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# Research of air quality in closed car parks in Konya Province

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**Graphical abstract**

**Abstract**

Nowadays, due to the development of the world, harmful gases and vapours have begun to enter the atmosphere significantly, so we are faced with the problem of air pollution and its low quality. This paper, therefore, focused on enclosed car parks, a parking system that needs to be well examined from an environmental perspective. It is not possible to predict in advance what levels of pollution from engines burning fossil fuels will reach in indoor environments. Because many factors can affect the concentration, such as vehicle type and fuel ventilation, as well as cumulative vehicle emissions in the environment. This study presents the relationship between indoor meteorology factors and pollutants besides evaluating the air quality in closed car parks by collecting the concentration of emitting pollutants. The data were aggregated from five garages in the centre of Konya province. The data were analyzed by using the program SPSS statistics 25. It has been mentioned the points that must be considered, measurements and suggestions to reduce air pollution in the car parks. Correlation coefficients showing the relationship between indoor air quality parameters and their importance levels were determined. According to the significance level, $\alpha = 0.05$; It has been determined that there is a highly positive and significant relationship between indoor particulate matter ($PM_{2.5}$, $PM_{10}$). In addition, it was determined that there was a moderate and significant relationship between temperature and $CO_2$ value. In addition, it has been determined that there is a weak positive relationship between particulate matter ($PM_{2.5}$ and $PM_{10}$) and gases ($CO_2$ and CO) values, and between CO, $PM_{2.5}$ and $PM_{10}$ and Temperature value. There was a weak negative significant relationship between temperature and relative humidity. Pearson correlation analysis showed that $CO_2$ concentration had a strong correlation with temperature (r: 0.547, p: 0.00).When the measurement results were evaluated, it was observed that the $PM_{2,5}$ and $PM_{10}$ levels in all car parks exceeded EPA, WHO specified standards, but the $CO_2$ and CO concentrations were at acceptable levels according to the specified values, suggesting that certain ventilation measures need to be taken to reduce the concentration of pollutants in the garage.

**Keywords:** Air quality, carbon dioxide, carbon monoxide, parking garages, particulate matter

## 1. Introduction

With the growth of Turkey's population and the development of technology in the world, the number of vehicles on the road is increasing day by day, especially the increase in the number of cars has brought the increase of closed parking lots. City. There are many types of car park layouts: underground garages, car parks, multi-storey concept car parks. Smaller garages are usually naturally ventilated, while larger garages have mechanical ventilation systems. Most indoor car parks are operated by individuals or companies, and it consists of indoor car parks operating in dense urban areas where trade and commercial centres are located, with the most common indoor car parks located in shopping malls. Many employees work in these parking lots, such as parking, securing, cleaning, and collecting parking fees (Kurtuluş *et al*., 2021). Recent research and legislation have paid increasing attention to air pollution due to its impact on human health and overall environmental quality. Vehicle exhaust is a complex mixture derived from unburned fuel, lubricants and combustion products. Its main components are carbon monoxide (CO), carbon dioxide ($CO_2$), nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), volatile organic compounds (VOCs) and particulate matter (Baltrėnas, 2006). These emissions are released directly from the vehicle into the air in the garage. Exhaust gas is a term for emissions from the vehicle's internal combustion process that can negatively impact health because they can be inhaled by workers in these garages (Güngör *et al*., 2011). Air quality is a characteristic of indoor and outdoor air determined by the presence and concentration of descriptive parameters. The describe of IAQ is the absence of air contaminants that may impair the comfort or health of building occupants (Rousseau, 2003). There are many air pollutants in indoor environments and their types depend on some factors like the number of pollutants in the boundary, the location of the building, the distance between the source of pollution and building, even from

room to room in the same building (Ağca, 2015). It has been shown that garages can become a source of particulate matter and cause infiltration into adjoining occupied office buildings and housing apartments.

The allowed CO limit value in car parks is 60 ppm. These values easily show us how high-risk carbon monoxide is in car parking. Therefore, if the CO level is in an acceptable range, all other pollutants are considered safe levels and the car parking ventilation is working according to the CO level.

The aim of this study was to measure the concentrations of particulate matter, carbon monoxide and carbon dioxide in parking garages. In addition, indoor temperature and humidity values were recorded. Statistical analysis methods were applied to determine whether there is a relationship between pollutants and meteorological parameters.

### *1.1. Review of related studies*

Ankara Çankaya municipality made a study to evaluate CO concentrations in Sıhhiye indoor car parking. In this study; The ratios of carbon dioxide, carbon monoxide, sulfur dioxide and nitrogen oxides were determined and nitrogen oxides were determined as 0.25-0.50 ppm, 0.1-0.3 ppm sulfur dioxide and 0.25-0. Monoxide was determined as 0.25-0.50 ppm. In the prepared report, it is stated that the results are far below the values specified in terms of health and safety measures, and there is no risk to human health (Çankaya Municipality, 2013).

In a study conducted in Ankara by Atımtay *et al*., 2000, the exposure of traffic police to carbon monoxide was determined. The CO levels in the outdoor environment and the CO exposure in the air breathed by the police were determined with a micro CO meter. It has been determined that CO levels in the air breathed by traffic police officers are highly variable (0.23 ppm - 54.5 ppm) during 6-hour shifts.

Demir *et al*. in research computed the concentrations of air pollutants emitted from vehicles' exhaust in multistory car parks with different ventilation systems like natural, ductwork and jet fan ventilation systems and he has been concluded that short-term exposure of people to the surroundings of this car park would not cause health problems (Demir, 2015).

Samal *et al*. reported a high value of CO it was between 12 and 164 ppm when measured at various times in a 13-storey car park in England in 2013. This is due to the high density of vehicles in the parking lot and poor ventilation. Additionally, most indoor pollutants are absorbed by particulate matter that is initially suspended in the air and then settles as dust. Therefore, resident indoor dust has been considered as a global indicator of exposure environment and indoor pollution (Yuning *et al*., 2015).

Particulate matter is considered a fairly serious pollutant, implicated in many adverse health effects (Obaidullah *et al*.,2012). Several studies have shown that increased concentrations of particulate matter in ambient air can negatively impact the health of exposed populations. Particles smaller than 2.5 µm in diameter are considered more dangerous to human health because they can penetrate deep into the lower respiratory tract (Frăsın *et al*., 2010). In addition, fine particles can be transported through the bloodstream to other body organs, such as the liver and brain, within 4 to 24 hours after exposure (Cheng *et al*, 2008). However, few publications have been found in the literature on particulate matter concentration in parking lots. Parking garages may have high levels of mobile source-related PM pollutants. Thus, although people may have a short time in parking lots, there is a strong rationale for studying PM concentrations in car parks.

Erdogan (2012) stated that the products that occur during the combustion of diesel, gasoline, and jet fuel are similar since they are composed of pollutants originating from the land, sea, and air transportation regarding mobile source types. Okutan *et. al* (1993) mention other contaminants apart from those separated as fixed and mobile sources. However, air pollution originating from the combustion process, vehicle exhausts, and industrial facilities come to the fore; there are also a wide variety of air pollutants, which are called other sources and are generally ignored. These other pollutants mentioned; can be counted as the burning of the objects thrown as garbage, the polluted water bodies that occur after the pollution of the waters, and the pollution from the constructions. Comment by Okutan *et. al*, (1993) on the formation of these other pollutants; garbage decomposes in anaerobic environments and turns into $CO_2$ and $H_2S$. Water bodies containing high levels of organic pollutants release $H_2S$ and other gases into the air during anaerobic decomposition. In constructions, it has been known that particulate matter causes some contaminants in the air. In outdoor environments, PM explosives are released during mining activities such as excavation, machinery and vehi-cle movements, iron processing in industry, metal plating, transportation and affect the entire ecosystem by being carried to other places by air (Morozesk *et. al*, 2021).

Air pollution sources for Turkey; are primarily industry (thermal power plants, cement, iron-steel sector, etc.), followed by fossil fuels used in residences (coal, heating oil, etc., responsible for 80% of winter air pollution) and traffic-related exhaust emissions (Ozer *et. al*, 1997).

## 2. Material and method

### *2.1. Sampling locations*

Indoor particulate matter, $CO_2$ and CO were checked out in five different enclosed car parks in Konya city with different vehicle intensity and layouts (Table 1). Iplikçi Multi-Storey, Othman Wheat Bazaar Multi-storey and Mevlana Multi-storey garages are located on the ground floor and basement below the shop and market respectively, while another garage Zafer-Konevi Multi-Storey is located on the ground floor of the park (Figure 1). The ventilation in the garages was a ducted mechanical ventilation system except in Zindankale Multi-Storey Garage was a combination of mechanical and natural ventilation.

**Table 1.** Characteristics of the Parking garages of the study area

| Garages | Area (m2) | No. Of floors | Capasity (no. of cars ) |
|---|---|---|---|
| İplikçi Multi-Storey Car Park | 1.781 | 2 | 400 |
| Zindankale Multi-Storey Car Park | 19.101 | 7 | 669 |
| Zafer-Konevi Multi-Storey Car Park | 12.015 | 4 | 300 |
| Ottoman Wheat Bazaar Multi-Storey Car Park | 23.600 | 2 | 1000 |
| Mevlana Multi-Storey Car Park | 5.575 | 2 | 333 |

**Figure 1.** Location of the study area (Konya / Turkey)

*2.2. Selection of monitoring ınstruments*

CEM DT-9880 model device was used for particulate matter measurement. This device is configured to determine the concentration of suspended particles in the air. This device is used in clean rooms, indoor air quality, exposure to exhaust, tobacco or cigarette smoke and other harmful air pollutants, and for monitoring airborne dust levels. Six different particle sizes (0.3, 0.5, 1, 2.5, 5, 10) µm can be collected with the DT-9880 counter, in addition, this device has sensors for measuring temperature and relative humidity.

An IAQ-CALC 7575 device was used to monitor $CO_2$ and CO. The IAQ-CALC 7575 is designed to work with a wide range of plug-in probes which expands measurement capability IAQ probes are available to measure temperature, humidity, CO and $CO_2$ of indoor environments.

## 3. Method

Obtain average hourly data during the measurement period to study changes in pollutant concentrations in the garage. In addition, independent samples t-tests were used to compare differences in pollutant concentrations and meteorological parameters. where $p < 0.01$ and $p < 0.05$ represent statistically significant differences within the 99% and 95% confidence intervals, respectively. Pearson correlation and partial correlation test for the effect of indoor temperature and pollutant concentrations by SPSS Statistics 25.0. A linear correlation analysis was performed to determine the correlation between indoor temperature and pollutant concentrations. However, pollution parameters ($PM_{2.5}$, $PM_{10}$, $CO_2$ and CO) are optioned as dependent variables, and meteorological parameters (temperature and relative humidity) as independent variables to establish regression equations. The coefficient of determination (R) is calculated to show that the per cent change in the dependent variable (Y) is defined by the independent variable ($R^2$). If there is a perfect correlation between X and its variables, and the correlation coefficients are very close to -1 and +1, their squares will be very close to 1 (Gürbüz ve Şahin, 2018).

$$R^2_{y.x} = 1 - \frac{\sum^{n}(y_i - y_i^{K})^2}{\sum(y_i - \bar{y})^2}$$

## 4. Result

In this study, temperature, humidity, $CO_2$, CO and particulate matter measurements were made in five parking lots (one of them semi-closed) located in Konya Province, Karatay, Selçuklu and Maram regions. In order to determine indoor air pollution in car parks, the relationship between pollutants and potential physical properties that may cause the formation of these pollutants was examined. The summary and evaluation of the results obtained are given below.

While measuring $PM_{2.5}$, $PM_{10}$, CO and $CO_2$ values, some parameters such as the efficiency of the ventilation system and the indoor quality were taken into account. However, we focused on this indicator to evaluate parking lots. It was determined that the pollutants in the Iplekçi car park had the highest values due to the ventilation system not working during the measurement. In the car parks where the measurements were made, the $PM_{2.5}$ average values of the İplikçi Multi-Storey Car Park, Zindankale Multi-Storey Car Park, Zafer-Konevi Multi-Storey Car Park, Ottoman Wheat Bazaar Multi-storey Car Park and Mevlana Multi-storey Car Park were 4228.34 µg/m$^3$, 3024 µg/m$^3$, 1028 µg/m$^3$ and 1402.78 µg/m$^3$ were measured respectively. $PM_{10}$ was found to be 423.34 µg/m$^3$, 179.2 µg/m$^3$, 168.16 µg/m$^3$ and 159.35 µg/m$^3$ as we see in Table 2.

As can be seen, the reason for the high average values is related to the vehicle density in the parking lot, the location of the parking lot and the ventilation system. At the same time, the fact that the measurements made on the first floors are higher than the next floors is related to the fact that the other floors pass fewer vehicles before the first floors are filled.

In the measurements made according to the car parks, the average CO values were found to be 3.05 ppm in the Iplikçi Multi-Storey Car Park, 0.86 ppm in the Zindankale Multi-Storey Car Park, 1.49 ppm in the Zafer-Konevi Multi-storey Car Park, and 1.46 ppm in the Othman Wheat Bazaar Multi-storey Car Park. Table 3 shows the measured CO and $CO_2$ concentrations. It is observed that the values are in the Iplikçi Multi-Storey Car Park. This inconsistency is due to the number of cars in the garage as well as the type of ventilation available in the parking lot. As we noticed in the Iplikçi Multi-Storey Car Park, the concentrations increased when the ventilation system was broken, while the ventilation system in Zindankale Multi-storey Car Park is

available in both natural and closed floors, so it was least concentrated among the five car parks where the measurements were made. In the same order, carbon dioxide values (593.31, 594.11, 499.40, 462.84 and 399.07) ppm were determined, where the highest concentrations were found in the Iplikçi Multi-storey Car Park and Mevlana Multi-storey Car Park because, during the measurement, the ventilation system of the Iplikci Multi-storey Car Park failed. and the efficiency of the ventilation system in the Mevlana multi-storey car park is poor.

**Table 2**. Particulate matter ($PM_{2.5}$ and $PM_{10}$ $\mu g/m^3$) values measured in the five garages

| | | Floor | Minimum | Avarage | Maximum | Standard deviation |
|---|---|---|---|---|---|---|
| **Iplikçi Multi-Storey Car Park** | **$PM_{2.5}$** | -1 | 2603 | 5459,13 | 7697 | 1640,18 |
| | | -2 | 2716 | 2909,64 | 3315 | 148,49 |
| | **$PM_{10}$** | -1 | 240 | 644,33 | 984 | 268,85 |
| | | -2 | 463 | 500,28 | 552 | 23,28 |
| **Zindankale Multi-storey Car Park** | **$PM_{2.5}$** | 4 | 1097 | 2515,88 | 3925 | 479,09 |
| | | 3 | 4011 | 4143 | 5282 | 230,09 |
| | | 2 | 2420 | 2884,33 | 3295 | 345,01 |
| | | 1 | 2240 | 2812,50 | 3638 | 1053,55 |
| | | -1 | 2376 | 2728,77 | 3076 | 135,63 |
| | | -2 | 3057 | 3735 | 4184 | 337,45 |
| | **$PM_{10}$** | 4 | 114 | 145,50 | 222 | 40,09 |
| | | 3 | 130 | 164,55 | 213 | 25,99 |
| | | 2 | 140 | 209,77 | 369 | 68,69 |
| | | 1 | 47 | 157,66 | 389 | 116,76 |
| | | -1 | 155 | 176,66 | 195 | 20,20 |
| | | -2 | 128 | 208.44 | 258 | 59,89 |
| **Zafer-Konevi Multi-storey Car Park** | **$PM_{2.5}$** | -4 | 504 | 554 | 628 | 53,68 |
| | | -3 | 527 | 1019 | 1511 | 388,96 |
| | | -2 | 1264 | 1728.2 | 2038 | 336,16 |
| | | -1 | 853 | 1001 | 1149 | 117,00 |
| | | Entry | 648 | 837.8 | 1073 | 198,62 |
| | **$PM_{10}$** | -4 | 72 | 98 | 136 | 27,61 |
| | | -3 | 63 | 179 | 295 | 91,70 |
| | | -2 | 237 | 319,40 | 375 | 59,52 |
| | | -1 | 123 | 153 | 183 | 23,71 |
| | | Entry | 30 | 91,40 | 166 | 61,01 |
| **Othman Wheat Bazaar Multi-storey Car Park** | **$PM_{2.5}$** | -1 | 686 | 812.56 | 1662 | 278,89 |
| | | -2 | 789 | 1993 | 5099 | 1127,14 |
| | **$PM_{10}$** | -1 | 50 | 265,70 | 674 | 66,53 |
| | | -2 | 17 | 53 | 252 | 185,52 |
| **Mevlana multi-storey car park** | **$PM_{2.5}$** | -1 | 1135 | 1593,17 | 5633 | 979,61 |
| | | -2 | 1140 | 2099,27 | 3740 | 897,24 |
| | **$PM_{10}$** | -1 | 634 | 190,73 | 113 | 120,26 |
| | | -2 | 106 | 361,60 | 641 | 204,37 |

Statistical analysis was performed on the pollutants obtained from the parking lot to reveal the relationship between the parameters, as shown in Table 4. According to the significance level, the Pearson correlation test was performed on the influence of indoor temperature and pollutant concentration, and the results were as follows, $\alpha = 0.05$; it was determined that indoor particulate matter ($PM_{2.5}$, $PM_{10}$) was highly positively correlated, and temperature and $CO_2$ were significantly correlated. Moderately correlated particulate matter was significantly correlated with gases ($CO_2$ and CO), with weak positive correlations between CO, $PM_{2.5}$ and $PM_{10}$ and temperature values.

From the above Table 4, we can see that there is a weak to moderate the statistically significant relationship between temperature and other parameters.

Which we can make clearer by graphical representation in the below figures, so we can demonstrate that the presence and diffusion of pollutants in the interior space increases when the temperature increases.

There is a weak positive correlation relationship between particular matter and temperature Figures 2 and 3. the same with the $CO_2$ and the in the Figure 4. We notice that

there is a weak negative relationship between relative humidity and temperature.

**Table 3.** The measured CO and $CO_2$ concentrations in ppm

| | | Floor | Minimum | Avarage | Maximum | Standard deviation |
|---|---|---|---|---|---|---|
| Iplikçi Multi-Storey Car Park | CO | -1 | 2,20 | 4,30 | 5,90 | 1,31 |
| | | -2 | 1,30 | 1,72 | 2,00 | 0,21 |
| | $CO_2$ | -1 | 478 | 680,13 | 984 | 123,86 |
| | | -2 | 463 | 500,28 | 552 | 27,98 |
| Zindankale Multi-storey Car Park | CO | 4 | 0,20 | 0,30 | 0,40 | 0,06 |
| | | 3 | 0,030 | 1,18 | 2,60 | 0,97 |
| | | 2 | 0,20 | 0,56 | 1,70 | 0,47 |
| | | 1 | 0,20 | 0,61 | 1,90 | 0,65 |
| | | -1 | 0,90 | 0,96 | 1,10 | 0,11 |
| | | -2 | 1,10 | 1,43 | 1,90 | 1,43 |
| | $CO_2$ | 4 | 383 | 482,33 | 558 | 78,74 |
| | | 3 | 372 | 392,33 | 430 | 25,32 |
| | | 2 | 378 | 397 | 461 | 25,94 |
| | | 1 | 386 | 499,11 | 619 | 77,56 |
| | | -1 | 520 | 524 | 527 | 3,60 |
| | | -2 | 430 | 512,33 | 567 | 58,04 |
| Zafer-Konevi Multi-storey Car Park | CO | -4 | 1,10 | 1,42 | 1,80 | 0,28 |
| | | -3 | 1,50 | 2,1 | 2,70 | 0,47 |
| | | -2 | 1,40 | 1,8 | 2,20 | 0,31 |
| | | -1 | 1,10 | 1,3 | 1,50 | 0,15 |
| | | Entry | 0,30 | 0,84 | 1,70 | 0,55 |
| | $CO_2$ | -4 | 420 | 469,2 | 543 | 53,45 |
| | | -3 | 434 | 434 | 434 | 0,00 |
| | | -2 | 428 | 430,8 | 433 | 1,92 |
| | | -1 | 310 | 556 | 802 | 194,48 |
| | | Entry | 390 | 424,2 | 479 | 35,02 |
| Othman Wheat Bazaar Multi-storey Car Park | CO | -1 | 1,20 | 2,22 | 3,70 | 0,65 |
| | | -2 | 0,20 | 0,71 | 2,70 | 0,89 |
| | $CO_2$ | -1 | 56 | 403,87 | 466 | 103,61 |
| | | -2 | 102 | 354,26 | 502 | 71,04 |
| Mevlana multi-storey car park | CO | -1 | 1,10 | 5,86 | 13,60 | 4,66 |
| | | -2 | 0,20 | 0,83 | 1,90 | 0,42 |
| | $CO_2$ | -1 | 113 | 190,73 | 643 | 120,26 |
| | | -2 | 381 | 537,87 | 862 | 109,03 |

**Table 4.** The correlation coefficient between arithmetic averages of pollutants in car parks

| | | Correlations | | | | | |
|---|---|---|---|---|---|---|---|
| | | **$PM_{2.5}$ (ppm)** | **$PM_{10}$ (ppm)** | **$CO_2$ (ppm)** | **CO (ppm)** | **Humidity (%)** | **Temperature (℃)** |
| $PM_{2.5}$ (ppm) | Pearson Correlation | 1 | | | | | |
| | Sig. (2-tailed) | | | | | | |
| | N | 244 | | | | | |
| $PM_{10}$ (ppm) | Pearson Correlation | **.788**$^{**}$ | 1 | | | | |
| | Sig. (2-tailed) | .000 | | | | | |
| | N | 244 | 244 | | | | |
| $CO_2$ ( ppm) | Pearson Correlation | **.340**$^{**}$ | **.370**$^{**}$ | 1 | | | |
| | Sig. (2-tailed) | .000 | .000 | | | | |
| | N | 244 | 244 | 244 | | | |
| CO (ppm) | Pearson Correlation | **.220**$^{**}$ | **.269**$^{**}$ | **.279**$^{**}$ | 1 | | |
| | Sig. (2-tailed) | .001 | .000 | .000 | | | |
| | N | 244 | 244 | 244 | 244 | | |
| Humidity (%) | Pearson Correlation | .078 | .053 | .126$^{*}$ | .075 | 1 | |
| | Sig. (2-tailed) | .225 | .409 | .049 | .246 | | |
| | N | 244 | 244 | 244 | 244 | 244 | |
| Temperature (℃) | Pearson Correlation | **.130**$^{*}$ | **.165**$^{**}$ | **.547**$^{**}$ | **.180**$^{**}$ | **-.286**$^{**}$ | 1 |
| | Sig. (2-tailed) | .042 | .010 | .000 | .005 | .000 | |
| | N | 244 | 244 | 244 | 244 | 244 | 244 |

**. Correlation is significant at the 0.05 level (2-tailed).*

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

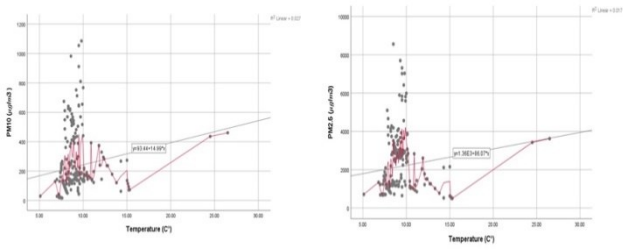

**Figure 2**. Shows the relationship between particular matter and temperature

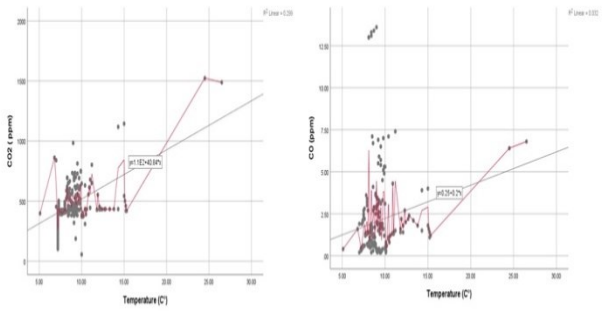

**Figure 3**. Shows a weak positive correlation relationship between CO and temperature

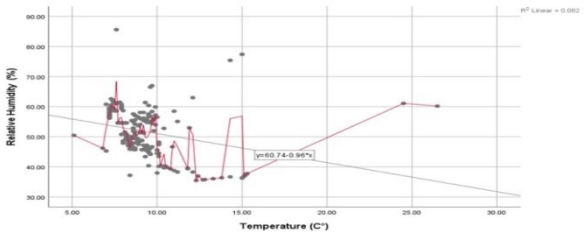

**Figure 4**. The correlation relationship between relative humidity and temperature.

## 5. Conclusion

CO, $CO_2$, $PM_{2.5}$ and $PM_{10}$ concentrations were assessed in a mechanically ventilated underground garage in Konya, Turkey by field sampling. This study shows that there are significant spatiotemporal differences in the concentrations of gases (CO, $CO_2$) and particulate matter ($PM_{2.5}$, $PM_{10}$).

Due to differences in ventilation conditions and vehicle operating conditions on winter days, the concentrations of CO, $CO_2$, $PM_{2.5}$ and $PM_{10}$ were higher during peak hours than at other times of the day in garages besides we find the distribution of gas and particulate matter concentrations was not uniform in floors of the garage, the spatial Gas and particulate concentrations were higher in the upper part of the garage than in the lower part because of the lower floors had the filled up and the upper floors had a few numbers of vehicles.

Pearson correlation analysis showed that $CO_2$ concentration had a strong correlation with temperature (r: 0.547, p: 0.00). The reason may be that the vehicle may warm up at low temperatures before leaving the garage, resulting in an increase in the concentration of pollutants in the garage. Furthermore, the humidity in the garage was negatively correlated with temperature (r: -0.286, p: 0.00). During this measurement period, the CO and $CO_2$ concentrations did not exceed the standard (<5 ppm) and (< 600 ppm), respectively, but the particulate matter concentration significantly exceeded the standard. Therefore, the use of natural ventilation alone in commercial underground garages does not guarantee a "safe" exposure level to particulate pollution in this study. Therefore, certain ventilation measures need to be taken to reduce the concentration of pollutants in the garage.

Due to the few published types of research in Turkey on indoor air pollution, especially those that revolve around indoor pollution of closed car parks, we discussed in this study the measurement of the six major air concentrations and finding if there is a relationship between those concentrations with indoor air parameters, however, weak positive correlations among gases, particulate matter and temperature reached, as there is an inverse relationship between temperature and humidity.

This study evaluated the installed ventilation system and the distribution of inlet and outlet ducts to keep the air in the garages within the acceptable stander limits thereby ensuring the safety and health of the occupants in the garages. However, this study was a limitation so we hope this study can help academics to introduce further research.

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