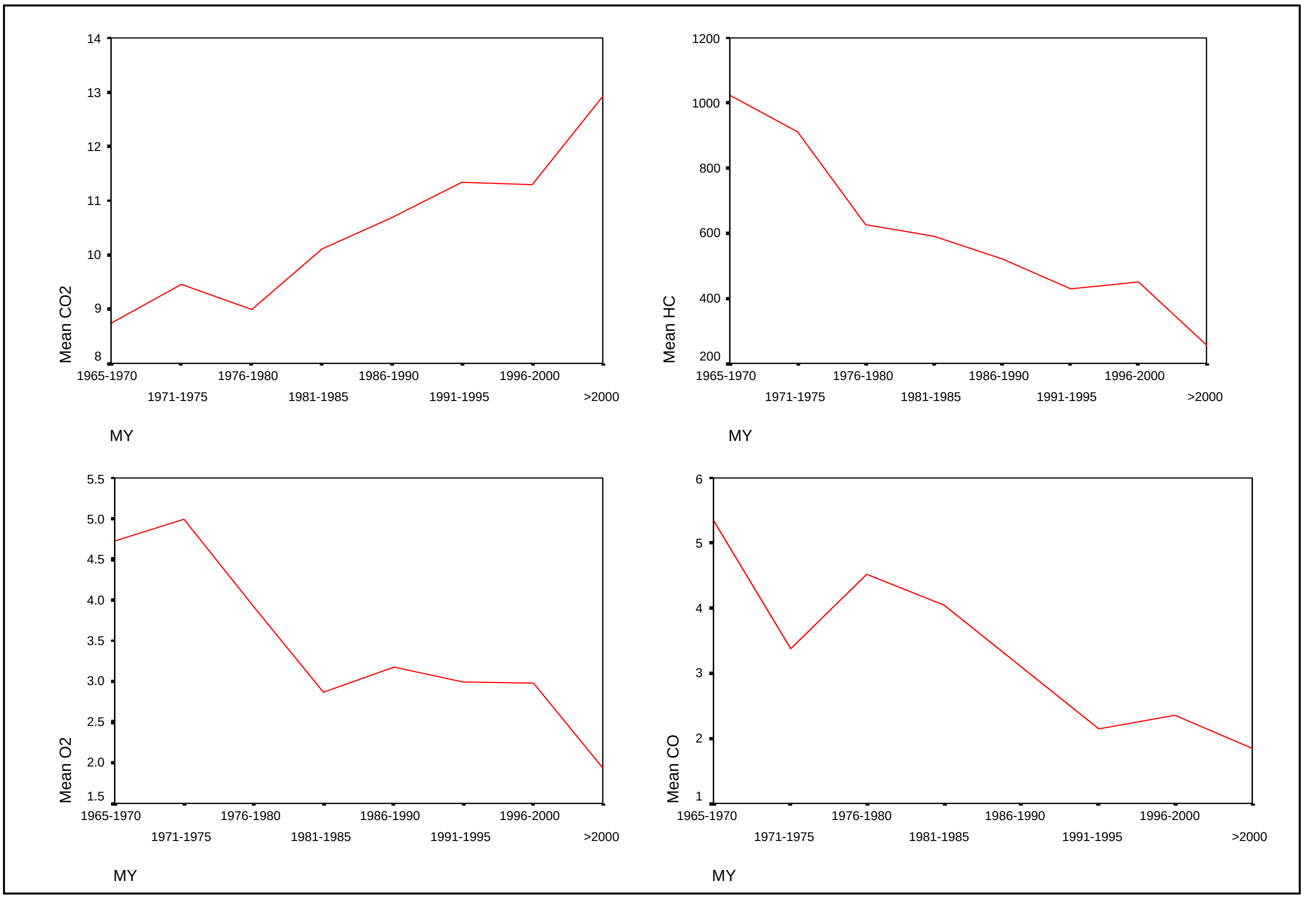

Table (9): Summary statistics of maintenance for major emissioms.

	CO2		HC		O2		CO	
Maintenance	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
No test	10.700	2.362	523.98	537.61	3.1706	2.9155	2.9035	2.8391
every 1 mon	12.021	1.761	340.79	338.00	2.6653	2.0109	1.5311	2.0785
2 Months	11.626	2.292	358.06	339.60	3.2464	2.9348	2.0098	2.5716
3 months	11.525	2.118	382.97	323.10	2.6682	2.1778	2.5276	2.7876
4 months	11.696	1.291	309.79	112.88	2.0950	1.1173	2.3029	2.2634
5 months	11.125	2.518	787.00	879.01	3.4850	2.8389	2.4975	.6697
6 months	11.183	2.196	370.03	187.53	2.8911	2.5530	2.6389	2.8664
8 months	12.000	.	390.00	.	.9100	.	2.8100	.
Total	10.905	2.327	487.65	497.10	3.0786	2.7939	2.7681	2.8033

3.2: Major Emission Comparisons by (Injection or Carburetor) I/C Vehicle Systems

Divergence in emission levels among fuel-system supplier (I/C) can be observed in Table (5). As shown in Table (5), HC, O_2 and CO emission levels in vehicles with carburetor system exceeds those with injection systems for most model years (MY).

Moreover, Table (6) shows Mann-Whitney U Test results for average emission comparisons for MY after 1976. There is no statistical difference in emission levels for the MY before 1985, except for O2, there is significance difference between injection and carburetors supply system for the MY after 1985. For the MY after 2000, in fact it is not comparable since there was only one vehicle with carburetor system among all these models for that the test was not significant. The results indicate that there are statistical significances in average emission levels of CO_2, HC and CO. The trends of these results are based on mean ranks which encourage using injection fuel supply systems.

3.3: Major Emission Comparisons by Vehicle Capacity

The vehicles classified to be small corresponded to less than 1500cc, medium higher than 1500cc and lower than 2500cc, and large for the capacity higher than 2500cc. Also, the test performed for vehicle MY 1976 to 2000 for the shortage number of vehicles outside of these MY among some vehicles' capacities. Except for CO_2 emissions in the MY 1986-1990, and HC emissions MY 1986-1995; (Table 7) of K-W test suggests that there is no significance difference between vehicle capacity in its emission levels among all MY. However, U test suggested that medium engine size is better than small engine size in reducing emissions.

Table (8) shows the summary statistics (mean and standard deviation) for emission levels with respect to vehicles' capacity.

3.4: Major Emission Comparisons by Test Results of Vehicle

The test results of vehicles (Pass of Fail) based on the national standards of vehicles emissions. Where the Jordanian standards of CO_2, CO, O_2 and HC are as follows, at least 10%, maximum 5%, maximum 6% and maximum 600ppm, respectively. The vehicle is considered passing the test if it has satisfied all the emission standards otherwise it fails. The test results of all vehicles, based on the Jordanian standards of gasoline vehicle emissions showed that 60.7% of the sample passed the test. Major emission levels are presented in (Figure 2) for each model year with respect to test results. It can be noted that the trend of the emission level decreases for HC, CO and O_2 with modern vehicles and it increases for CO_2 emission. It can be indicated that most of the new cars pass the test.

3.5: Major Emission Comparisons by Vehicle Maintenance

The K-W test (The table of this test is eliminated because it is tedious to write it down and it has only one result for all MY) suggested that there is no statistical difference between emission levels among all MY with respect to frequent maintenance. The reasons behind this result, most of the old car owners avoid frequent maintenance. On the other hand, most of the technicians have lag knowledge with the new technology in the new brands. We opted for pooling all observation for the variable maintenance in order to describe this variable; Table (9) presents the summary statistics for this variable.

4. EMISSION TRENDS OF MODERN VEHICLES (1995-2003)

Our final analysis is concerned with the relationships of the modern cars and their emission levels. This analysis aims to explore the current relationship between emissions and characteristics in Jordan fleet. We use 1995-2003 test data (most modern brand vehicles). Since the distribution of raw data significantly deviated from normality, [see Figure (2) and Table (1)]; the experimental data were transformed to natural logarithm, then Ordinary Least Square (OLS) were used in our analysis. The analysis is undertaken for the three main pollutants using the following model:

$$Ln(E_i) = Constant + b_1 * Maintenance + b_2 * System + b_3\ Fuel\,Type + b_4\ * size + \varepsilon_i$$

where E_i: pollutant emissions, Maintenance: number of times the car is sent for usual maintenance every year, System: dummy variable taking the value 1 if the fuel car is based on Injection system and 0 if this system is Carburetor, Fuel Type: dummy Variable: 0-Normal, 1-Super, Results: dummy variable with 0:fail and 1: Pass. Size represents the engine size. The results of this analysis are represented in Table (10).

Table (10): OLS estimates of emission levels for modern vehicles.

Emissions	CO_2	HC	CO
Constant	2.308** (0.058)	6.3** (0.13)	0.825** (0.303)
Maintenance	0.019 (0.013)	-0.0302 (0.028)	-0.095 (0.066)
System I/C	0.029 (0.045)	-0.38** (0.1)	-0.172 (0.234)
Fuel Type	0.117* (0.035)	-0.320** (0.079)	-0.426* (0.186)
Engine Size	0.0116 (0.031)	-0.069 (0.07)	-0.271* (0.164)
Adjusted-R^2	0.307	0.437	0.265

Note: standard errors in parentheses; *Statistically significant at 5%; ** Statistically significant at 1%;

The pattern of emission vehicles characteristics changed considerably from 1995 to 2003. The regression results show that; after controlling Maintenance, System (I/C), Fuel type and Engine size; emissions of HC and CO tend to decrease while CO_2 increases with these characteristics. However, emissions of (HC and CO) decrease and CO_2 increases by fuel type, fuel system supplier and engine size more than frequent maintenance. This relationship supports the fact that modern technology is very important, which means; the drivers should keep the catalytic converter, or they better use Injection fuel suppliers and clean fuel such as super fuel.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

This research and analysis provide important information and contribute to a better understanding of exhaust gas emissions; "CO, HC, CO_2 and O_2" levels from different vehicles model years ranged from 1965 to 2003; " new and old technology". The data collected using exhaust gas analyzer from Irbid Directorate in the period May 2003 to October 2003, based on the fact that the distribution of major emissions is deviated from normality; non-parametric Kruskal-Wallis (K-W) and the Mann- Whitney U test; were performed in order to determine whether the difference in the mean of exhaust emissions from different groups of vehicles characteristics (such as model year (MY), manufacturer, engine capacity, fuel supply system injection / carburetor (I/C), test result of emission levels based on Jordanian Standards, maintenance and fuel type) is statistically significant. The test results indicate that there is a statistical significance between emission levels and vehicle characteristics "fuel type and supply fuel system (I/C) among model years" and there was no statistical evidence to indicate that the different emission levels were affected by frequent maintenance or the test results with respect to the Jordanian vehicle emission standards. However, to reduce the emission levels in Jordan we recommend "based on this study" the drivers to start using unleaded gasoline. By using unleaded fuel, the emission levels will decrease which leads to a positive effect on our health and environment. However, this recommendation needs to be improved, firstly; by supplying the fuel stations with unleaded fuel, so everyone can use it" for example in Irbid there are only three stations that have this fuel type, and there are more than 50000 vehicles. In addition, we encourage the government to support such fuel type by reducing its price, so that most of car users could buy it. The other recommendation could be drawn from the results of our analysis, is to encourage people to start using the new technology that is available in the modern vehicles (1995 –2003). For example, Injection fuel system instead of carburetor, in addition to keep Catalytic Converter in the vehicles which is an anti-pollution device that converts exhaust emissions such as CO and nitrogen oxides to normal atmospheric gases such as nitrogen and water. In Jordan, most car users remove the catalytic converter from their own cars. Moreover, to reduce gas emission, we encourage car users to start an efficient frequent inspection and maintenance.

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التحليل الإحصائي لتلوث الهواء بالغازات المنبعثة من عوادم السيارات التي تعمل بالبنزين

*طلال المومني وأمجد الناصر**

ملخص

يهدف هذا البحث الى دراسة الملوثات المنبعثة من عوادم السيارات التي تعمل بالبنزين في محافظة اربد. تم إجراء (1000) قياس للغازات المنبعثة من عوادم السيارات التي تعمل بالبنزين وأهمها: أول أكسيد الكربون، وثاني أكسيد الكربون، والأكسجين، والهيدروكربونات.

أشارت النتائج الإحصائية للدراسة إلى وجود دلالات مختلفة ذات مغزى بين معدل انبعاث عوادم السيارات والعوامل المختلفة التي تؤثر في مستويات الانبعاث مثل: نوع الوقود، وعمر السيارة، ونظام توصيل الوقود للمحرك، والصيانة الدورية. وقد أثرت هذه العوامل في نسب نجاح المركبات ومطابقتها للمواصفة الأردنية الخاصة لعوادم المركبات.

الكلمات الدالة: الملوثات المنبعثة من عوادم السيارات، التلوث الهوائي، اختبارات لامعلمية.

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