Trend Analysis of vehicular Traffic Contribution to Air Pollution in Urban City

ABSTRACT

The study investigated contributions of vehicular emissions to air pollution for two years (24months), 2017-2018. The daytime pattern, monthly pattern, major traffic congested areas and factors that aid dispersion of air pollutants were considered. Traffic records were taken at the designated locations by counting the number of vehicles passing through a point for two hours in the morning, afternoon and evening, using a close circuit television (Plate 5.1). All the parameters were monitored in each location once every month (Monday to Friday) for two years (2017-2018). Data obtained were analyzed using descriptive analysis, ANOVA and multiple linear regressions where appropriate. Results obtained revealed statistically that mean concentration of all the pollutants exhibited a similar pattern in their trend of temporal variation and were significantly ($P<0.05$) different within the daytime. Similarly, the mean traffic volume varied highly and significantly ($P<0.05$) within the daytime, between the two study years. Furthermore, all the pollutants exhibited a similar pattern in their trend of temporal variation, the lower concentration of each occurring in 2017 while the higher occurred in 2018. Statistical analysis revealed that, the concentration of all the air pollutants and traffic volume varied significantly ($p < 0.05$) between 2017 and 2018.

Keywords: Trend, Concentration Level, Traffic Volume, Vehicular Emission, Air Pollutants

Introduction

Air is a universal gas, composed of nitrogen (78%) and oxygen (21%), leaving about 1% for all other components. It is regarded as the most important natural life support system probably due to the oxygen component. All living organisms require oxygen to breath and no organism can survive more than five minutes of hypoxia. Air therefore makes human existence and other forms of life possible. The ability of air to effectively support life, however, depends on its quality. Quality air is generally regarded as that which is in the right natural proportion. Deviation to this makes the air polluted. The degree of pollution depends on what additional constituents or pollutants it contains. There are many types of pollutants classified on the bases of their sources, type and toxicity. Thus, while good quality is very essential in sustaining life, polluted air is detrimental to it. There are several sources of air pollution but it is generally believed that the most important sources are those related to human activity.

According to FEPA, (1991) air pollution is defined as any substance in air which could, if in high enough concentration could harm man, animals, vegetation, or artificial composition of matter capable of being airborne. There are some many other definitions that agree with above. But, it is important to understand that air pollution occurs mostly as a result of human activity which is a problem to the environment. The pollutants that results to disequilibrium of air in the atmosphere are either primary source; which are substances directly emitted from a process, or secondary; which are produced by reactions between primary pollutants. These sources include industrial, transportation among others. Among these sources, transportation accounts for greater percentage of toxic pollutants emitted (USEPA, 1993). Carbon monoxide has 77% and Oxides of Nitrogen has 80-90% with about 36% of volatile organic compounds and 22% of particulate matter results due to increase in vehicular emissions (CEC, 1993). Land transportation sources of air pollutant have contributed more to air pollution than other sources, especially in developing countries like Nigeria. Vehicular traffic has constituted increased air pollutants in the atmosphere, which is becoming threat to urban cities. Traffic congestion has disproportionate contributions to air pollution probably as a result of incomplete combustion in stationary vehicles (Goyal, 2006). For instance, it has been shown that about 50-80% of NO_2 and CO concentration in developing countries is attributable to traffic congestions. Therefore, taking inventory of air pollutants from vehicular emission from a long period of time has become necessary.

Contributions of vehicular traffic to air pollution

This section discusses different studies that focused on how vehicular emissions contribute to air pollution in most Nigerian cities;

A study carried out by Jimo and Ndoke, (2000) in Minna, Niger State reported a concentration of 5,000ppm for CO_2 in congested areas. This is however less than WHO stipulated maximum value of 20,000ppm. Maximum value for CO emission obtained was 15ppm, which is less than WHO baseline of 18ppm, and FEPA standard of 20ppm. They gave the reason for the low emission concentration in Minna to be due to low traffic and industrial activities in the city.

A study of the impacts of urban road transportation on the ambient air was conducted by Koku and Osuntagun (1999) in three cities Lagos, Ibadan and Ado-Ekiti. Air quality indicators that were monitored were CO, SO_2, NO_2 and total suspended particulates (TSP). Their findings reported concentrations of CO-23.3ppm, at idumota, $S0_2$-2.9ppm at Idumota, $N0_2$-1.5ppm at Iyana-ipaja and total particulates 852ppm at Oshodi bus stop. For CO and SO_2 concentration of 27.1ppm and 0.44ppm respectively were measured at Mokola round about, while 10ppm of NO_2 was obtained at Bere round about. In Ado-Ekiti the highest concentration obtained were CO-31.7ppm at Oke Isha, $N0_2$-O.6ppm at Ijibo junction and SO_2-0.8ppm at old Garage junction. The concentrations obtained for CO, SO_2, NO2, and particulate counts per minute were higher than FEPA limits (CO-10ppm, $S0_2$-0.0lppm, NO_2-0.04 to 0.06ppm). The study concluded that there is an increasing risk of traffic-related air pollution in Nigeria cities. The author covered some major cities in Nigeria which is a merit on the study. Notwithstanding, the duration of the study is not known. Also, factors that affect dispersion rate were not considered.

Jerome (2000) did a comparative study of emissions in Lagos and Niger Delta, with emphasis on Port Harcourt and Warri. The result obtained, showed that concentration of total suspended particulates, NO_x (oxides of Nitrogen), SO_2 and CO_2 in Lagos and the Niger Delta were above FEPA recommended limit. The concentration of CO emissions for Lagos was quite high, being in the range of 10-250ppm, as compared with 5.0-61.0ppm recorded for oil communities in the Niger Delta. The total suspended particulates were also higher in the study areas when compared with W.H.O standard. The study showed an increasing trend in those cities, and thus possesses a potential hazard to the population. In the above study, the researcher should have analyzed the data statistically, as well as formulating hypotheses which would have given more relevance to the work.

Abam and Unachukwu (2009) investigated vehicular emissions in selected areas of Calabar, Nigeria and reported concentration of CO, NO_2, $S0_2$, PM_{10} and noise level in the range of 3.3-8.7ppm, 0.02-0.09ppm, 0.04-0.5ppm and 72.4db respectively. The pollutants when compared with air quality index (AQI) gave the following results: CO-poor to moderate, and moderate to poor in different locations: SO_2 very poor to poor, NO_2- very poor to poor and PM_{10} and noise level poor at all locations. The study concluded that transport-related pollution in Calabar is significant with possible severe health consequences.

Utang and Peterside (2011) examined vehicular emissions during traffic peak periods in parts of Port Harcourt in Nigeria. The level of variation in concentration of emissions between peak and off peak periods of traffic, and between locations was determined. Only traces of SO_x (Oxides of Sulphur) were detected at all times and locations, while the concentration of CO was higher than the federal environmental protection agency limit and recommended municipal (local) standard. NO_x (Oxides of Nitrogen) was generally above the local and international standards in all the locations during peak traffic periods. They concluded that the city was under threat of traffic related pollution which was intensified by increasing population influx and heavy vehicular traffic.

Ojo and Awokola (2012) reported the results of the investigation of air pollution from automobiles at intersections on some selected major roads in Ogbomosho, South Western Nigeria. Four sampling routes were considered with ten sampling points (SP1- SP10) placed 2.0m away from the edge of the road. Priority parameters: SO_2, NO_x, CO were monitored. The results of SO_2, NO_x CO were in the range of 0.02-0.09ppm, 0.009-0.039ppm, and 1.79-51.38ppm respectively with peaks at traffic congestions and intersection points. Compared with standard; AQI (Air quality index) SO_2- rated very poor to good, NO_x - good to very good, CO-very good to moderate and moderate to poor in different locations. The study concluded that, it has become quite important to understand the role of mobile source emissions on air quality through well-designed studies, and that this information can provide important input for the formulation of effective air quality management strategies.

A study was conducted by Okelola and Appolonia (2013) on vehicular carbon emission concentration in Minna, Nigeria. In their study, they examined the trend of level of vehicular carbon footprints emissions in Minna, Niger State, Nigeria. It provided an insight into the obtainable emission levels in the selected flashpoints for the study. These flashpoints are spread across the city of Minna's road network. The measurements were achieved using gasman meters for each type of gas investigated in this study namely: carbon dioxide (CO_2), carbon monoxide (CO), sulphur dioxide (SO_2), ammonia (NH_3), nitrogen dioxide (NO_2), chlorine (Cl_2) and hydrogen suiphide (H_2S). The measurements were carried out at the peak and off peak traffic periods. The average emission values for the peak and off-peak times were calculated and also represented with the Arc-GIS software. The complete data was also computed and analyzed using appropriate statistical methods. The results established that emissions' level of carbon dioxide from vehicular emissions in particular exceeded internationally accepted safe limits of 350 parts per million in the atmosphere.

Prince and Essiet (2014) investigated pollution from automobiles during traffic peak periods at intersections on some selected roads in Uyo, Nigeria. They investigated selected air pollutants namely NO_2, CO, SO_2, and H_2S, in six sampling locations in Uyo during morning and evening (peak traffic hours) and afternoon (off-peak hours) periods. Concentration of CO was found to be higher during the peak periods of traffic congestion and intersections, when long waiting time for vehicles was recorded. Emission levels at this period exceeded the Federal Ministry of Environment limits/Standards. Also, the concentration of SO_2 was alarmingly high; especially in location C. Levels of Nitrogen oxides (NO_2) and Hydrogen sulphide (H_2S) varied in time and space and was also above recommended municipal and international standards in all the six locations during the peak traffic period.

Ucheje and Ikebude (2015) reported comparative analysis of vehicular emissions in urban and rural milieus .They analyzed the concentrations of carbon monoxide, Nitrogen dioxide and sulphur dioxide, in Port Harcourt (urban milieu) and Etche (Rural Milieu,). A simple random, sampling technique was adopted in selecting the sample locations cities. From the analysis, carbon monoxide gave the highest concentration in the two peak periods (morning and evening), and for both milieus; sulphur dioxide was found to have the lowest concentration, for both Port

Harcourt and Etche. The analysis showed that the urban milieu is more polluted than rural milieu, probably as a result of traffic congestion in Port Harcourt city.

The above studies by different scholars emphasized how vehicular traffic emissions have contributed immensely to urban air pollution. Similarly, there seems to be a serious threat of increased air pollutants concentration in urban cities. Conversely, these studies failed to properly establish a trend of air pollution contributed by vehicular emissions in urban milieus, for more than two seasons. This study therefore, bridged the gap, by investigating the contributions of vehicular emissions to air pollution for two years (24months), 2017-2018. The daytime pattern, monthly pattern, major traffic congested areas and factors that aid dispersion of air pollutants were considered.

Materials and Methods

Sampling Technique

Sampling stations for the study was identified using purposive method, based on existing information on traffic density in different parts of Port Harcourt, Nigeria. Utang and Peterside (2011) opined that there are ten high traffic density junctions in Port Harcourt, while the remaining is of medium to low density. Three (3) high traffic density locations (Rumuokoro roundabout, Rumuola and Location/Adageorge) were selected for the study, through stratified random sampling.

Method of Data Collection

Information was collected from each of the selected locations in three sessions, namely morning (7:00am to 9:00am), afternoon (12.00 noon-2.00pm) and evening (5:00pm to 8:00pm) periods.

According to Utang and Peterside (2011) the morning and evening are peak periods of traffic density while the afternoon is low density period in Port Harcourt. Each location was monitored from Mondays to Friday every month for twenty-four months. Information collected during each session of investigation includes:

Traffic Volume Count: The number of vehicles that cross a given point during each sampling session was collected using a close circuit television (Plate 5.1).

By Pollutant Monitoring: The pollutants monitored on each sampling day include; Carbon monoxide (CO), Sulphur dioxide (SO_2) and Particulate matters ($PM_{2.5}$ & PM_{10}). The concentration of CO and SO_2 were determined using MX6 Ibrid Multigas monitor hand held device and MET ONE GT 321 particulate matter counter for Particular matters ($PM_{2.5}$ & PM_{10}). Also, the meteorological parameters (wind speed, temperature, and humidity) were determined using Davis Vantage Vue Weather Station which was mounted at each of designated locations for the period specified.

Statistical Analysis

The data obtained through investigation was analyzed using appropriate descriptive and inferential statistical methods. Descriptive presentation include summary of data in tables and graphs. Difference of means between explanatory variables was analyzed using Independent t-test, for variables with only two means, one way analysis of variance (one way ANOVA) for more than two means, and Multiple Linear Regression (MLRM) for relationship between variables.

Result and Discussion

Table 1: Statistics of Pollutants, Meteorological variables and Traffic variables in the Analysis

Variables	N	Minimum	Maximum	Mean	Std. Deviation
CO (ppm)	1800	0.02	48.00	16.92	12.86
$PM_{2.5}$ (mg/L)	1800	6.00	336.00	140.65	92.21
PM_{10} (mg/L)	1800	13.00	327.00	142.50	91.07
SO_2 (ppm)	1800	0.00	1.66	0.18	0.28
Air temp (^oC)	1800	16.00	34.00	25.12	3.99
Wind speed (MS^{-1})	1800	1.28	2.39	1.39	0.13
Rel. Humidity (%)	1800	30.00	52.00	42.40	4.62
Traffic Volume (Vehicles/hr)	1800	11.00	1200.00	592	473

Table 1 revealed the concentration of air pollutants, meteorological variables and traffic volume within the study sites in Port Harcourt, Nigeria. The lowest mean concentration of all the air pollutants, and traffic volume were far lower than the maximum values. This demonstrates high variation pollutants and traffic volume respectively experienced between the two study years.

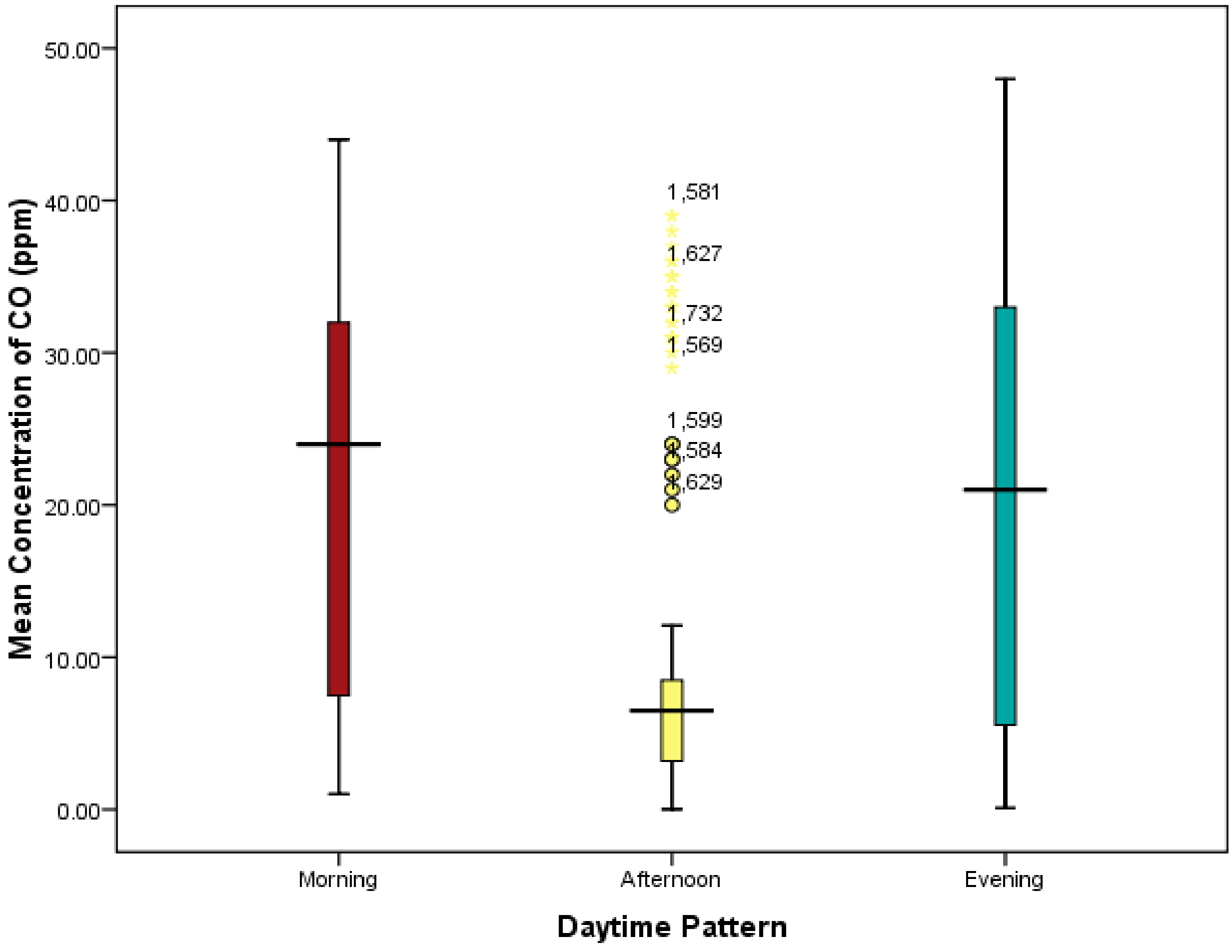

Figure 1: Daytime variations of CO concentration between 2017 and 2018 in Port Harcourt, Nigeria

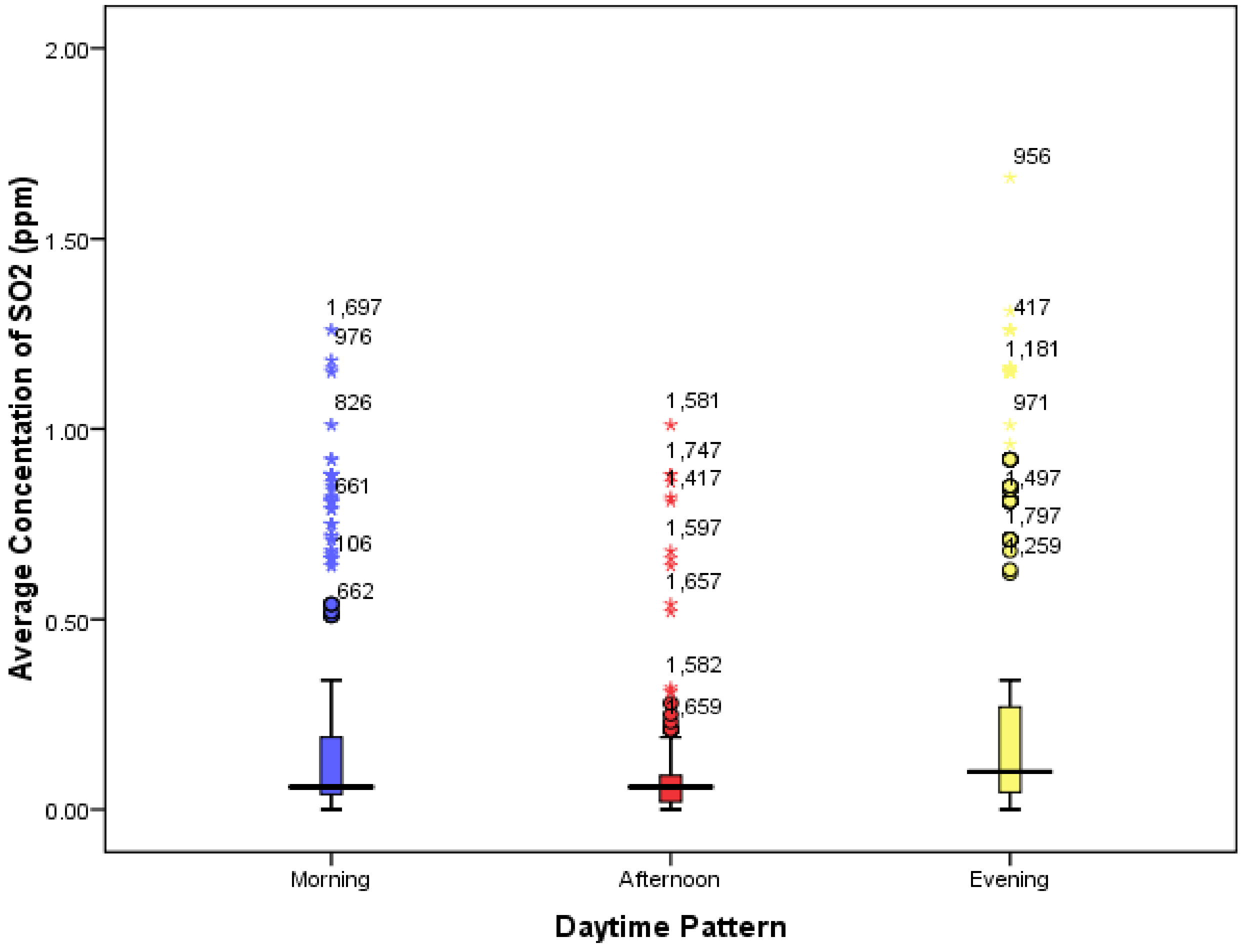

Figure 2: Daytime variations of SO_2 concentration between 2017 and 2018 in Port Harcourt, Nigeria

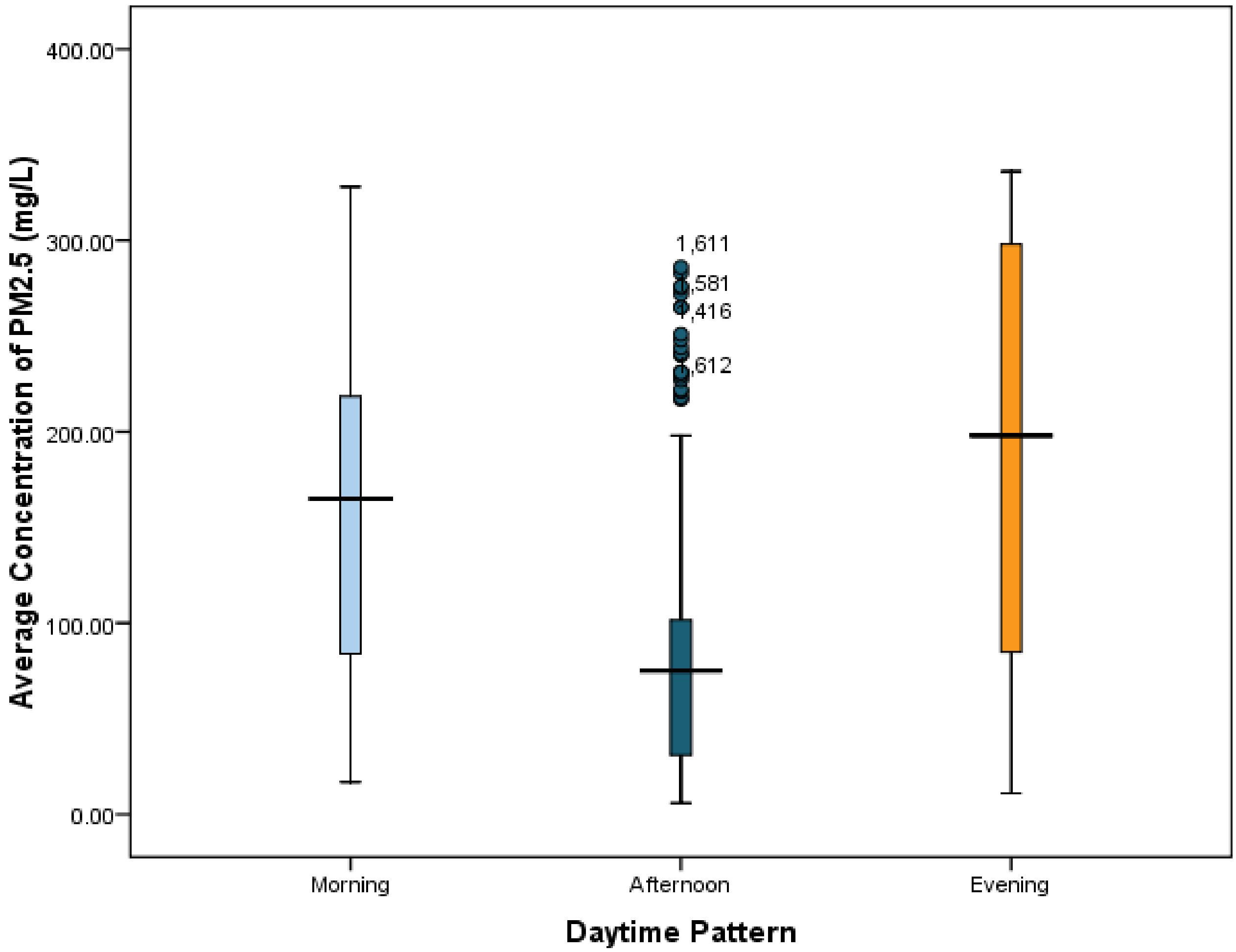

Figure 3: Daytime variations of $PM_{2.5}$ concentration between 2017 and 2018 in Port Harcourt, Nigeria

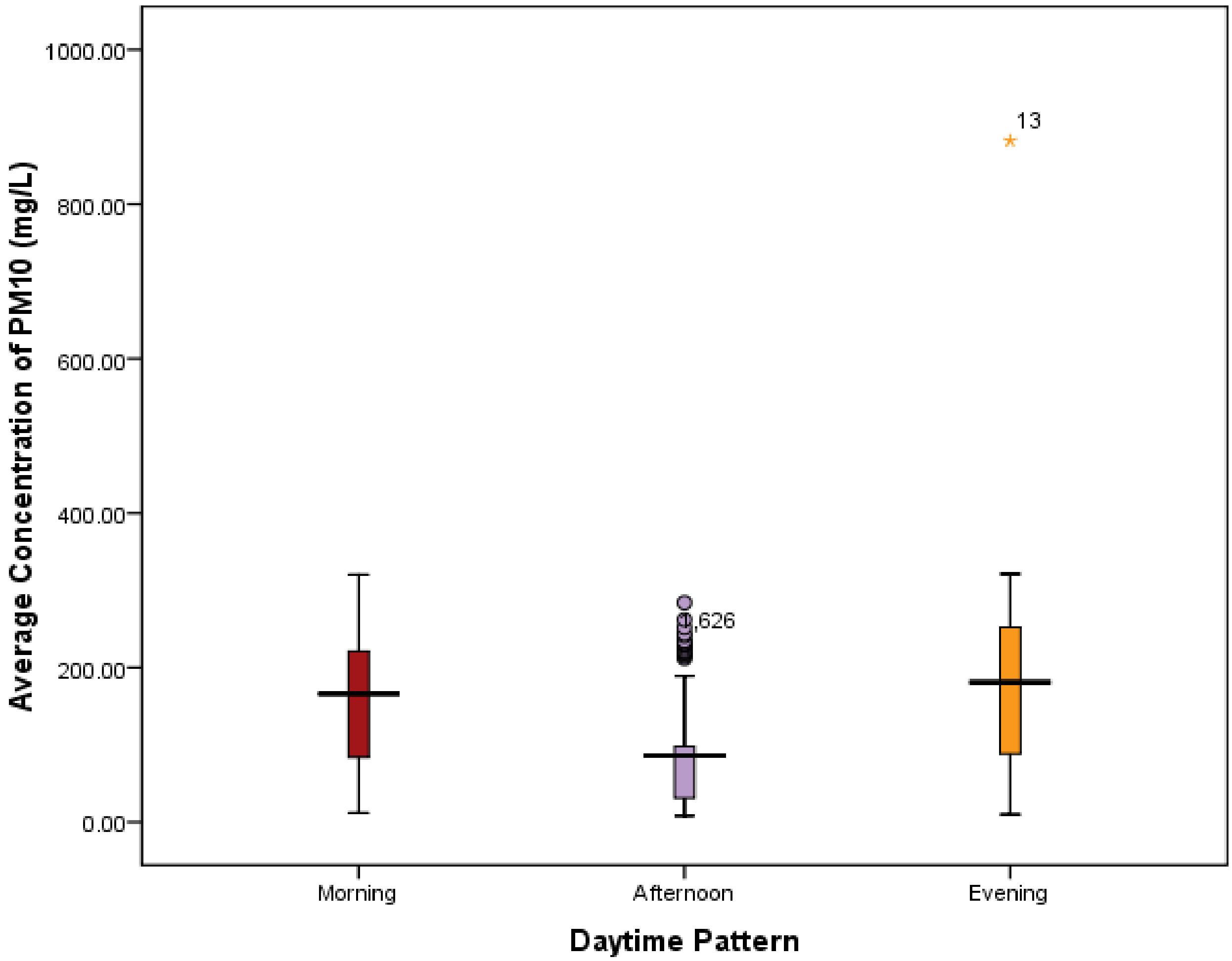

Figure 4: Daytime variations of PM_{10} concentration between 2017 and 2018 in Port Harcourt, Nigeria

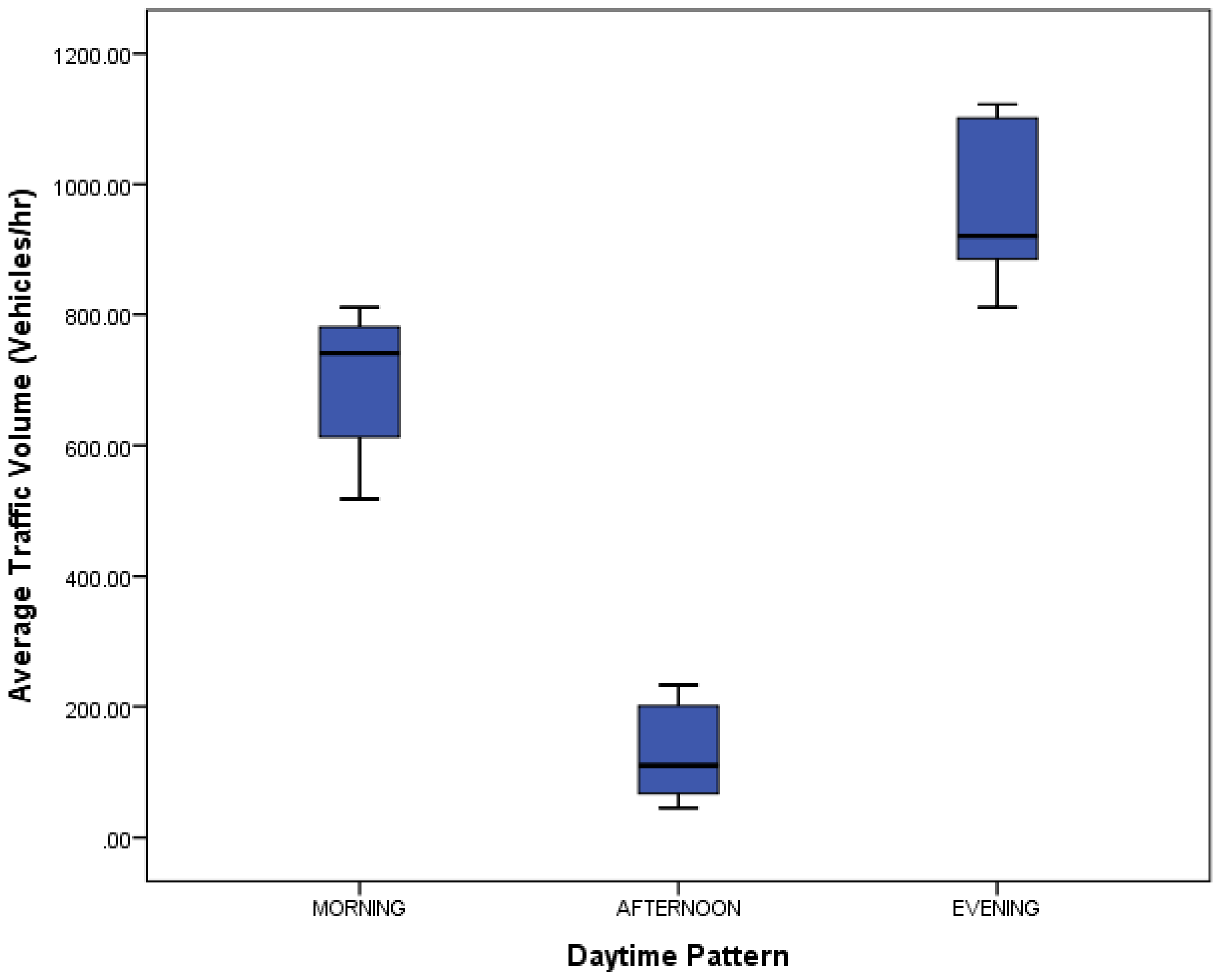

Figure 5: Daytime variations of traffic volume between 2017 and 2018 in Port Harcourt, Nigeria

Daytime distribution of air pollutants and traffic volume

Figures 1, 2, 3, 4 and 5, showed the concentration of air pollutants and traffic volume within the daytime in 2017 and 2018. The mean traffic volume was highest in the evening (956±109 vehicles/hr) and lowest in the afternoon peak (133±67 vehicles/hr) across the two study years. The overall mean concentration of CO was highest in morning peak (21.00±13.18ppm) and lowest in the afternoon peak (7.78±8.08ppm). Similarly, mean concentration of SO_2 occurred highest in the evening peak (0.26±0.35ppm) and lowest in the afternoon peak (0.08±0.11ppm). Furthermore, the overall mean concentration of $PM_{2.5}$ and PM_{10} were highest in the evening peak

(184.81±104.48mg/L) and (167.00±89.70mg/L) respectively and lowest in the afternoon peak (79.35±53.68mg/L) and (77.60±50.06mg/L) respectively. Statistically, mean concentration of all the pollutants exhibited a similar pattern in their trend of temporal variation and were significantly ($P<0.05$) different within the daytime. Similarly, the mean traffic volume varied highly and significantly ($P<0.05$) within the daytime, between the two study years. This can be attributed to the high traffic volume experience during the morning and evening hours within the Port Harcourt city, Nigeria.

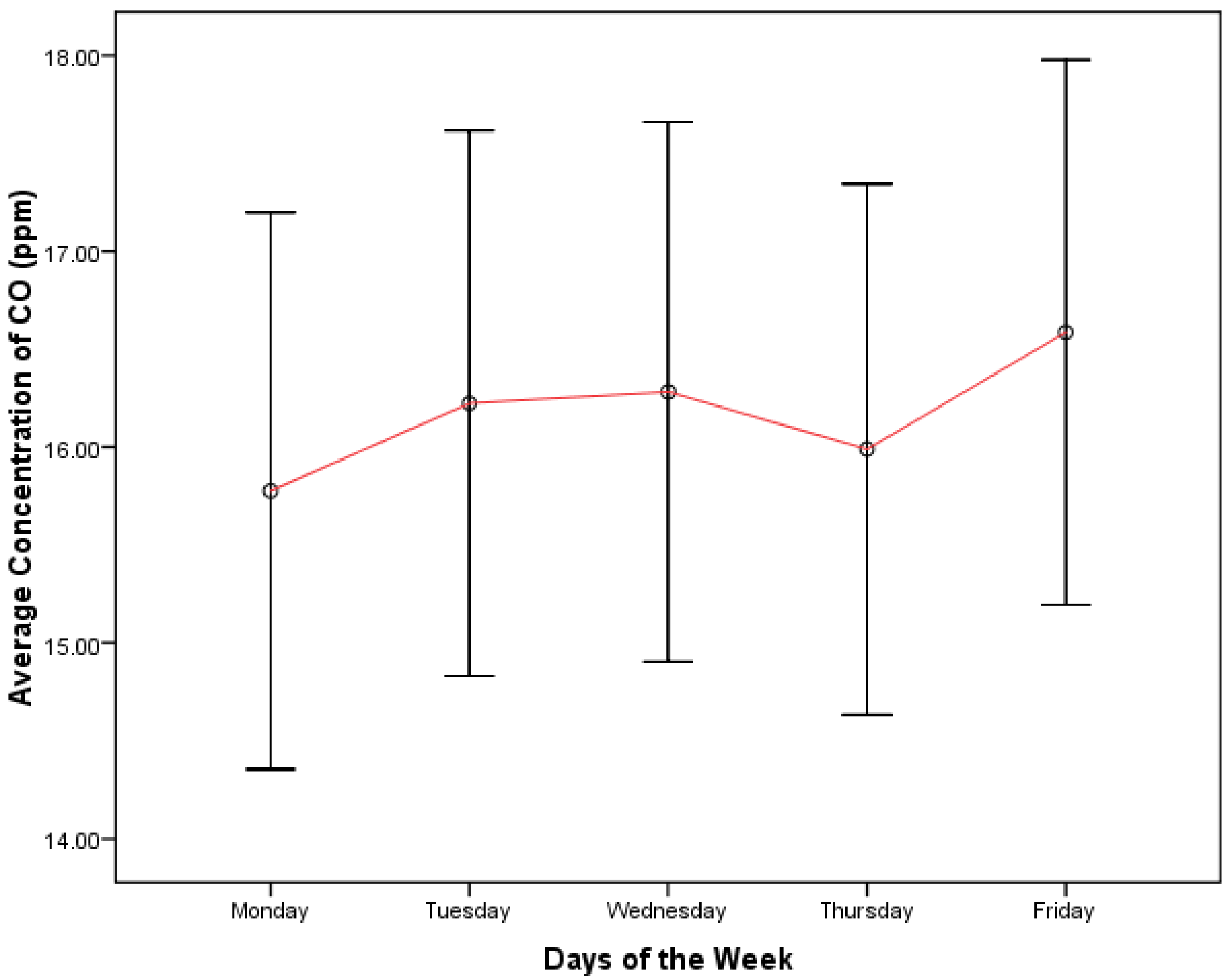

Figure 6: Days of the week variations of CO concentration between 2017 and 2018 in Port Harcourt, Nigeria

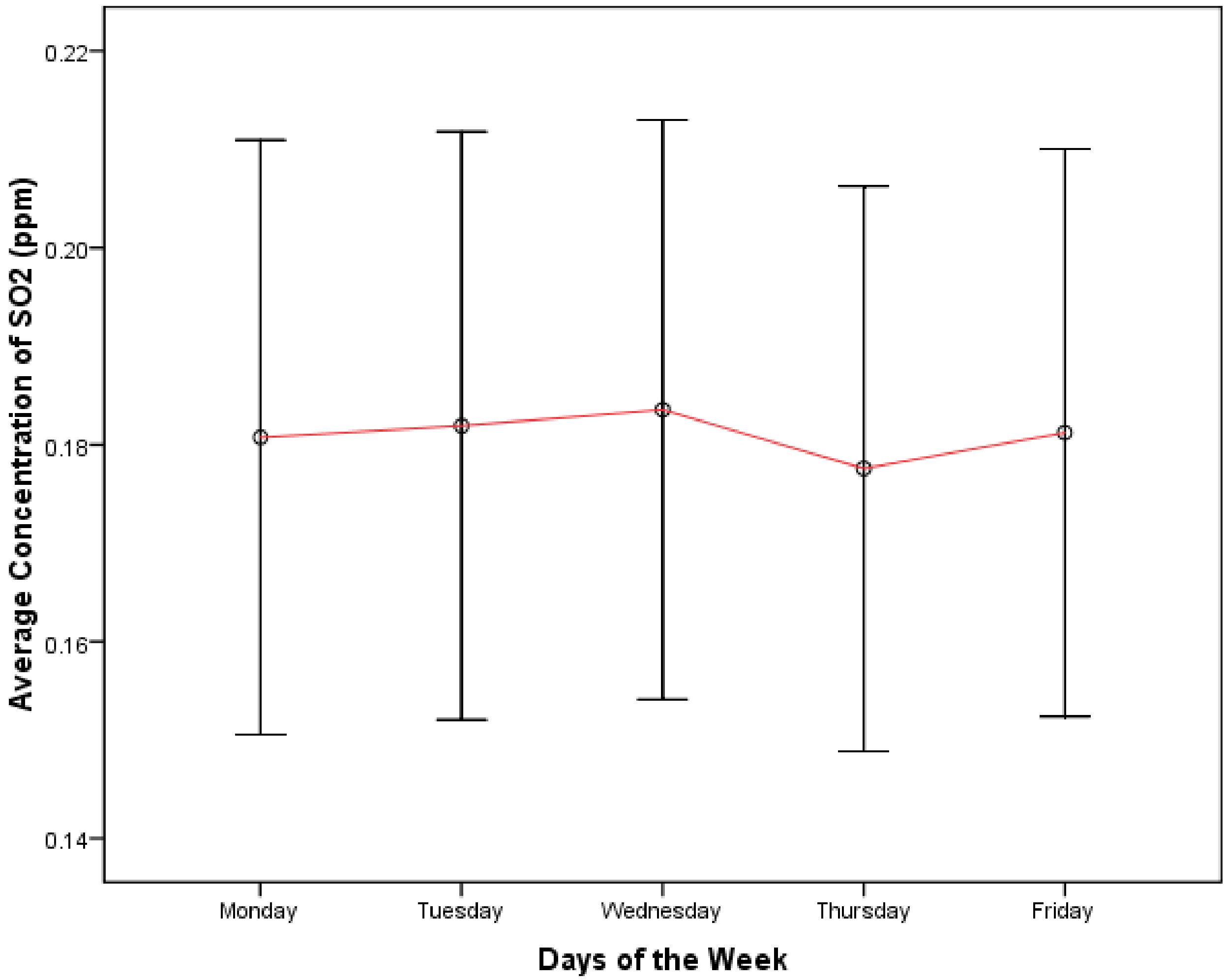

Figure 7: Days of the week variations of SO_2 concentration between 2017 and 2018 in Port Harcourt, Nigeria

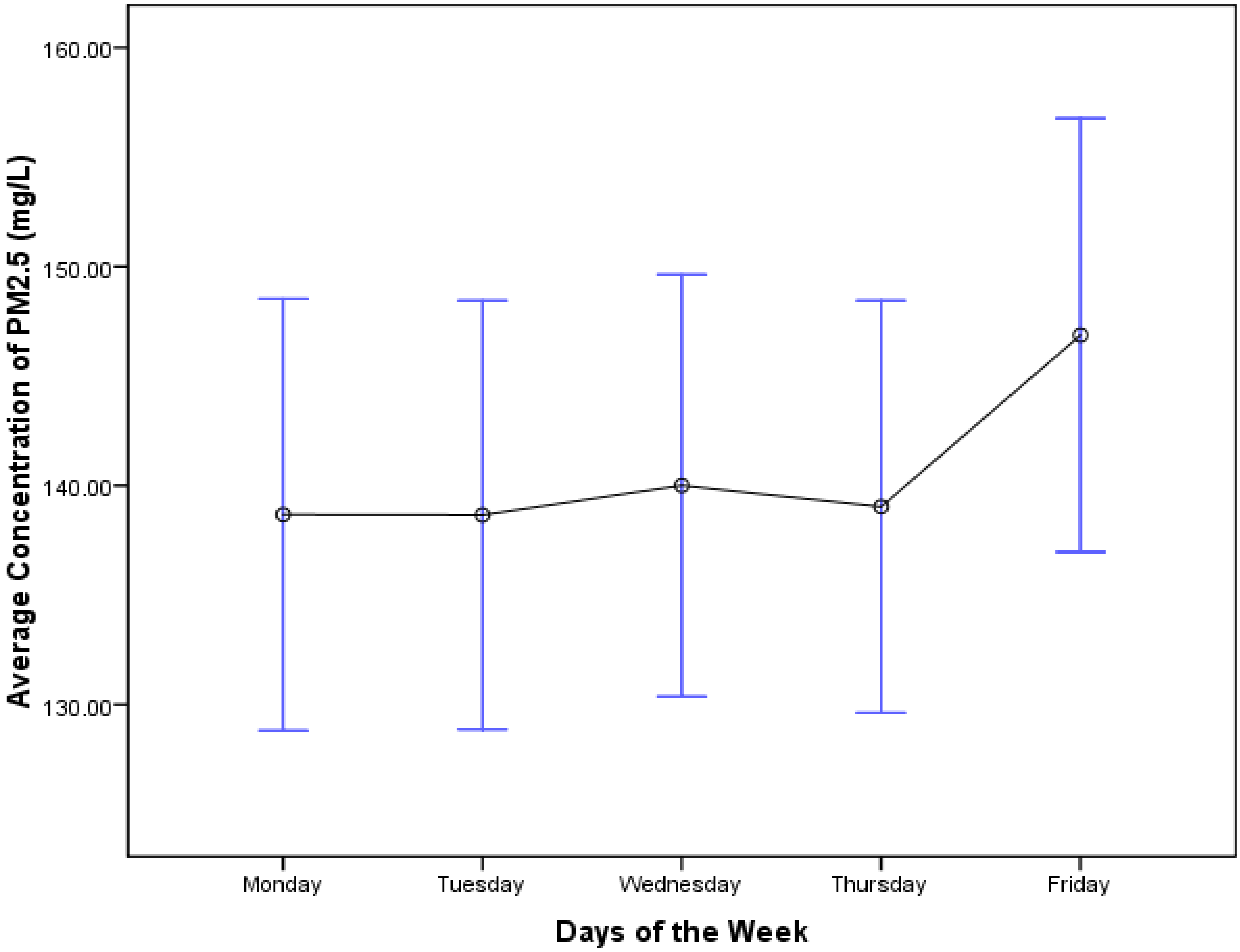

Figure 8: Days of the week variations of $PM_{2.5}$ concentration between 2017 and 2018 in Port Harcourt, Nigeria

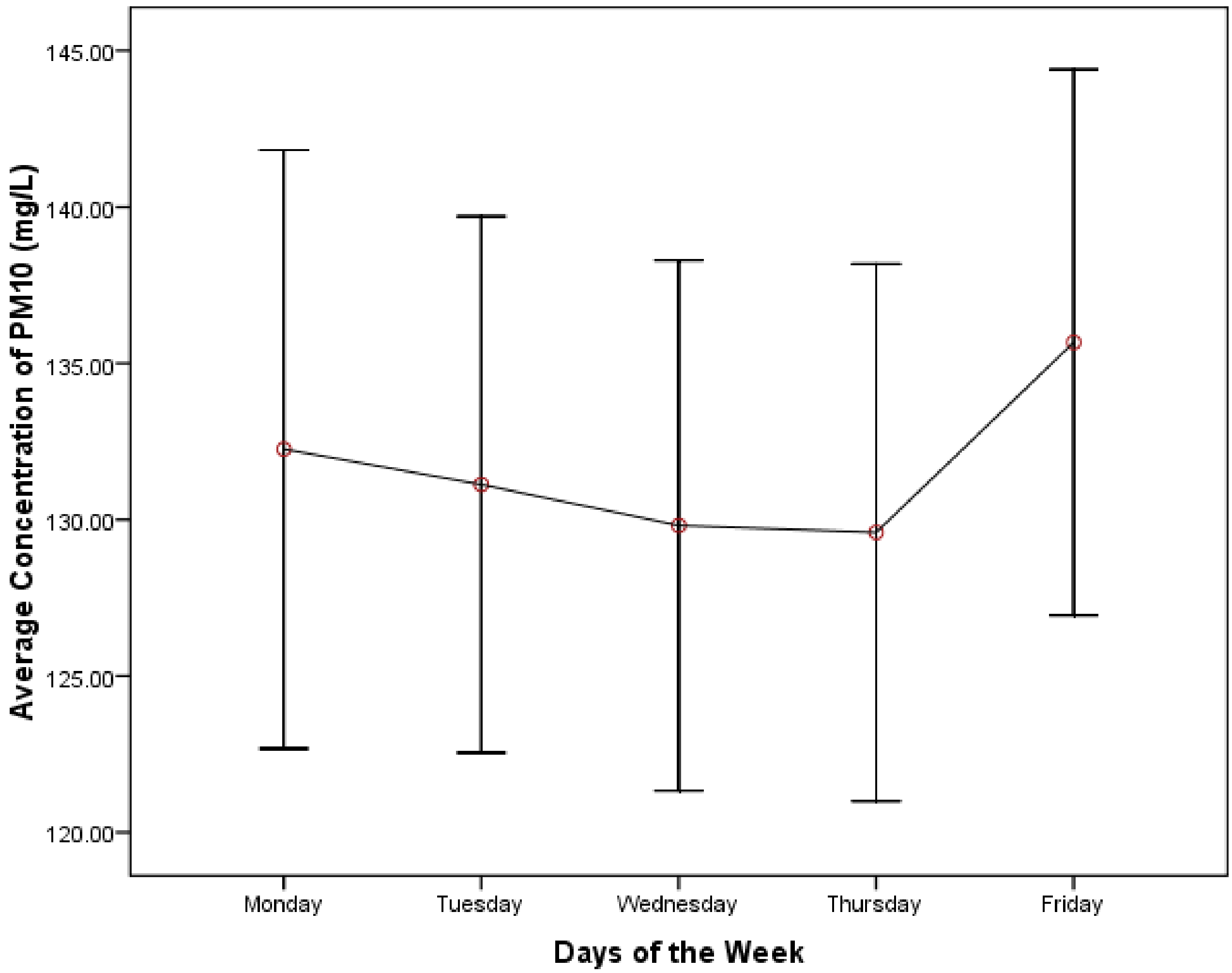

Figure 9: Days of the week variations of PM_{10} concentration between 2017 and 2018 in Port Harcourt, Nigeria

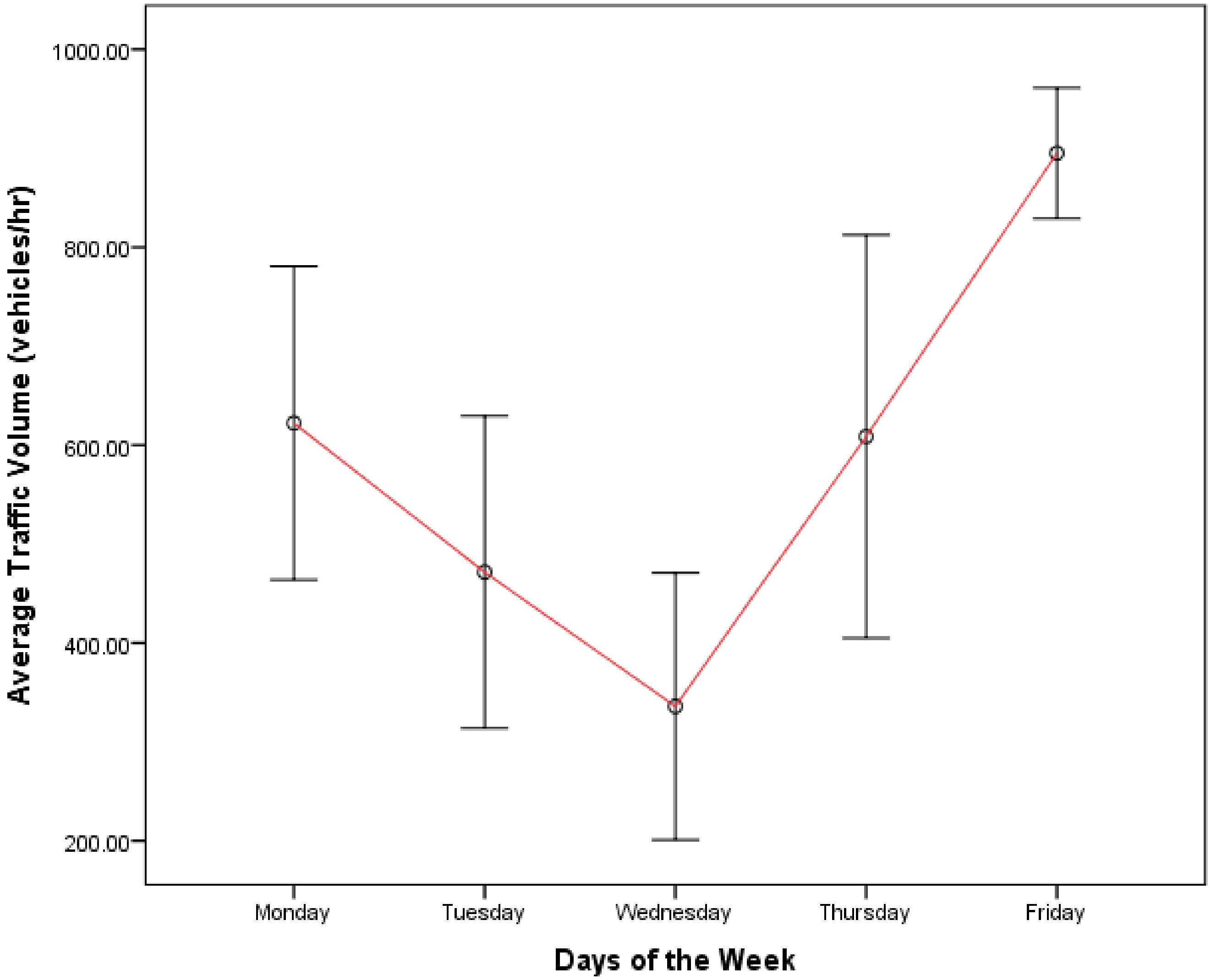

Figure 10: Days of the week variations of traffic volume between 2017 and 2018 in Port Harcourt, Nigeria

The pattern of air pollutants and traffic volume distribution at different days of the week

Figures 6, 7, 8, 9 and 10, show the concentration of air pollutants and traffic volume at different days of the week in 2017 and 2018. The mean concentration of CO, $PM_{2.5}$, and PM_{10} occurred highest on Friday at 16.59±13.42 ppm, 146.87±94.00 mg/L and 135.67±82.82 mg/L respectively. Conversely, the mean concentration of SO_2 occurred highest on Wednesday at 0.184±0.28 ppm. Traffic volume distribution was highest on Friday at 895±148 vehicles/hr. Statistical analysis showed that the variation in pollutants concentration over the different days of the week was not significantly ($p > 0.05$) different, while the average traffic volume was significantly ($p < 0.05$) different within the days of the week. The implication is that the more increase in concentration of pollutants apart from SO_2 experienced on Fridays , is most likely to be attributed to high traffic volume.

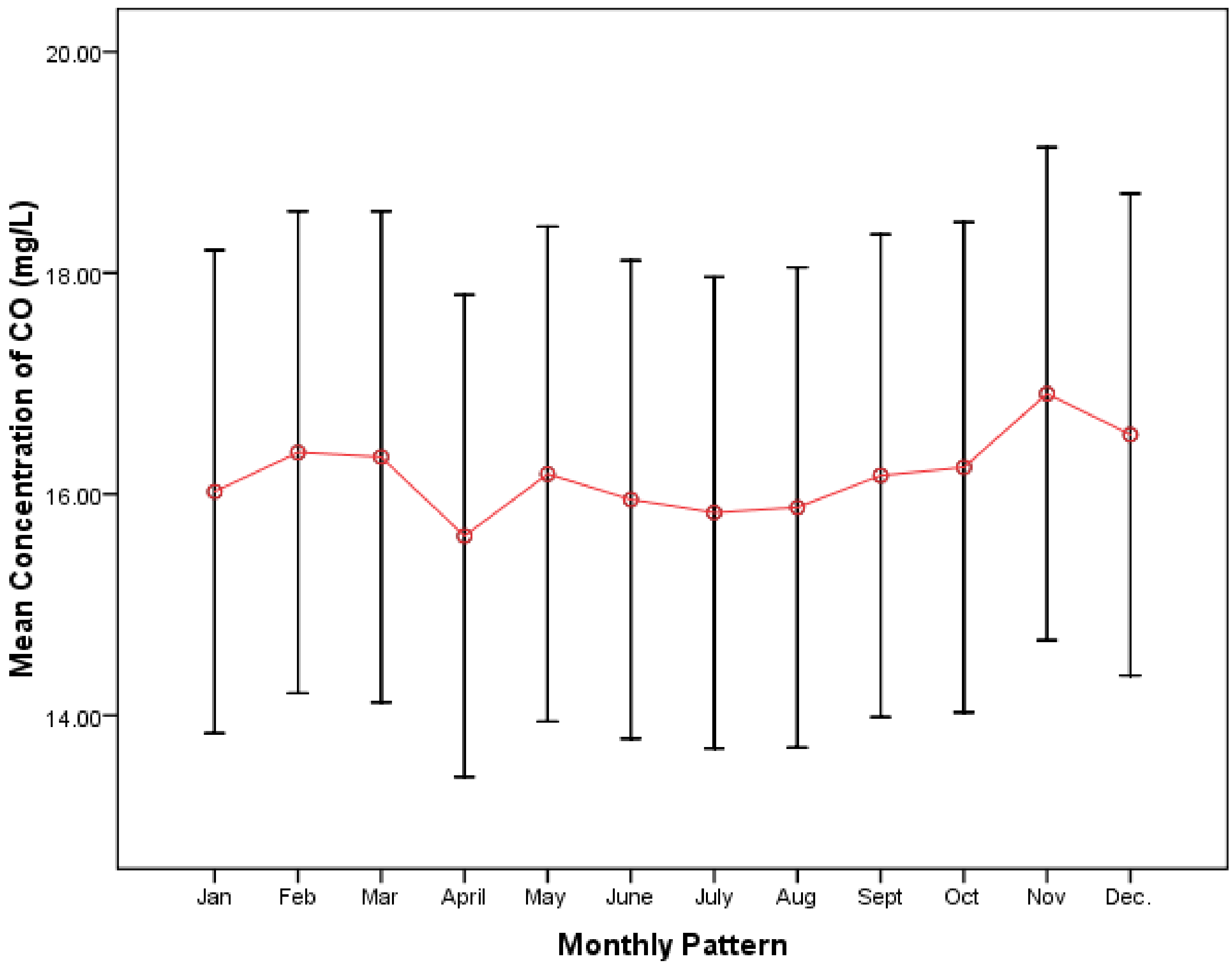

Figure 11: Monthly variations in CO concentration between 2017 and 2018 in Port Harcourt, Nigeria

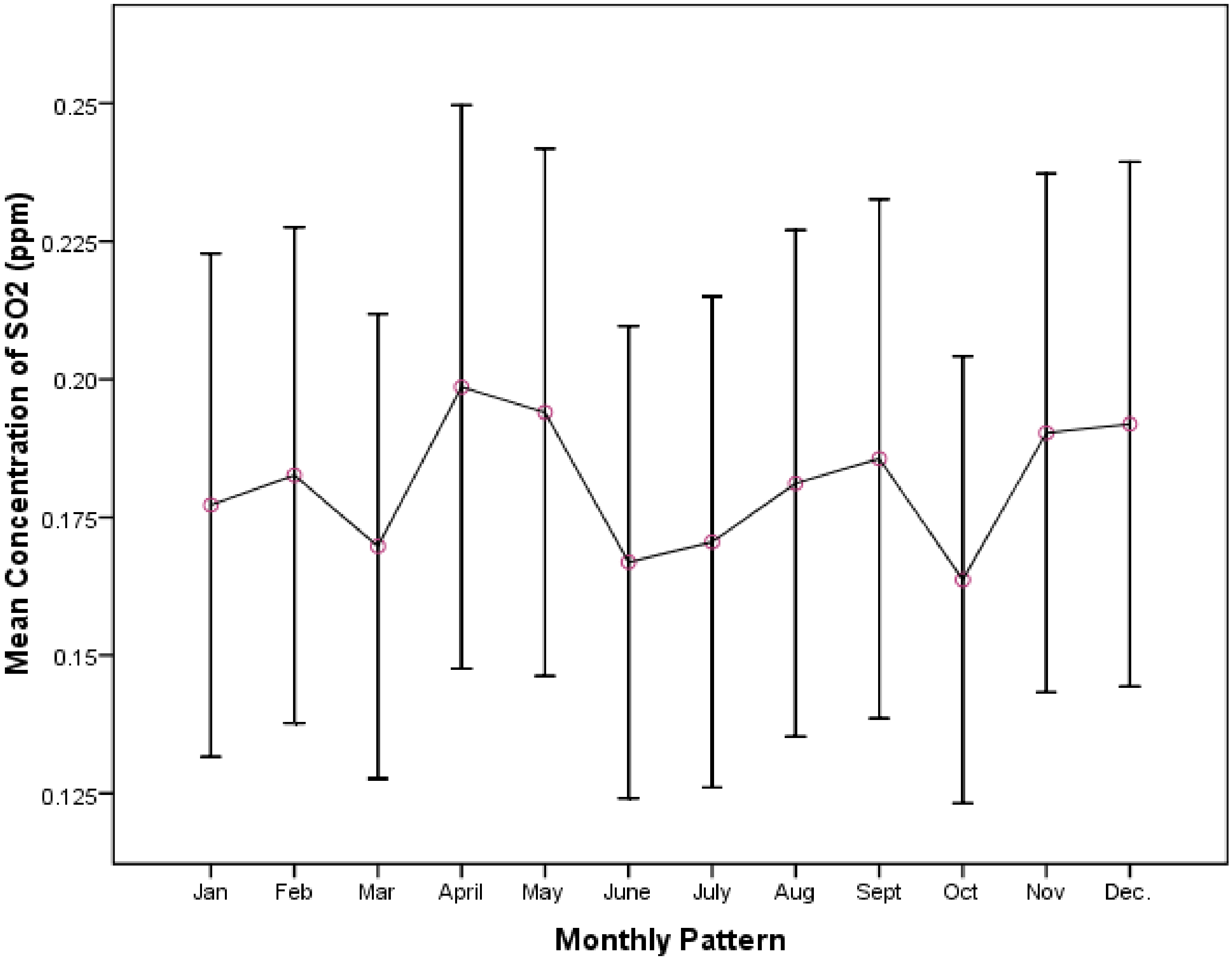

Figure 12: Monthly variations in SO_2 concentration between 2017 and 2018 in Port Harcourt, Nigeria

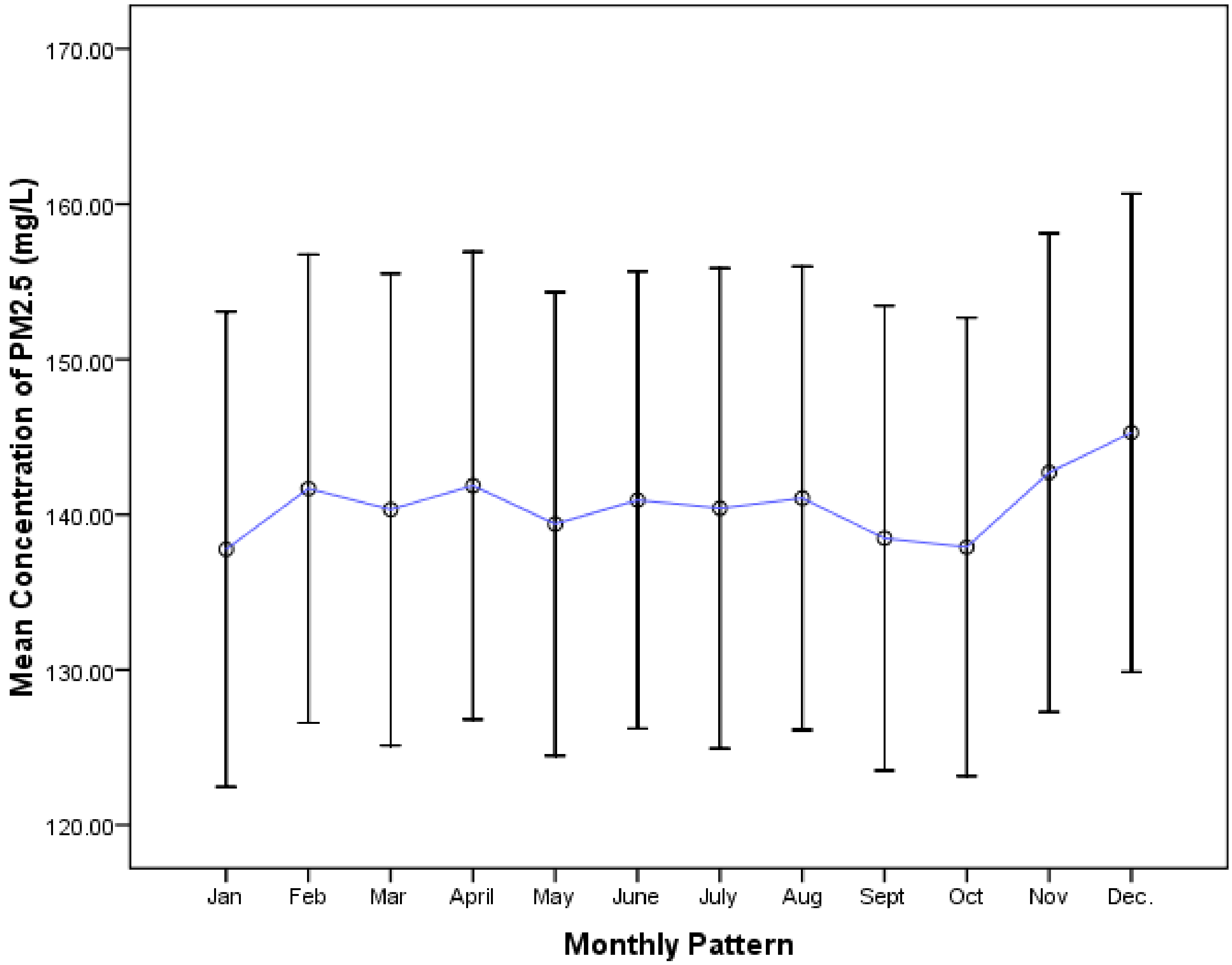

Figure 13: Monthly variations in $PM_{2.5}$ concentration between 2017 and 2018 in Port Harcourt, Nigeria

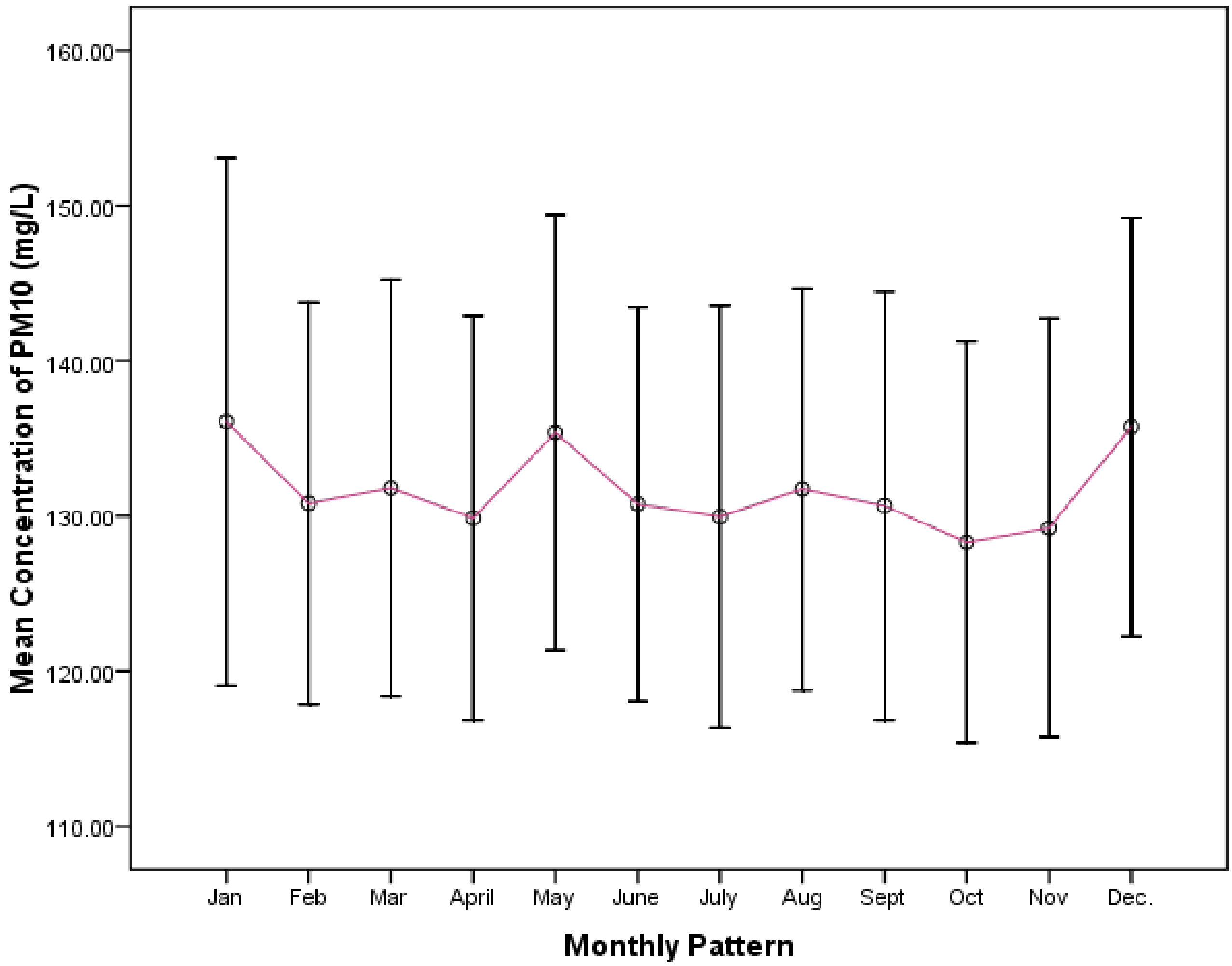

Figure 14: Monthly variations in PM_{10} concentration between 2017 and 2018 in Port Harcourt, Nigeria

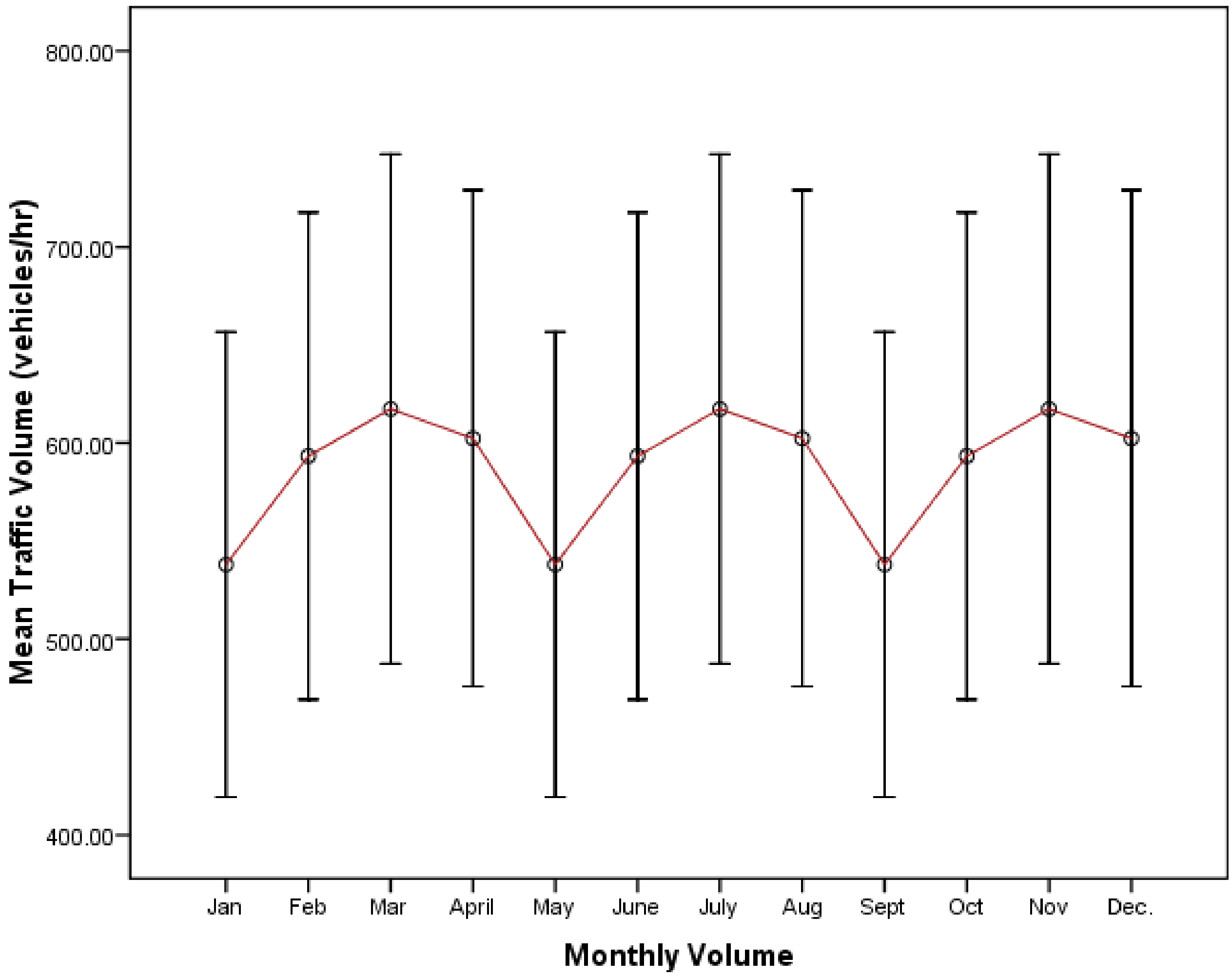

Figure 15: Monthly traffic volume between 2017 and 2018 in Port Harcourt, Nigeria

The pattern of monthly distribution of pollutants and traffic volume is shown in Figures 11 to 15

Figures 11, 12, 13, 14 and 15 revealed the monthly concentration of air pollutants and traffic volume within the study areas in Port Harcourt, Nigeria. The mean concentration of all the pollutants varied slightly between January to December. CO concentration occurred highest (16.91±13.65 ppm) in November and lowest (15.62±13.36 ppm) in the month of April. However, SO_2 recorded the highest concentration (0.20±0.31 ppm) in the month of April and lowest concentration (0.16±0.25 ppm) in October. For particulate matters, mean concentration of $PM_{2.5}$ occurred highest (145.27±94.31m/L) and lowest (137.77±93.69 m/L) in the month of December and January respectively; highest (136.08±104.06m/L) and lowest (129.23±82.63 m/L) concentration of PM_{10} was recorded in January and November respectively. Furthermore, the average traffic volume occurred highest (617±796 vehicles/hr) in March, July and August and lowest (538±726 vehicles/hr) in January, May and September respectively. Statistically, air pollutants and traffic volume did not varied significantly ($p>0.05$) between the month of January to December.

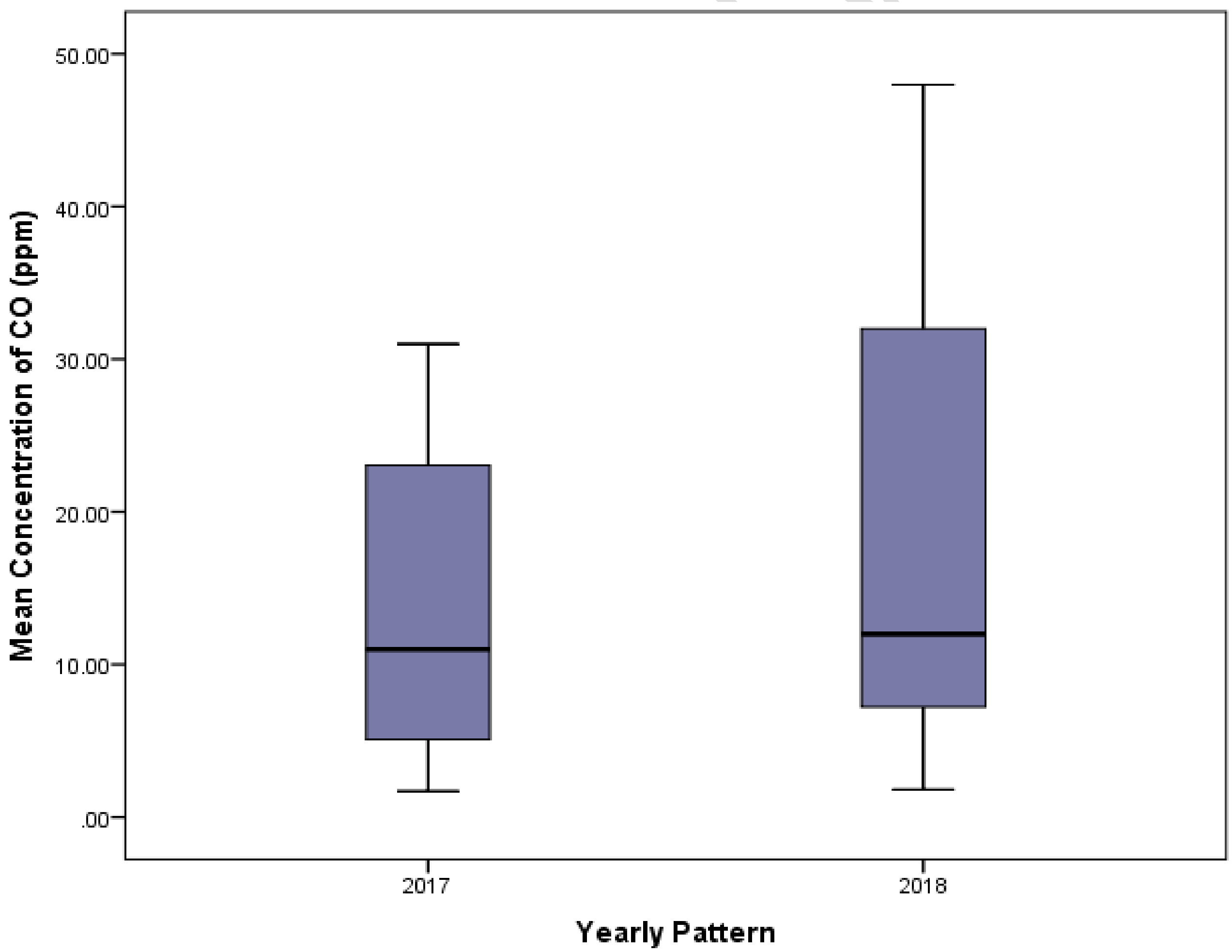

Figure 16: Annual variations in CO concentration between 2017 and 2018 in Port Harcourt, Nigeria

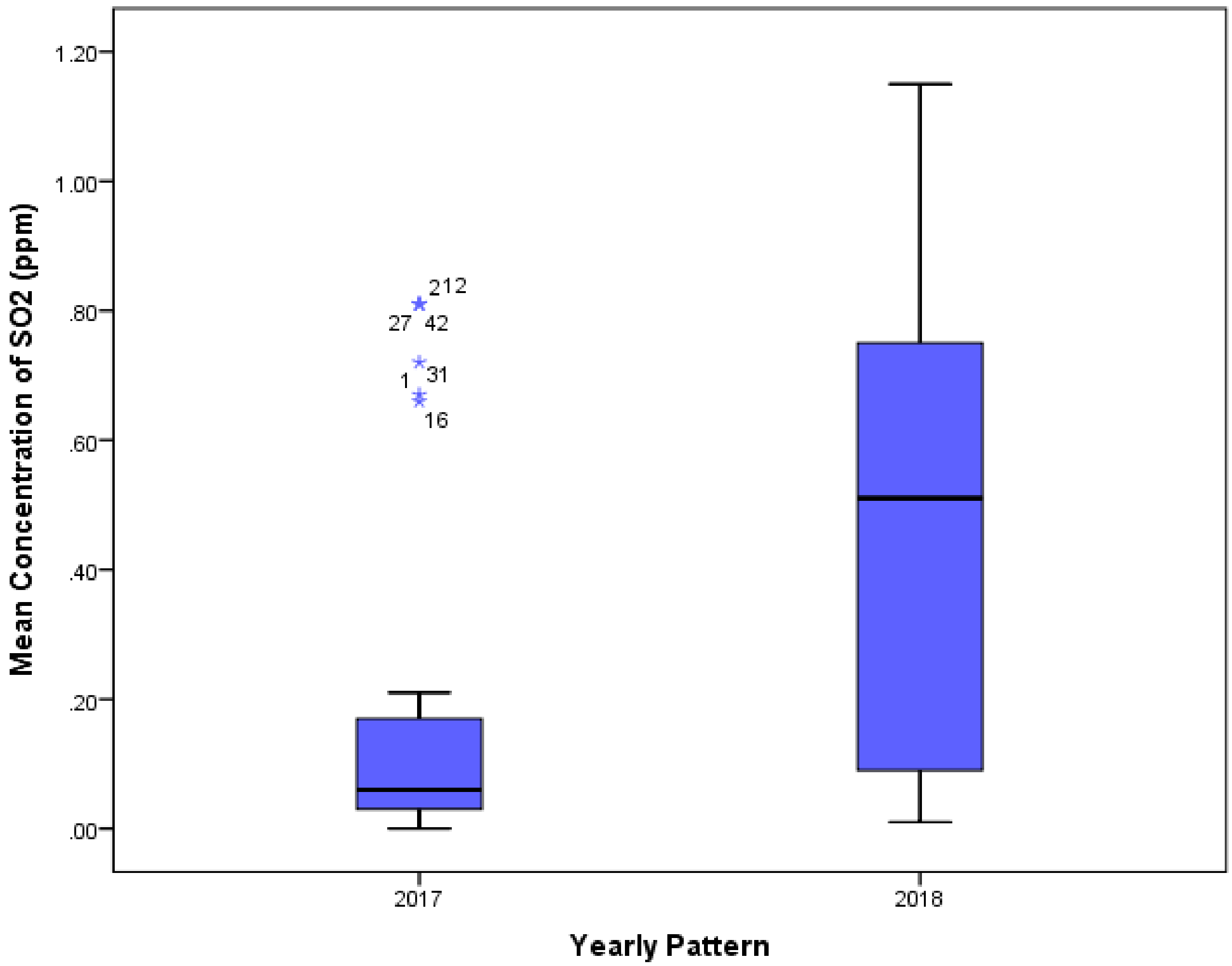

Figure 17: Annual variations in SO_2 concentration between 2017 and 2018 in Port Harcourt, Nigeria

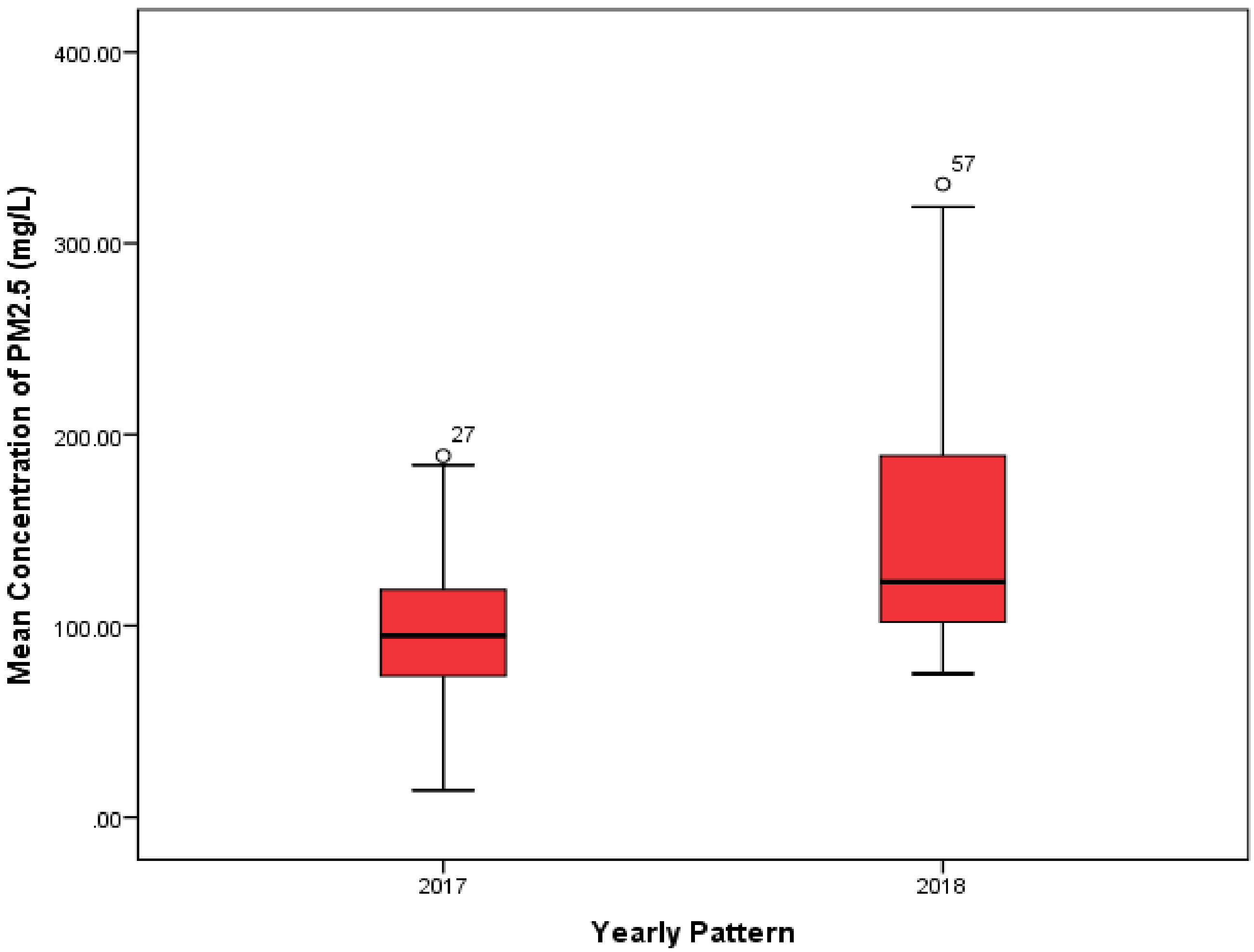

Figure 18: Annual variations in $PM_{2.5}$ concentration between 2017 and 2018 in Port Harcourt, Nigeria

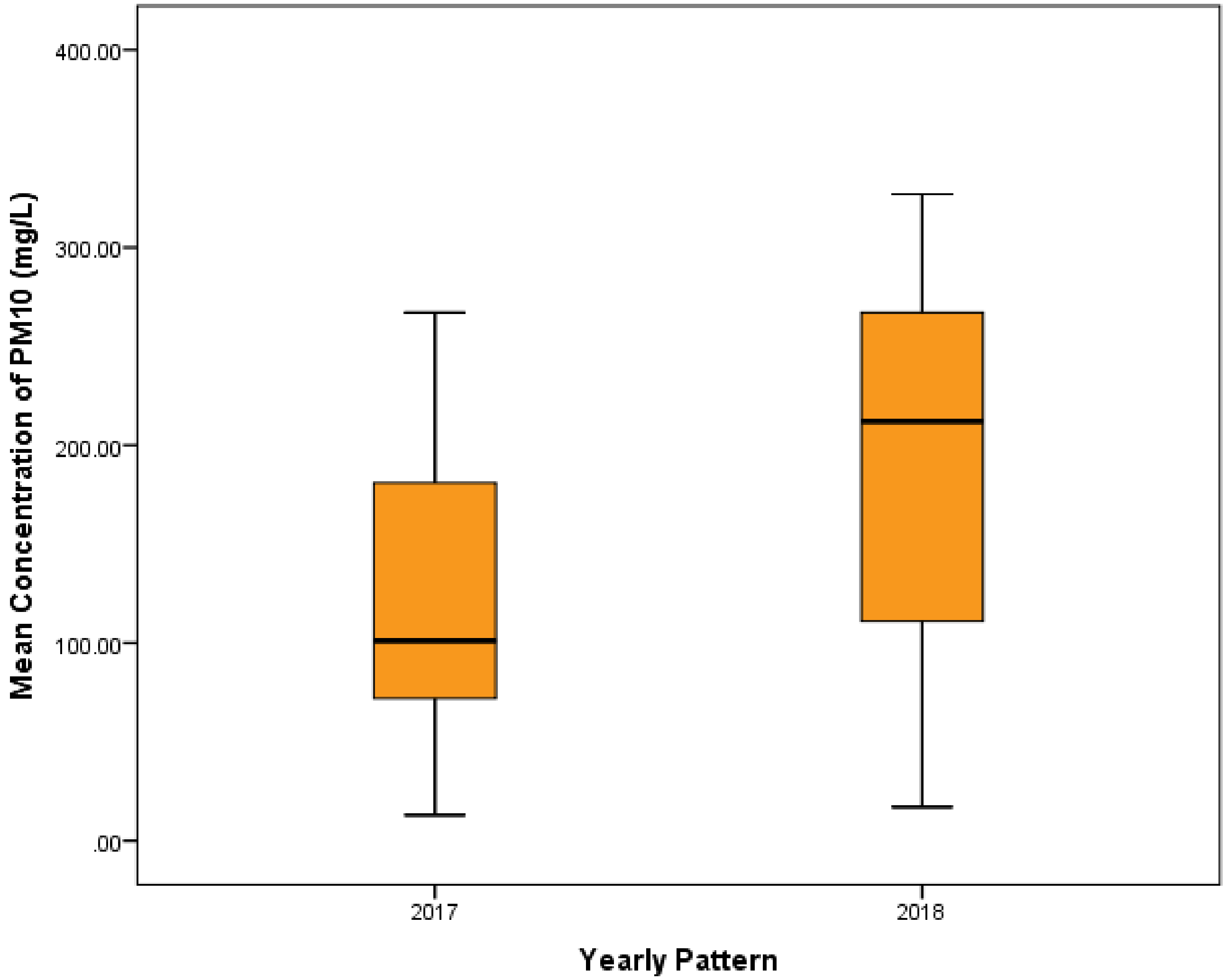

Figure 19: Annual variations in PM_{10} concentration between 2017 and 2018 in Port Harcourt, Nigeria

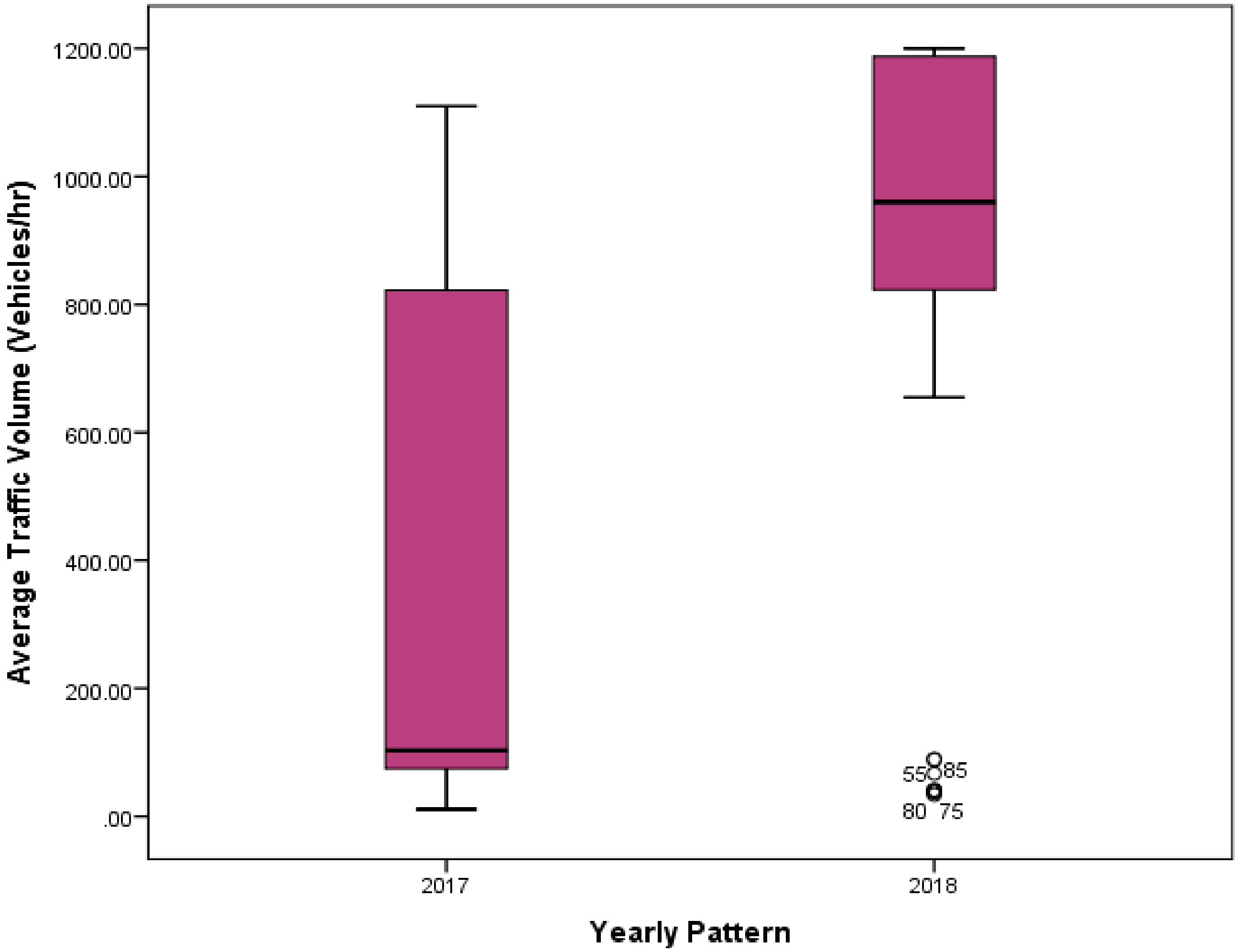

Figure 20: Annual variations in traffic volume between 2017 and 2018 in Port Harcourt, Nigeria

Seasonal distribution of air pollutants and traffic volume

Figure 16 to 20 revealed the concentration of the air pollutants and traffic volume in 2017 and 2018. The overall mean concentration of CO was not stable in the two years, increasing highly and significantly from 16.47±13.34 ppm in 2017 to 20.25±14.62 ppm in 2018. The corresponding values for the other pollutants were SO_2 (0.18±0.28 ppm in 2017 to 0.35±0.33 ppm in 2018); $PM_{2.5}$ (140.04±91.21 mg/L in 2017 to 157.16±75.82 mg/L in 2018) and PM_{10} (132.06±84.21mg/L in 2017 to 193.32±90.67mg/L in 2017). Furthermore, average traffic volume is (522±726 vehicles/hr in 2017 to 839±423 vehicles/hr in 2018). Therefore, all the pollutants exhibited a similar pattern in their trend of temporal variation, the lower concentration of each occurring in 2017 while the higher occurred in 2018. Statistical analysis revealed that, the concentration of all the air pollutants and traffic volume varied significantly ($p < 0.05$) between 2017 and 2018.

Table 2: Relationship between AT, WS, RH and TV on Mean Concentration of CO in the Study Areas (2017-2018)

Dependent Variables (Y)	Independents Variables(X)	N	Mean ± SD	T-value	B	P-value	R^2
	Air Temp	1800	25.12±3.99	25.123	2.972	0.004	
CO	Wind Speed	1800	1.39±0.13	-1.836	-0.157	0.874	0.637
	Rel. Humidity	1800	42.40±4.62	-2.455	-0.123	0.024	
	Traffic Volume	1800	592.00±473.00	4.773	0.012	0.000	
Constant				1.331	34.093	0.187	

Table 2 presented the result of multiple regression analysis of air temperature (AT), wind speed (WS), relative humidity (RH) and traffic volume (TV) on the concentration of CO within the study areas of Port Harcourt, Nigeria. The concentration of CO increased with increasing air temperature, relative humidity and traffic volume. However, air temperature, relative humidity and traffic volume were significantly ($P<0.05$) predictive of CO. The coefficient of determination ($R^2 = 0.637$) revealed that 63.7% variation in concentration of CO can be explained by air temperature, wind speed, relative humidity and traffic volume.

Table 3: Relationship between AT, WS, RH and TV on Mean Concentration of SO_2 in the Study Areas (2017-2018)

Dependent Variables (Y)	Independents Variables(X)	N	Mean ± SD	T-value	B	P-value	R^2
	Air Temp	1800	25.12±3.99	12.204	0.019	0.000	
SO_2	Wind Speed	1800	1.39±0.13	-0.657	-0.073	0.511	0.742
	Rel. Humidity	1800	42.40±4.62	-2.619	-0.004	0.009	
	Traffic Volume	1800	592.00±473.00	14.540	0.001	0.000	
Constant				4.830	0.852	0.004	

Table 3 showed the result of multiple regression analysis of air temperature (AT), wind speed (WS), relative humidity (RH) and traffic volume (TV) on the concentration of SO_2 within the study areas of Port Harcourt, Nigeria. The concentration of SO_2 increased with increasing air temperature, relative humidity and traffic volume. However, air temperature, relative humidity and traffic volume were significantly ($P<0.05$) predictive of SO_2. The coefficient of determination ($R^2 = 0.742$) revealed that 74.2% variation in concentration of SO_2 can be explained by air temperature, wind speed, relative humidity and traffic volume.

Table 4: Relationship between AT, WS, RH and TV on Mean Concentration of $PM_{2.5}$ in the Study Areas (2017-2018)

Dependent Variables (Y)	Independents Variables(X)	N	Mean ± SD	T-value	B	P-value	R^2
	Air Temp	1800	25.12±3.99	-41.611	-18.802	0.000	
$PM_{2.5}$	Wind Speed	1800	1.37±0.06	3.546	156.115	0.020	0.881
	Rel. Humidity	1800	39.20±4.10	0.752	0.484	0.604	
	Traffic Volume	1800	588.00±763.00	8.712	10.201	0.001	
Constant				2.999	335.222	0.003	

Table 4 showed the result of multiple regression analysis of air temperature (AT), wind speed (WS), relative humidity (RH) and traffic volume (TV) on the concentration of $PM_{2.5}$ within the study areas of Port Harcourt, Nigeria. The concentration of $PM_{2.5}$ increased with increasing air temperature, wind speed and traffic volume. However, air temperature, wind speed and traffic volume were significantly ($P<0.05$) predictive of $PM_{2.5}$. The coefficient of determination (R^2 = 0.881) revealed that 88.1% variation in concentration of $PM_{2.5}$ can be explained by air temperature, wind speed, relative humidity and traffic volume.

Table 5: Relationship between AT, WS, RH and TV on Mean Concentration of PM_{10} in the Study Areas (2017-2018)

Dependent Variables (Y)	Independents Variables(X)	N	Mean ± SD	T-value	B	P-value	R^2
	Air Temp	1800	25.12±3.99	-22.301	-24.611	0.000	
PM_{10}	Wind Speed	1800	1.37±0.06	5.421	88.002	0.010	0.798
	Rel. Humidity	1800	39.20±4.10	0.752	0.484	0.411	
	Traffic Volume	1800	588.00±763.00	11.306	10.201	0.006	
Constant				5.122	117.112	0.008	

Table 5 presented the result of multiple regression analysis of air temperature (AT), wind speed (WS), relative humidity (RH) and traffic volume (TV) on the concentration of PM_{10} within the study areas of Port Harcourt, Nigeria. The concentration of PM_{10} increased with increasing air temperature, wind speed and traffic volume. However, air temperature, wind speed and traffic volume were significantly ($P<0.05$) predictive of PM_{10}. The coefficient of determination (R^2 = 0.798) revealed that 79.8% variation in concentration of PM_{10} can be explained by air temperature, wind speed, relative humidity and traffic volume.

Conclusion

The study revealed statistically that mean concentration of all the pollutants exhibited a similar pattern in their trend of temporal variation and were significantly ($P<0.05$) different within the daytime. Similarly, the mean traffic volume varied highly and significantly ($P<0.05$) within the daytime, between the two study years. This can be attributed to the high traffic volume experience during the morning and evening hours within the Port Harcourt city, Nigeria. It was deduced that average traffic volume was significantly ($p < 0.05$) different within the days of the week, meaning that the more increase in concentration of pollutants apart from SO_2 experienced on Fridays , is most likely to be attributed to high traffic volume. Furthermore, all the pollutants exhibited a similar pattern in their trend of temporal variation, the lower concentration of each occurring in 2017 while the higher occurred in 2018. Statistical analysis revealed that, the concentration of all the air pollutants and traffic volume varied significantly ($p < 0.05$) between 2017 and 2018.

These findings agreed with those of Ojo and Awokola (2012) which investigated the effects of traffic volume on air pollution along four major roads in Ogbomosho, South Western Nigeria. Their findings revealed that the concentration of SO_2, NO_x, CO in all sample locations were higher than regulation standards. They concluded that their study area was highly polluted and attributed this to heavy traffic congestion in the areas. Similar studies in Lagos, Ibadan and Ado - Ekiti in South-west Nigeria also corroborated the findings of this investigation (Koku and Osuntogun, 1999). The study revealed that in each of the cities, the highest concentration of pollutants (CO, NO_2, and SO_2) was recorded in areas where the highest volume of traffic was also recoded. The finding of these studies thus, unequivocally confirmed the positive relationship between pollutants pollution of air and traffic density.

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