Publishing Information

ICER-PH 2018

Proceedings of the 3rd International Conference on
Environmental Risks and Public Health

Makassar, Indonesia
26-27 October 2018

EDITORS
Bambang Wispriyono
Anwar Mallongi
Dino Pisaniello
Veny Hadju

EAI
RESEARCH MEETS INNOVATION

EUDL
European Union Digital Library

Proceedings   Series   Journals   Search   EAI

Proceedings of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018, 26-27, October 2018, Makassar, Indonesia

Research Article

Air Pollution Index and Inhalation Risk Assessment to Carbon Monoxide and Nitrogen Dioxide to Traders in the bus station

Cite BibTeX Plain Text

Download
101 downloads

Deddy Alif Utama[1,*], **Anwar Daud**[2], **Masni Masni**[2]
1: Environmental Health Department of Universitas Muhammadiyah Kalimantan Timur1
2: School of Public Health of Hasanuddin University
*Contact email: dau475@umkt.ac.id

Abstract

In addition to decreasing air quality, carbon monoxide (CO) and nitrogen dioxide (NO2) gases also have a major impact on the deterioration of human health. Air pollution index (API) was investigated as well as the potential health risk from the exposure of carbon monoxide and nitrogen dioxide to traders in Malengkeri bus station, Indonesia. Samples were collected by purposive sampling technique. The results revealed that air pollution index of CO and NO2 at the beginning of the week were 1473.82 and 2.57, respectively. While on the weekend were 2874.83 and 1.53, respectively. The average risk quotient of acute exposure at the beginning of the week for CO was 0.0036. While on the weekend was 0.0041. The average risk quotient of chronic exposure at the beginning of the week for NO2 was 0.02. While on the weekend was 0.01. The air pollution index of CO from the beginning until the end of the week could be described as a danger for human health, while for NO2 was good. Both average risk quotient of CO and NO2 had not exceeded the guideline (>1) and not indicated any noncarcinogenic health risk. However, the male might suffer from the effect compared with female
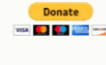
Keywords co no2 traders

About | Contact Us

EAI   DOA   DIRECTORY OF OPEN ACCESS JOURNALS   dblp   ProQuest   EBSCO

EUDL
European Union Digital Library

Proceedings   Series   Journals   Search   EAI

ICER-PH 2018

ICER-PH

Proceedings of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018, 26-27, October 2018, Makassar, Indonesia

This book constitutes a through refereed proceeding of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018 that held on 26-27 of October 2018, in Makassar, Indonesia. The conference was organized by the Faculty of Public Health, Universitas Hasanuddin. The 39 fu...

more »

Editor(s): Bambang Wispriyono (Universitas Indonesia), Anwar Mallongi (Universitas Hasanuddin, Indonesia), Dino Pisaniello (Adelaide University, Australia) and Veny Hadju (Universitas Hasanuddin, Indonesia)

Other Years
ICER-PH 2018

Ethics and Malpractice Statement

Back to CCER

search terms here...

Ordered by title ▲ or year ▼

Showing 1–10 of 39 results

Page size: 10 25 50

1 2 3 4 Next Last

Activities Testing of Mengkudu Folium Extract Powder (Morinda citrifolia) as Aedes aegypti larvicide 2018
Research Article in Proceedings of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018, 26-27, October 2018, Makassar, Indonesia
Tri Budi Julianti, Hansen Hansen

Effectiveness of Emotional Demonstration Method in Counseling Handwashing with Soap in Small Islands of Makassar
Research Article in Proceedings of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018, 26-

Air Pollution Index and Inhalation Risk Assessment to Carbon Monoxide and Nitrogen Dioxide to Traders in the bus station

Deddy Alif Utama[1], Anwar Daud[2], Masni[3]
{dau475@umkt.ac.id[1], anwardaud66@gmail.com[2], masnimappajanci@rocketmail.com[3]}

Environmental Health Department of Universitas Muhammadiyah Kalimantan Timur[1]
School of Public Health of Hasanuddin University[2,3]

Abstract. In addition to decreasing air quality, carbon monoxide (CO) and nitrogen dioxide (NO_2) gases also have a major impact on the deterioration of human health. Air pollution index (API) was investigated as well as the potential health risk from the exposure of carbon monoxide and nitrogen dioxide to traders in Malengkeri bus station, Indonesia. Samples were collected by purposive sampling technique. The results revealed that air pollution index of CO and NO_2 at the beginning of the week were 1473.82 and 2.57, respectively. While on the weekend were 2874.83 and 1.53, respectively. The average risk quotient of acute exposure at the beginning of the week for CO was 0.0036. While on the weekend was 0.0041. The average risk quotient of chronic exposure at the beginning of the week for NO_2 was 0.02. While on the weekend was 0.01. The air pollution index of CO from the beginning until the end of the week could be described as a danger for human health, while for NO_2 was good. Both average risk quotient of CO and NO_2 had not exceeded the guideline (>1) and not indicated any noncarcinogenic health risk. However, the male might suffer from the effect compared with female.

Keywords: CO, NO_2, Traders

1 Introduction

Air pollution is a multifaced mix consisting of suspended particulates and gaseous pollutants [1]. The increase in human population, industrialization, urbanization, and modernization are significant contributors to the rising urban air quality problem [2]. In many areas, decreasing ambient air quality cannot be separated from the significant increase in vehicles. Statistical data showed the number of vehicles in Makassar, Maros, Sungguminasa, and Takalar (Mamminasata) of South Sulawesi, Indonesia has increased in the last three years. Although the trend of vehicles that pass the emission test in three monitoring periods (2007 – 2011) have shown the continues to increase (50% to 80%), however, ambient air quality still has parameters with an average concentration exceeding the quality standard, namely HC which is two times higher than the standard quality value in 2012 [3]. Vehicle emission has also become the dominant source of various air pollutants, including carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOCs), nitrogen oxide (NO_X), and particulate matter (PM) [4]. These emissions continue to be a major environmental problem and contribute to risks of morbidity and mortality for drivers, commuters, and individuals living near roadways [5],[6].

Among some pollutant that comes from vehicles, carbon monoxide is one of the most dangerous from others. CO has classified as the 'respiratory pollutant' sub-group 'asphyxiants,' which is a pollutant that has an impact or effect on the respiratory and circulatory systems [7]. The amount of CO in the air by 0.032% comes from incomplete combustion. When running, CO gas produced in a gasoline engine is around 1% and 7% when not running. While diesel engines produce CO in the air by 0.2% when running and 4% when not running [8]. However, even at much lower doses typically found in outdoor air, numerous studies have found an association between short-term variation in outdoor CO levels and increased risk of cardiovascular morbidity and mortality [9],[10] Who set guideline values for CO, a 1-hour level of 30 mg/m^3, and an 8-hour level of 10 mg/m^3 [11].

In addition to the existence of CO as a dangerous pollutant substance, in urban air, NO_2, a secondary air pollutant which is also quite dangerous for human health, is mostly derived from local vehicular traffic through the oxidation of NO by O_2 in the atmosphere [12]. NO_2 is a highly reactive oxidant and corrosive, but it also a good surrogate indicator of traffic generated pollutant. NO_2 acts mainly as an irritant affecting the mucosa of the eyes, nose, throat, respiratory tract, and development of acute or chronic bronchitis [13]. Given the adverse health effect of NO_2, WHO set guideline values for NO_2, a 1-hour level of 200 µg/m^3 and 24-hour level of 40 µg/m^3 [12].

At present, public transport and its infrastructure are still a common feature of urban transportation in a developed and developing the country. But, the state of public transport in the cities of the developing countries differs widely from those of the developed countries [14],[15]. Public transport and its infrastructure in Makassar as one of the big cities in Indonesia is regarded as poorest in the world. There is no rail way of transit service as one of the alternative modes of transportation for the community. Thus, transportation mode in Makassar commonly refers to the motorcycle, microbus, and taxi. The city's public microbus lines suffer from an absence of effective regulations, which means there are no official microbus stops, and drivers can stop anywhere to let people on and off. Even in some cases, because the lack of facilities and the absence of specific regulations about vehicles, the bus station is not only used as a special transit site for buses but also used for other types of vehicles such as microbuses. It resulted in the more dense pollutant bus station and will impact all community, including traders.

2 Materials and methods

2.1 Study area overview and human samples

All pollutant (CO and NO_2) were collected as risk agents of vehicles emission on June 19th – July 25[th,] 2015 at Malengkeri Bus Station. Figure 1 shows the study area location. Considering the factors such as traffic flow rate, amount of vehicle, term of operation, sampling condition, eight sampling sites were selected through two measurement, in the beginning of the week (Monday – Wednesday) and on weekend (Friday – Sunday), including one in station entrance, one in station exit, four in the bus/minibus parking lot, two at the bus stop. Each risk agent in sampling site was measured three times a day for 1-hour measurement (morning, afternoon, and evening). The data obtained was used to calculate the air pollution index and inhalation risk assessment. The human samples which amounted to 58 people in this study were traders who worked during the bus station operating hours and were determined based on two criteria,

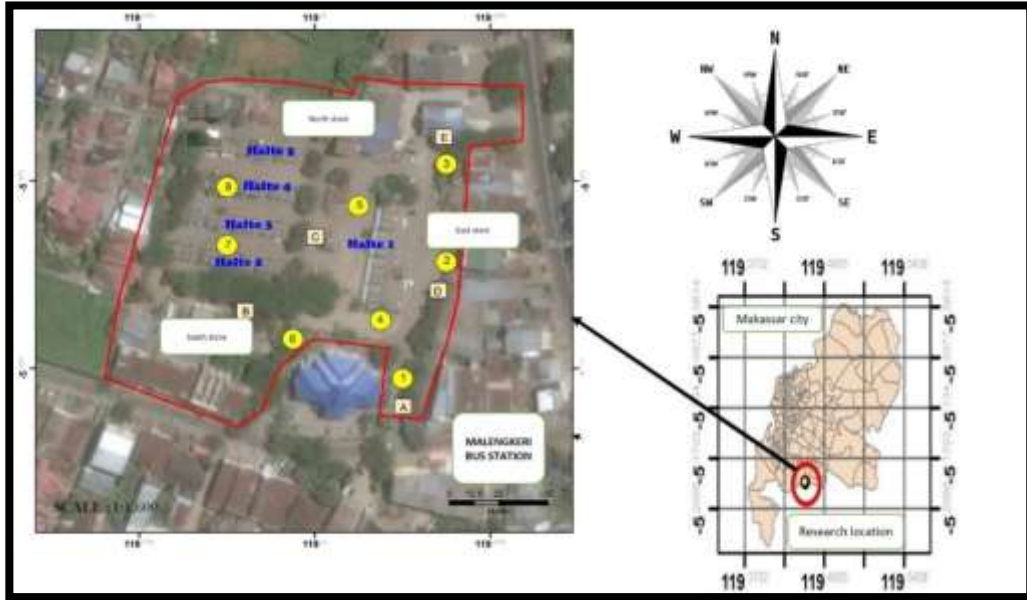(1) having worked for at least 1 year in the bus station area and (2) willing to participate in this study.

Fig 1. Study Area Location (1 - 8 sampling site; A = station entrance, B, C, D = bus/minibus parking site, E = station exit)

2.1 Sampling and analysis methods

Footnotes and acknowledgments

Air sampling. In this study, CO concentration in the air was determined by non-dispersive infrared (NDIR) method. While NO_2 concentration was determined by the Griess Saltzman method using impinge sampling technique and spectrophotometric measurement. Collected air sample was used to determine air pollution index (API) and inhalation risk assessment of traders. However, at the time of field measurement, the measurement time required for data retrieval is sometimes not by the measurement time specified in the quality standard, for example, carbon monoxide. Carbon monoxide was collected within 1-hour measurement in the field, while in the quality standard used 8-hours measurement. This can be anticipated by estimating the measurement time in the field with the measurement time by the quality standard by using the Canter constant in the mathematical expression (1) below:

$$C_1 = C_2 \left(\frac{t_2}{t_1}\right)^p (1)$$

Where, C_1 = average concentration of air pollutants with measurement time based on quality standards ($\mu g/m^3$); C_2 = average concentration of air pollutants based on field measurement time ($\mu g/m^3$); t_2 = average time based on field measurement(hours); t_1 = average time based on quality standard (hours); p = canter constant (0.186).

Air pollution index

API measurement was used to determine daily air pollution index of the pollutant for which EPA has to establish National Air Quality Standards (NAAQS) with an epidemiological function to determine a descriptor of human health effect due to short-term exposure (24 hour or less) [6]. The measurement was adopted in the decree of the Head of the Indonesian Environmental Impact Management Agency and contained:

1. Individual air pollution indexes and their corresponding concentration limits

Table 1. Individual Air Pollution Indexes and Their Corresponding Concentration Limits

Index	*PM_{10} (24 hours)	*SO_2 (24 hours)	*CO (8 hour)	*O_3 (1 hour)	*NO_2 (1 hour)
50	50	80	5	120	**
100	150	365	10	235	**
200	350	800	17	400	1130
300	420	1600	34	800	2260
400	500	2100	46	1000	3000
500	600	2620	57.5	1200	3750

* $\mu g/m^3$
** There is no index can be reported at low concentrations with short-term exposure

2. The health impact of air pollution index

Table 2. Health impact of air pollution index

Index	Categories	Impact
1 – 50	Good	Does not have a significant health impact on the human bodies, animals, plants, constructions, and value of esthetic.
51 – 100	Moderate	Does not have a significant health impact on the human bodies or animals but affect sensitive plants, construction, and value of esthetic.
101 – 199	Unhealthy	Detrimental to human health and affect sensitive animals, plants, constructions, and value of esthetic.
200 – 299	Very unhealthy	Harmful in some segments of the population
≥ 300	Hazardous	Harmful in all segments of the population

Both API of CO and NO_2 were calculated using the mathematical expression (2) and would be compared using the value in table 1:

$$Ip = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} (C_P - BP_{Lo}) + I_{Lo} \quad (2)$$

Where, I_p = the index value for pollutant P; C_P = the truncated concentration of pollutant, P; BP_{Hi} = the break site that is ≥ C_P; BP_{Lo} = the break site that is ≤ C_P; I_{Hi} = the AQI value corresponding to BP_{Hi}, I_{Lo} = the AQI value corresponding to BP_{Lo}

Inhalation risk assessment

Inhalation risk assessment methods of the U.S. Environmental Protection Agency (EPA)[17] was used to estimate health risk through inhalation pathway for two kinds of people (adult male and adult female). Because CO had an acute effect if inhaled more than 500 ppm for 1 hour[18],[19], then the individual intake of acute exposure rate for CO, calculated as an hourly dose, not daily dose using the mathematical expression (3)[(2)]:

$$AHD = C \; x \; \frac{IR}{W_b} \; (3)$$

Where AHD = the average hourly dose for inhalation (μg/kg/hour); C = the concentration of the chemical (μg/m^3); IR = the inhalation rate (m^3/hour); W$_b$ = the body weight (kg). While individual dose for chronic daily exposure pollution of NO$_2$, calculated using the mathematical expression (4)[20]:

$$ADD = \frac{C \; x \; IR \; x \; t_E \; x \; f_e \; x \; D_t}{W_b \; x \; t_{avg}} \quad (4)$$

Where, ADD = the average daily dose (mg/kg-day); C = the average concentration of air pollutant (mg/m^3); IR = the average values of inhalation rate (m^3/day or m^3/hour; male = 0.79 m^3/hour, female = 0.59 m^3/hour)[21]; t$_E$ = the average daily exposure time (hours/day); f$_E$ = the average exposure frequency (days/year); D$_t$ = the average exposure duration (years); W$_b$ = the average weight (kg); t$_{avg}$ = the average time period (30 x 365 days for noncarcinogenic; 70 x 365 days for carcinogenic).

After calculated average daily dose, the risk quotient (RQ) approach used the assumption of dose additivity to assess the noncancer health effects from the data on the components. Risk Quotient (RQs) was normalized doses or exposure levels of the components and consist of the ratios of the exposure doses or exposure levels of a component to the health guidance values of the component, such as ATSDR's minimal risk levels (MRLs) or EPA's reference doses (RfDs)/reference concentration (RfCs). The health guidance value was the normalizing factor. If the RQ values did not exceed guidelines (> 1), it means not indicated any noncarcinogenic health risks. However, If the RQ values had exceeded the guideline (>1), means indicated noncarcinogenic health risk for the whole lifespan. Noncarcinogenic RQ was calculated using the mathematical expression (5)[22]:

$$RQ = \frac{AHD \; or \; ADD}{MRL \; or \; RfD \; or \; RfC \; or \; REL} \quad (5)$$

Except for RfC CO, each MRL or RfC pollutants were taken from a list issued by ATSDR and EPA. For example, RfC NO$_2$ was 0.02 mg/kg-day. RfC CO (23 mg/m^3) was derived from the value of Office of the Environmental Health Hazard Assessment (OEHHAs) reference exposure level (RELs)[23], after being converted using equation (3) with average hourly dose equal to reference concentration (AHC = RfC), as follows:

$$RfC = C \; x \; \frac{IR}{W_b}$$

$$= \frac{23\frac{mg}{m^3} \; x \; 0.69\frac{m^3}{hour}}{57 \; kg} \quad (6)$$

$$= 0.27 \; mg/kg\text{-}hour$$

Inhalation rate used as a standard in this study set by China's ministry of environment (0.69 m^3/hour)[21] with an average body weight of traders as a sample. The value of China

inhalation rate was closed to the inhalation rate used in several studies in Indonesia although there was a difference in body weight by 5.2% of the average body weight of Indonesians [24], [25], [26]. Therefore, RfC of carbon monoxide and nitrogen dioxide used in this study were 0.27 mg/kg-hour and 0.02 mg/kg-day, respectively.

3.   Results and discussion

3.1 Pollutant concentration.

Air sampling concentration (carbon monoxide and nitrogen dioxide) were shown in Table 3. Air samples were collected within 1-hour measurement. For carbon monoxide level across all the station area at the beginning of the week, sampling site 4 had the highest average concentration (522.21 µg/m^3) with a maximum value of 812.19 µg/m^{3}while the least was obtained in sampling site 1 (244.16 µg/m^3) with a maximum value of 148.27 µg/m^3. On the weekend, sampling site 4 was also recorded the highest average CO concentration (814.64 µg/m^3) with a maximum value of 1152.44 µg/m^3. This value has increased by 56% when compared to the beginning of the week. Furthermore, sampling site 5 has recorded the lowest average CO concentration that is equal to 239.49 µg/m^3 with a maximum value of 271.71 µg/m^3.

In terms of average concentration for nitrogen dioxide at the beginning of the week, sampling site 1 has the highest concentration (20.24 µg/m^3) with a maximum value of 23.05 µg/m^3 while the lowest was obtained in sampling site 7 (7.53 µg/m^3) with a maximum value of 11.11 µg/m^3. On weekend, sampling site 3 was recorded the highest average NO$_2$ concentration (15.08 µg/m^3) with a maximum value of 27.03 µg/m^{3}while the least was also obtained in sampling site 7 (6.75 µg/m^3) with a maximum value of 6.85 µg/m^3. The average concentration of carbon monoxide and nitrogen dioxide in the beginning of the week for all sampling site were 333.95 µg/m^3 and 14.54 µg/m^3, respectively. While on weekend were 408.91 µg/m^3 and 8.63 µg/m^3, respectively.

Table 3. Pollutant concentration

Sampling site	Measurement period	Concentration (µg/m^3)							
		CO				NO$_2$			
		Min	Max	Mean	SD	Min	Max	Mean	SD
1	BOW	148.27	411.73	244.16	145.61	17.54	23.05	20.24	2.75
	WKD	449.83	644.39	571.84	106.29	9.91	16.31	12.13	3.61
2	BOW	303.04	403.16	356.90	50.49	10.13	26.80	16.65	8.90
	WKD	622.91	1041.86	844.96	210.60	4.68	9.34	7.70	2.62
3	BOW	202.68	333.42	250.87	71.82	10.71	22.34	16.33	5.82
	WKD	235.27	1163.76	653.10	471.15	3.33	27.03	15.08	11.85
4	BOW	334.48	812.19	522.21	254.73	15.83	20.65	17.86	2.49
	WKD	619.72	1152.44	814.64	293.69	2.55	14.81	8.46	6.14
5	BOW	195.10	362.75	283.58	84.21	7.17	13.69	10.45	3.26
	WKD	220.78	271.71	239.49	28.01	2.68	5.60	4.45	1.55
6	BOW	285.61	613.40	477.99	171.16	10.25	25.78	16.89	8.00
	WKD	168.41	385.63	263.99	110.92	4.45	8.36	5.76	2.25

7	BOW	207.23	361.20	273.43	79.21	4.69	11.11	7.53	3.27
	WKD	215.75	398.46	326.29	97.21	6.65	6.85	6.75	0.1
8	BOW	233.78	436.52	341.61	101.98	6.49	15.68	10.36	4.76
	WKD	226.30	419.36	325.35	96.62	4.38	13.30	8.69	4.46
Total	BOW	148.27	812.19	333.95*	151.11	4.69	26.80	14.54	6.22
	WKD	168.41	1163.76	408.91*	300.97	2.55	27.03	8.63	5.52

* Median
BOW = Beginning of the week
WKD = Weekend

3.2 Air pollution index

In terms of air pollution index (API) showed in table 4, the variation across all sampling sites revealed that the average concentration of carbon monoxide was highly enough and increased by 47.2% from 233.55 µg/m^3 to 342.98 µg/m^3 during the beginning of the week to the weekend. Although both average concentrations have not passed the level of national air pollution standards, this increase has caused average air pollution index in the bus station area also increased significantly by 95.3% from 1473.82 to 2874.83. This condition has been categorized as hazardous. In contrast, the average concentration of nitrogen dioxide from the beginning of the week had shown low concentration if compared with national air pollution standards and decreased by 41.3% on the weekend. Thus, the air pollution index for both measurement periods also shows good conditions. When viewed based on sampling sites (Figures 2 and Figure 3), the standard values of air pollutant index for carbon monoxide parameters at sampling site 1-4 were increased during the weekend when compared to the beginning of the weekOn the contrary, for sampling sites 5 - 8, it was decreased. The highest value at the beginning of the week came from sampling site 4 (2972.56), while the lowest came from sampling site 8 (1464.92). On the weekend, the highest value came from sampling site 2 (4990.72), and the lowest came from sampling site 8 (1399.95). In general, all sampling sites were categorized as hazardous. For nitrogen dioxide, the value of the air pollutant index at each sampling site had decreased on the weekend. The value of air pollutant index at the beginning of the week was ranged between 1.33 - 3.58 and on the weekend were ranged between 0.79 - 2.67. In general, the whole site can be categorized as good.

Table 4. Air Pollution Index

Parameter	BOW (µg/m^3)	API	Categories	WKD (µg/m^3)	API	Categories
Carbon monoxide (CO) *						
Min	165.84			162.67		
Max	354.71	1473.82	Hazardous	573.93	2874.83	Hazardous
Mean	233.55			342.98		
SD	71.31			168.47		
Nitrogen dioxide (NO$_2$) **						
Min	4.69			2.55		
Max	26.90	2.57	Good	27.03	1.53	Good
Mean	14.54			8.63		
SD	6.22			5.22		

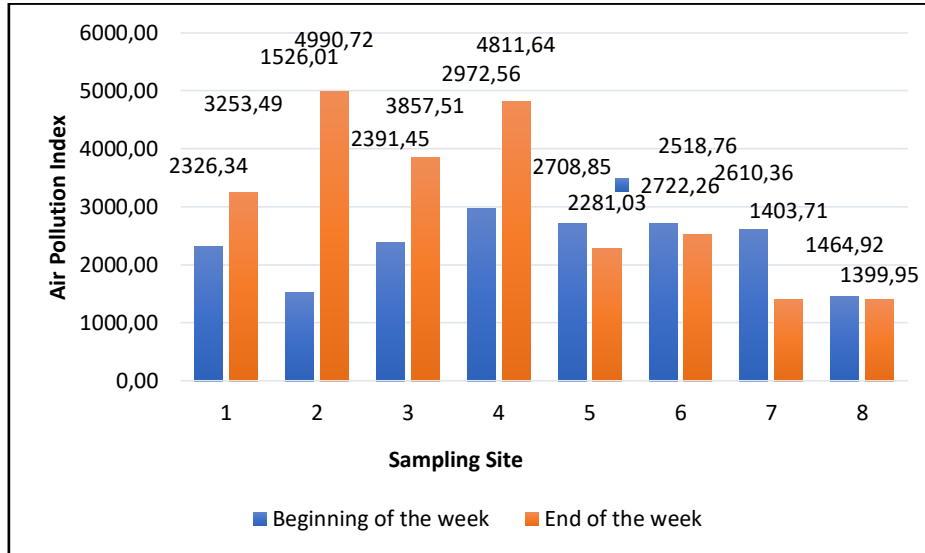* 8-hours measurement　　　　　　BOW = Beginning of the week

Fig 2. Air pollution index of carbon monoxide (CO) in sampling site
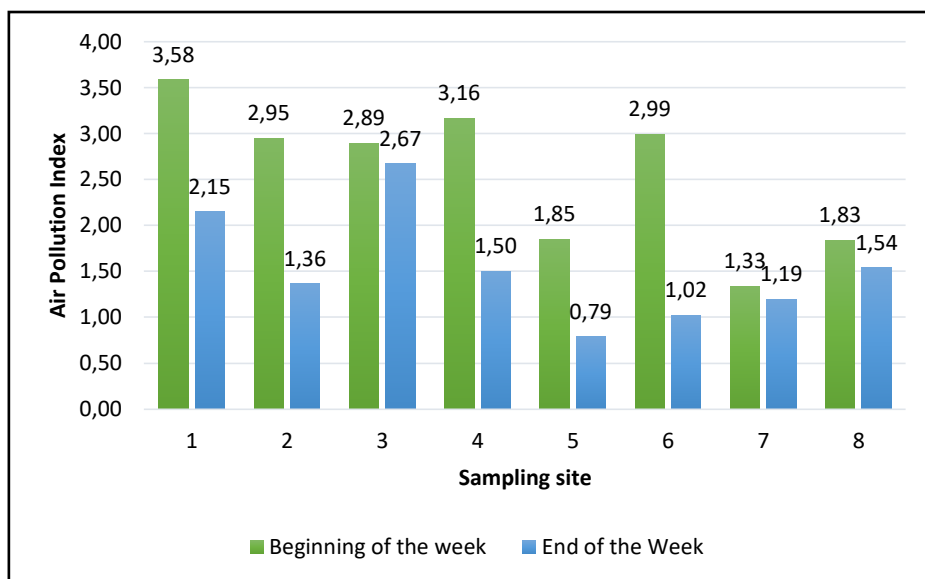

Fig 3. Air pollution index of nitrogen dioxide (NO$_2$) in sampling site

3.3 Anthropometric characteristics and exposure factors

Summary of anthropometric variables value and patterns of respondent activity as exposure factors in the research location were listed in table 5. The average body weight of respondent was 56.6 kg. This value was 24% lower than EPA's default body weight standard (70 kg). The average daily exposure time was 10.4 hours/day. This value was 0.3% higher than EPA's default daily exposure time for field worker (8 hours/day) but 56.7% higher than EPA's default daily exposure time for residential (24 hours/day). The average exposure frequency was 360.1 days/year, and the average exposure duration was 11.97 years.

Table 5. Average hourly and a daily dose of traders in the sampling site (n = 58)

Variable	Min	Max	Mean	SD
Body weight (Kg)	34	86	56.6	10.82
Daily exposure time (hours/day)	9	11	10.4	0.528
Exposure frequency (days/year)	310	363	360.1	9.224
Exposure duration (year)	1	23	11.97	8.115

3.4 Average hourly and a daily dose

In terms of average hourly dose (AHD) and average daily dose (ADD) showed in table 6, the variation across all sampling sites at the beginning of the week revealed that the average hourly dose for carbon monoxide was ranged from 0.0026 – 0.0067 mg/kg-hour with the highest value came from sampling site 4 (0.0091 mg/kg-hour). While on the weekend was ranged from 0.0029 – 0.0082 mg/kg-day with the highest value came from sampling site 2 (0.0191 mg/kg-day). For nitrogen dioxide at the beginning of the week, the average daily dose at each sampling site was ranged from 0.0001 – 0.0013 mg/kg-day with the highest value came from sampling site 2 (0.0031 mg/kg-day). While on the weekend was ranged from 0.0001 – 0.0006 mg/kg-day with the highest value also came from sampling site 2 (0.0014 mg/kg-day).

Table 6. Average hourly and a daily dose of traders in the sampling site

SP	MP	Average hourly dose (mg/kg-hour) CO				Average daily dose (mg/kg-day) NO_2			
		Min	Max	Mean	SD	Min	Max	Mean	SD
1	BOW	0.0022	0.0032	0.0027	0.0007	0.0006	0.001	0.0008	0.0002
	WKD	0.0053	0.0075	0.0064	0.0015	0.0003	0.0006	0.0004	0.0001
2	BOW	0.0029	0.0081	0.0035*	0.0018	0.00006	0.0031	0.0009	0.001
	WKD	0.0069	0.0191	0.0082*	0.0042	0.00003	0.0014	0.0004	0.0004
3	BOW	0.0023	0.0037	0.0026*	0.0004	0.00006	0.0004	0.0001	0.0001
	WKD	0.0061	0.0096	0.0066*	0.0012	0.00005	0.0004	0.0001	0.0001
4	BOW	0.0051	0.0091	0.0067	0.0013	0.00006	0.0025	0.0013	0.0009

	WKD	0.0079	0.0141	0.01	0.002	0.00003	0.0012	0.0006	0.0004
5	BOW	0.0025	0.0055	0.0032*	0.0007	0.00009	0.001	0.0004	0.0002
	WKD	0.0021	0.0046	0.0029	0.0007	0.00008	0.0004	0.0002	0.0001
6	BOW	0.0041	0.0067	0.0052*	0.0008	0.00015	0.0017	0.0009	0.0005
	WKD	0.0023	0.0037	0.0028*	0.0004	0.00005	0.0006	0.0003	0.0001
7	BOW	0.0024	0.0038	0.0029	0.0005	0.00007	0.0006	0.0004	0.0002
	WKD	0.0029	0.0045	0.0035	0.0006	0.00006	0.0006	0.0003	0.0001
8	BOW	0.0026	0.0044	0.0044	0.001	0.00009	0.0004	0.0002	0.0002
	WKD	0.0025	0.0042	0.0042	0.0009	0.00008	0.0004	0.0001	0.0001
Σ	BOW	0.0022	0.0091	0.0036*	0.0016	0.00006	0.0031	0.0004*	0.0006
	WKD	0.0021	0.0191	0.0041*	0.0034	0.00003	0.0014	0.0002*	0.0002

* Median

MP = Measurement period

SP = Sampling site

BOW = Beginning of the week

WKD = Weekend

3.5 Average risk quotient and risk quotient cumulative

Average risk quotient, according to gender, was shown in table 7. At the beginning of the week, the average risk quotient of CO for male in all sampling sites was 0.0053, with the highest value came from sampling site 2 (0.0081). While on the weekend was 0.0046 with the highest value also came from sampling site 2 (0.0191). For female, the average risk quotient of CO in all sampling site was 0.0035, with the highest value came from sampling site 4 (0.006). On the weekend was 0.0041 with the highest value came from sampling site 2 (0.008). In general, average risk quotient of acute exposure at the beginning of the week for CO was 0.0036. While on the weekend was 0.0041. The measured average risk quotient of NO_2 for male at the beginning of the week was 0.05 with the highest value came from sampling site 2 (0.157), while on the weekend was 0.02 with the highest value came from sampling site 4 and 7 (Both were 0.03). For female, the average risk quotient at the beginning of the week was 0.02 with the highest value came from sampling site 4. While on weekend was 0.01 with the highest value also came from sampling site 4 (0.03). In general, average risk quotient of chronic exposure at the beginning of the week for NO_2 was 0.02. While on weekend was 0.01. The estimation of risk for acute and chronic exposure to CO and NO_2 revealed that RQ < 1.0 for all population (male and female). This implied a negligible risk for all traders, both male and female. However, based on the results that have been explained previously, male may suffer from the effects compared with female.

Table 7. Average Risk Quotients for traders in sampling site

SP	MP	Risk Quotients					
		CO			NO$_2$		
		Male	Female	Mean	Male	Female	Mean
1	BOW	0.0022*	0.0032*	0.0027±0.0007	0.05*	0.03*	0.04±0.014
	WKD	0.0053*	0.0075*	0.0064±0.0015	0.03*	0.018*	0.02±0.008
2	BOW	0.0081*	0.003±0.0003	0.0035**	0.157*	0.03±0.02	0.049±0.05
	WKD	0.0191*	0.008±0.0008	0.0082**	0.07*	0.01±0.01	0.02±0.02
3	BOW	0.0028*	0.002**	0.0027**	0.012*	0.009±0.007	0.01±0.007
	WKD	0.0072*	0.006**	0.0066**	0.01*	0.008±0.007	0.009±0.006
4	BOW	0.0066*	0.006±0.0015	0.006±0.001	0.06±0.02	0.06±0.05	0.06±0.04
	WKD	0.01*	0.01±0.0024	0.01±0.002	0.03±0.01	0.03±0.02	0.03±0.02
5	BOW	0.0055*	0.003±0.0004	0.0032**	0.02*	0.02±0.01	0.02±0.01
	WKD	0.0046*	0.002±0.0005	0.0027**	0.01*	0.01±0.005	0.01±0.005
6	BOW	0.0058±0.0006	0.004±0.0006	0.005±0.0008	0.05±0.03	0.04±0.02	0.04±0.03
	WKD	0.0032±0.0003	0.002±0.0003	0.002±0.0004	0.02±0.01	0.01±0.008	0.01±0.009
7	BOW	0.0032*	0.003±0.0005	0.003±0.0005	0.03*	0.018±0.01	0.02±0.01
	WKD	0.0038	0.003±0.0007	0.003±0.0006	0.03*	0.02±0.009	0.02±0.01
8	BOW	NP	0.0044**	0.0044**	NP	0.01±0.01	0.01±0.01
	WKD	NP	0.0042**	0.0042**	NP	0.01±0.009	0.01±0.009
Σ	BOW	0.0053±0.0018	0.0035**	0.0036**	0.05±0.04	0.02**	0.02**
	WKD	0.0046**	0.0041**	0.0041**	0.02±0.02	0.01**	0.01**

* Only one person
** Median
MP = Measurement period
SP = Sampling site
NP = No person
BOW = Beginning of the week
WKD = Weekend

Air pollution is now fully acknowledged to be a significant public health problem, responsible for a growing range of health effects that are well documented from the results of an extensive research effort conducted in many regions of the world[27]. Long-term effects of air pollution on the onset of diseases such as respiratory infections and inflammations, cardiovascular dysfunctions, and cancer is widely accepted; hence, air pollution is linked with millions of deaths globally each year[28]. Our finding revealed that CO concentration on weekends is much higher than at the beginning of the week. This is consistent with the several studies where air pollution on the weekend increases relatively higher than during working days. On weekends, most people go for a vacation and use vehicles such as motorcycle, car or public transport, resulting in increasing the number of vehicles on the road that has an impact on the increased concentration of pollutants. But this does not apply to certain types of

pollutants[29-31]. For example, NO_2 concentration has significantly decreased on the weekend. This contrasts with the results obtained for carbon monoxide. The low concentration of NO_2 recorded in our study may be because NO_xemission has started to decrease considerably around the world [32]. In the USA, surface NO_2 level was decreased by 33% between 2001 and 2010 [33]. In Germany, NO_x has decreased significantly since the mid-80s for about approximately 60%. In East Asia, there has also been a decrease in NO_2 concentration when compared to CO_2 [34]. The overall decrease in concentration is due to several factors. Some of them are a significant reduction in the use of fossil fuels, distance from the highway and the speed of reaction in the formation of substances that is much slower when compared to other pollutants [34-36].

Carbon monoxide and nitrogen dioxide level in urban and industrial areas closely reflect traffic density (in combination with weather condition). In Germany, even has decreased significantly since the mid-80s, nitrogen oxide emissions are still largely caused by road traffic. Nationwide, the share of road transport in the total NO_x emissions is currently around 60%[32]. A study in Nigeria revealed, the highest CO concentration was recorded at two major traffic intersection; this may be due to the high presence of vehicle during sampling[37]. This condition also occurs in this study during the process of measuring air samples. Because bus stations are not used specifically for buses, but public transport like minibus can enter the station to pick up passengers, there is a density of traffic flow inside the bus station[31]. Another study revealed that higher significant concentration of CO found at the bus station location. This higher level of some air pollutants may be due to the combustion of fuel types and idling buses[38]. Also, meteorological factors (temperature, humidity, and wind speed) have a positive correlation with the concentration of pollutants in the air [39].

In this study, air pollution index of both CO and NO_2 gives different results according to the measurements of air concentration. The air pollution index of CO from the beginning until the end of the week could be described as a danger for human health, while NO_2 can be described as good. It means that CO is harmful to all segments of the population including traders. While NO_2 does not have a significant health impact on the human bodies. In health risk assessment approach, both average risk quotient of CO and NO_2 had not exceed the guideline (>1) and not indicated any noncarcinogenic health risk to traders. However, the male might suffer from the effect compared with female. As we know that CO and NO_2 are dangerous pollutant which can have adverse health effects for humans and several studies have revealed it. Both pollutants can affect the respiratory system and cardiovascular system[40-42], . CO can cause acute vertigo, binds to hemoglobin in red blood cells, reducing their ability to transport and release oxygen throughout the body [19]. Moderate exposure of CO to the occupants along the study area can aggravate cardiac ailments such as the brain and heart[43]. While NO_2 can cause asthma, and some study revealed that NO_2 can caused cancer[44], [45],[46], [47]. Some of these health effects require a comprehensive approach and need quick and appropriate environmental management so that they do not cause adverse effects in the future. Some possible solutions that can be done are reducing the use of fossil fuels, using PPE if working in pollution-prone places and prioritizing the use of public transportation rather than private [48], [49], [50].

4. Conclusion

The study shows the air pollution index of CO from the beginning until the end of the week could be described as a danger for human health especially to traders, thus requiring environmental management quickly and appropriately by the government to reduce the health

impacts that may arise while NO_2 does not have a significant health impact on traders but still need to be maintained in the future. There is no health risk found to be associated with acute and chronic exposure to the pollutants through male and female traders, but for a male is more likely to suffer the health effects. Identification of the possibility of these pollutants will make valuable contributions to government and relevant stakeholders in taking more concrete steps to protect and prolong human lives. Additionally, these findings will assist policymakers in enforcing existing legislation that limits the release of pollutants into the atmosphere or institutes risk management strategies.

References

[1] Mustafić H, Jabre P, Caussin C, Murad MH, Escolano S, Tafflet M.: Main air pollutants, and myocardial infarction. a systematic review and meta-analysis. Jama. Vol. 307,pp. 713-21. ((2012)

[2] Morakinyo OM, Adebowale AS, Mokgobu MI, Mukhola MS.: Health risk of inhalation exposure to sub-10 μm particulate matter and gaseous pollutants in an urban-industrial area in South Africaan ecological study. BMJ open. Vol. 7, pp 9-17(2017)

[3] PPESUMAPAPUA. Environmental status of MAMMINASATA Ecoregions (Makassar, Maros, Sungguminasa and Takalar). (2013)

[4] NRC. The Congestion Mitigation and Air Quality Improvement Program. Assessing 10 Years of Experience. Transportation Research Board. Pp. 520 (2002)

[5] Zhang K, Batterman S.: Air pollution and health risks due to vehicle traffic. Science of the total Environment. Vol. 450, pp. 307-16. (2013)

[6] Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H.: A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010 a systematic analysis for the Global Burden of Disease Study 2010. The lancet. Vol, 380**.** pp. 2224-60. (2012)

[7] McCracken JP, Wellenius GA, Bloomfield GS, Brook RD, Tolunay HE, Dockery DW,:Household air pollution from solid fuel use. Global Heart. Vol, **7**. pp, 223. (2012)

[8] Damanik KY.: Analysis of Carbon Monoxide (CO) and Lead (Pb) Concentration and Health Effect on Mechanical Motorbike Workshops in Medan Sunggal Subdistrict.North Sumatera University. Pp 9-20 (2017)

[9] Burnett RT, Cakmak S, Brook JR, Krewski D.: The role of particulate size and chemistry in the association between summertime ambient air pollution and hospitalization for cardiorespiratory diseases. Environmental health perspectives. Vol. 105**,** pp. 614. (1997)

[10] Bell ML, Peng RD, Dominici F, Samet JM.: Emergency hospital admissions for cardiovascular diseases and ambient levels of carbon monoxide. results for 126 United States urban counties, 1999–2005. Circulation. Vol. 120**,** pp. 949-55. (2009)

[11] WHO.: Air quality guidelines: global update 2005. World Health Organization. (2006)

[12] Abam F, Unachukwu G.: Vehicular emissions and air quality standards in Nigeria. European Journal of Scientific Research. Vol. 34**,** pp. 550-60. (2009)

[13] Larabee K, Phipatanakul W.: The Respiratory Health Effects of Nitrogen Dioxide in Children With Asthma. Pediatrics. Vol 130**,** pp. 56-60 (2012)

[14] Evren G, Akad M.: Transportation Planning Problems in Developing Countries. Department of Transportation, Technical University of Istanbul, Working Paper. pp. 143-800. (2001)

[15] Zheng X, Zhao W, Yan X, Shu T, Xiong Q, Chen F.: Pollution characteristics and health risk assessment of airborne heavy metals collected from Beijing bus stations. International journal of environmental research and public health. Vol. 12,pp. 9658-71. (2015)

[16] Birnbaum R, Damberg R, Fitz-Simons T, Frank N, Freas W.: National air quality and emissions trends report, 1997. Environmental Protection Agency, Emissions, Monitoring, and Analysis Div.Research Triangle Park, NC (United States). pp. 67-90 (1998)

[17] Bennet D, Chang S, Cooper D, Dinan J, Hofmann E, Barry T,.: Risk Assessment Guidance for Superfund. Process for Conducting Probabilistic Risk Assessment. Washington: U, S. Environmental Protection Agency. Vol. 3, pp. 8-13 (2001)

[18] NRC.: Acute exposure guideline levels for selected airborne chemicals. National Academies Press. Pp. 9-18 (2009)

[19] Fierro MA, O'Rourke MK.: Burgess JL. Adverse health effects of exposure to ambient carbon monoxide. University of Arizona Report. 10-19(2001)

[20] Louvar JF, Louvar BD.: Health and environmental risk analysis: fundamentals with applications. Prentice Hall Upper Saddle River, NJ. (1998)

[21] Wang Z, Duan X, Liu P, Nie J, Huang N, Zhang J.: Human exposure factors of Chinese people in environmental health risk assessment. Research of Environmental Sciences. Vol. 22, pp.1164-75. (2009)

[22] Wilbur SB.: Guidance manual for the assessment of joint toxic action of chemical mixtures: Agency for Toxic Substances and Disease Registry. Pp. 15-19(2001)

[23] Hickox WH, Denton JE.: The Determination of Acute Reference Exposure Levels for Airborne Toxicants. (1999)

[24] Rahman A, Nukman A, Setyadi S, Akib CR, Sofwan S, Jarot J.: Environmental Health Risk Analysis of Limestone Mining in Sukabumi, Cirebon, Tegal, Jepara and Tulung Agung. Jurnal Ekologi Kesehatan.Vol.9. pp. 9-19(2008)

[25] Basri S, Bujawati E, Amansyah M.: Environmental Health Risk Analysis (Model for Measuring the Risk of Air Pollution Against Health). Jurnal Kesehatan. Vol. 7, pp.8-19(2014)

[26] Arista G, Sunarsih E, Mutahar R.: Health Risk Analysis of Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) Exposure to Street Vendors at Palembang Ampera Terminal in 2015. Jurnal Ilmu Kesehatan Masyarakat.Vol. 6, pp. 15-25 (2015)

[27] Kelly FJ, Fussell JC.: Air pollution and public health. Emerging hazards and improved understanding of risk. Environmental geochemistry and health. Vol. 37, pp. 631-49. (2015)

[28] Ghorani-Azam A, Riahi-Zanjani B, Balali-Mood M.: Effects of air pollution on human health and practical measures for prevention in Iran. Journal of research in medical sciences. The official journal of Isfahan University of Medical Sciences.Vo.5 pp. 6-17. (2016)

[29] Shang J, Zheng Y, Tong W, Chang E, Yu Y.: Inferring gas consumption and pollution emission of vehicles throughout a city. Proceedings of the 20th ACM SIGKDD international conference on Knowledge discovery and data mining. Pp. 78 (2014)

[30] Davis LW.:The effect of driving restrictions on air quality in Mexico City. Journal of Political Economy. Vol. 116. Pp. 38-81. (2008)

[31] Utama DA, Daud A, Masni.: The Risk Assessment due to the Exposure of CO and NO_2 in the Traders in Malengkeri Terminal Area. Makassar City. International Journal of Sciences. Basic and Applied Research. Vol.3. pp.88-90. (2015)

[32] Kurtenbach R, Kleffmann J, Niedojadlo A, Wiesen P.: Primary NO 2 emissions and their impact on air quality in traffic environments in Germany. Environmental Sciences Europe. Vol. 24, pp. 21. (2012)

[33] Lamsal LN, Duncan BN, Yoshida Y, Krotkov NA, Pickering KE, Streets DG.: US NO2 trends (2005–2013). EPA Air Quality System (AQS) data versus improved observations from the Ozone Monitoring Instrument (OMI). Atmospheric Environment. Vol. 110, pp. 130-43. (2015)

[34] Reuter M, Buchwitz M, Hilboll A, Richter A, Schneising O, Hilker M.: Decreasing emissions of NO x relative to CO 2 in East Asia inferred from satellite observations. Nature Geoscience. Vol. 7, pp. 792. (2014)

[35] Dorado M, Ballesteros E, Arnal J, Gomez J, Lopez F.: Exhaust emissions from a Diesel engine fueled with transesterified waste olive oil. Fuel. Vol. 82, pp. 1311-5. (2014)

[36] Gilbert NL, Woodhouse S, Stieb DM, Brook JR.: Ambient nitrogen dioxide and distance from a major highway. Science of the Total Environment. Vol. 312, pp. 43-6. (2003)

[37] Njoku KL, Rumide TJ, Akinola MO, Adesuyi AA, Jolaoso AO.: Ambient air quality monitoring in metropolitan city of Lagos, Nigeria. Journal of Applied Sciences and Environmental Management. Vol. 20,pp. 178–85. (2016)

[38] Salama KF, Alhajri RF, Al-Anazi AA.: Assessment of air quality in bus terminal stations in Eastern Province, Kingdom of Saudi Arabia. International Journal Of Community Medicine And Public Health. Vol 4, pp. 1413-8. (2017)

[39] Mapoma HWT, Tenthani C, Tsakama M, Kosamu IBM.: Air quality assessment of carbon monoxide, nitrogen dioxide and sulfur dioxide levels in Blantyre. Malawi: a statistical approach to a stationary environmental monitoring station. African Journal of Environmental Science and Technology. Vol. 8,pp. 330-43. (2014)

[40] Shah AS, Lee KK, McAllister DA, Hunter A, Nair H, Whiteley W.: Short term exposure to air pollution and stroke.Vol. 350, pp. 295. (2015)

[41] Franklin BA, Brook R, Pope III CA.: Air pollution and cardiovascular disease. Current problems in cardiology. Vol. 40, pp. 207-38. (2015)

[42] Stojić SS, Stanišić N, Stojić A, Šoštarić A.: Single and combined effects of air pollutants on circulatory and respiratory system-related mortality in Belgrade, Serbia. Journal of Toxicology and Environmental Health, Part A. Vol. 79,pp. 17-27. (2016)

[43] Yusuf KA, Oluwole S, Abdusalam IO, Adewusi GR.: Spatial patterns of urban air pollution in an industrial estate, Lagos, Nigeria. International Journal of Engineering Inventions. Vol. 2, pp. 1-9. (2013)

[44] Greenberg N, Carel R, Derazne E, Tiktinsky A, Tzur D, Portnov B.: Modeling long-term effects attributed to nitrogen dioxide (NO2) and sulfur dioxide (SO2) exposure on asthma morbidity in a nationwide cohort in Israel. Journal of Toxicology and Environmental Health, Part A. Vol. 80, pp. 326-37. (2017)

[45] Greenberg N, Carel RS, Derazne E, Bibi H, Shpriz M, Tzur D,.: Different effects of long-term exposures to SO2 and NO2 air pollutants on asthma severity in young adults. Journal of Toxicology and Environmental Health, Part A. Vol. 79, pp. 342-51. (2016)

[46] Hamra GB, Laden F, Cohen AJ, Raaschou-Nielsen O, Brauer M, Loomis D.: Lung cancer and exposure to nitrogen dioxide and traffic. A systematic review and meta-analysis. Environmental health perspectives. Vol. 123, pp. 1107. (2015)

[47] Chen X, Zhang L-w, Huang J-j, Song F-j, Zhang L-p, Qian Z-m:Long-term exposure to urban air pollution and lung cancer mortality. A 12-year cohort study in Northern China. Science of The Total Environment. Vol.571, pp. 855-61. (2016)

[48] Liu Z, Guan D, Wei W, Davis SJ, Ciais P, Bai J: Reduced carbon emission estimates from fossil fuel combustion and cement production in China. Nature. Vol. 524,pp. 335. (2015)

[49] Zhou SS, Lukula S, Chiossone C, Nims RW, Suchmann DB, Ijaz MK.: Assessment of a respiratory face mask for capturing air pollutants and pathogens including human influenza and rhinoviruses. Journal of thoracic disease. Vol. 10, pp. 2059. (2018)

[50] Litman T.: Evaluating public transportation health benefits. Victoria Transport Policy Institute. Pp. 20-19 (2016)