

Risk Analysis to Street Vendors Due to Exposure of Nitrogen Dioxide (NO₂), Carbon Monoxide (CON), and Total Suspended Particles (TSP)

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Received January 23, 2024; Revised April 30, 2024; Accepted May 20, 2024

Cite This Paper in the Following Citation Styles

(a): [1] Eni Adriani Abidin, Anwar Mallongi, Hasnawati Amqam, Agus Bintara Birawida, Apik Indarty Moedjiono, Hidayanty Healthy, Setiawan Kasim, "Risk Analysis to Street Vendors Due to Exposure of Nitrogen Dioxide (NO₂), Carbon Monoxide (CON), and Total Suspended Particles (TSP)," *Universal Journal of Public Health*, Vol. 12, No. 3, pp. 460-470, 2024. DOI: 10.13189/ujph.2024.120304.

(b): Eni Adriani Abidin, Anwar Mallongi, Hasnawati Amqam, Agus Bintara Birawida, Apik Indarty Moedjiono, Hidayanty Healthy, Setiawan Kasim (2024). *Risk Analysis to Street Vendors Due to Exposure of Nitrogen Dioxide (NO₂), Carbon Monoxide (CON), and Total Suspended Particles (TSP)*. *Universal Journal of Public Health*, 12(3), 460-470. DOI: 10.13189/ujph.2024.120304.

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Abstract Background: Bumi Tamalanrea Permai is a housing complex with all the dynamic problems of typical Metropolitan City residents. One of them is the activities of street vendors who sell close to the road shoulder, which makes the vendors vulnerable to exposure to emissions from passing motor vehicles. The aim of the study was to quantify the health hazards that street sellers face from being exposed to carbon monoxide (CO), nitrogen dioxide (NO₂), and total suspended particles (TSP). **Method:** Six ambient air sampling stations at BBLK were analyzed, and a total of 68 respondents were involved. Intake, RQ, and THQ values were calculated as part of the data analysis process. Risk management must be implemented if RQ is greater than 1. **Results:** The average concentration of Nitrogen Dioxide is 13.3 mg/Nm³, Carbon Monoxide 7953 mg/Nm³ and Total Suspended Particles 89.7 mg/Nm³. The morning intake values are for Nitrogen Dioxide 10.03 mg/Nm³, Carbon Monoxide 28.9 mg/Nm³ and Total Suspended Particles 10.7 mg/Nm³ while the average evening intake value for Nitrogen Dioxide is 23.7 mg/Nm³, Carbon Monoxide 28.9 mg/Nm³ and Total Suspended Particles 10.2 mg/Nm³. Quantitative data explained by calculating RQ and THQ Quotient both real time and

lifetime is still safe. **Conclusion:** The findings indicate that street sellers in Bumi Tamalanrea Permai are not in danger of developing health issues as a result of being exposed to NO₂, CO, and TSP.

Keywords NO₂, CO, TSP, ARKL, Makassar

1. Introduction

Because of its negative impact on human health, air pollution is a major concern of the World Health Organization when deciding how to control environmental pollution. Data shows that 6.7% of deaths worldwide are caused by air pollution [1]. Increased vehicle activity, especially motorized vehicles, is one factor [2].

One of the largest cities in terms of population is Makassar, which has many cars and heavy traffic. Every year the population of Makassar City continues to increase, affecting the ability of the transportation sector to meet community needs along with the increasing use of motorized vehicles. The weakness of the transportation

system is the increase in pollutant levels due to emissions (release) of motor vehicle exhaust gases. [3]. The United States Environmental Protection Agency (EPA) states that outdoor pollutants pose a higher health risk than indoors. Traffic patterns on the highway can affect the speed of the vehicles used. On urban highways that have several intersections, this will hinder vehicle speed due to the accumulation of vehicle intensity which is not balanced with the width of the road. Slow vehicle movement in congested traffic conditions will accelerate incomplete combustion in motor vehicle engines so that the toxic pollutants produced are greater [4].

Around Address Bumi Tamalanrea, there are many street vendors selling along the road. The street vendors' selling places are often located directly next to the road. The very close distance between the place of sale and the road certainly makes traders very vulnerable to exposure to motor vehicle emissions. Continuous exposure to motor vehicle emissions can have a negative impact on the health of traders. Research on the topic of risk analysis is carried out to see and predict risks that will occur over the next few years, and if the results of the risk analysis are found to be risk agents that pose a risk to health, then risk management will be carried out. The aim of this research is to identify categories of health risks faced by street vendors due to

exposure to Carbon Monoxide, Nitrogen Dioxide and Total Particle Suspension.

2. Research Methods

The research design used the Environmental Health Risk Analysis (ARKL) method. ARKL is a method for determining how much a hazardous material can harm the environment or human health [5]. This research uses observation methods and variable measurement simultaneously. This research was conducted from April to September 2023.

Population and Sample: The population in this study were all street vendors in Bumi Tamalanrea Permai, Makassar City, totaling 250 people. Meanwhile, there were 2 samples studied, namely humans, 68 street vendors and the environment, namely the subjects in this study were street vendors in Bumi Tamalanrea Permai who had sold for at least 1 year, while the environmental sample was ambient air in Bumi Tamalanrea Permai City. Makassar is taken at 6 predetermined points in the morning and afternoon with a duration of 1 hour. (Instantaneous Measurement). The research location is Bumi Tamalanrea Permai, Makassar City (Figure 1).

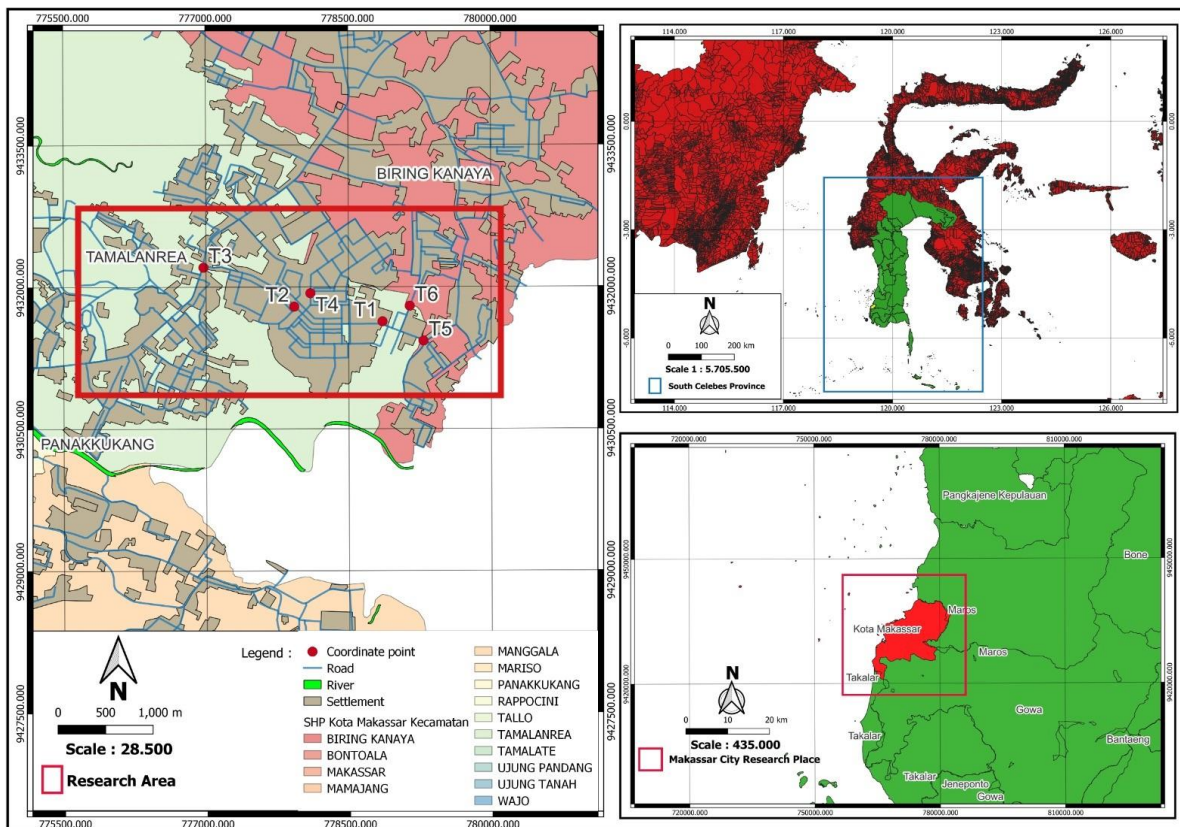


Figure 1. Map of sampling points

Information on the Location for Taking Ambient Air Samples

- Point 1 : Front of SMA 21 Makassar
Point 2 : SMP 30 Front of Vantafa Chicken

Porridge

- Point 3 : BTP exit gate
Point 4 : Telkomas BTP Axis in Front of Yudi

Salon

- Point 5 : BTP/NHP Gate
Point 6 : Daya Border Beauty Road

Sample point for taking ambient air at Bumi Tamalanrea Permai

Time	Point	
Morning: 07.00–08.00	Point 1	: In front of SMA 21 Makassar
	Point 2	: SMP 30 Front Vantafa and Chicken Porridge
Afternoon 17.00-18.00	Point 3	: BTP Exit Gate (Tamalanrea)
	Point 4	: Telkomas BTP Axis in Front of Yudi Salon
	Point 5	: Gate BTP/NHP
	Point 6	: Daya Border Beauty Path

These six location points were taken based on the results of initial observations, where 4 location points are the entrance to Bumi Tamalanrea Permai, and 2 points are in the middle of the research location which is densely packed with street vendors and is also congestion points and places for vehicles to turn around, resulting in traffic jams.

Research Instruments: Nitrogen Dioxide, Carbon Monoxide and Total Particle Suspension samples were taken by officers from the Health Laboratory Center (BBLK) Makassar. Respondents' body weight data was obtained using a weighing scale, while data on exposure time, exposure frequency and exposure duration were obtained by interview and recorded on the research observation sheet.

Research procedure: Hazard identification is carried out by measuring the concentrations of CO, NO₂, and TSP in the air of Bumi Tamalanrea Permai Makasar. CO, NO₂, and TSP sampling was carried out by officers from the Makassar Class I Environmental Health and Disease Control Engineering Center (BTKLPP) using an Air Sampler Impinger Model CS 5-96 AC for NO₂ sampling and a Non-Dispersive Infra Red (NDIR) Analyzer for sampling. CO samples and High Volume Air Sampler for TSP.

Data Analysis: In this research, an environmental health risk analysis (ARKL) was carried out in the following stages:

1. Hazard Identification

At this stage, the type of concentration contained in the ambient air is determined

2. Dose-Response Analysis

Nitrogen dioxide, carbon monoxide, and total suspended

particulates (permissible) concentrations of risk agents in the human body. A dose-response analysis was carried out based on standards issued by the US-EPA Agency for the Reference Concentration (RfC) value of nitrogen dioxide of 0.02 mg/kg/day while the RfC value of Carbon Dioxide was 7.667 mg/kg/day and the value of Total Particle Suspension was 2.42 particles/m³. [6]

3. Exposure Analysis

Air pollution by nitrogen dioxide, carbon dioxide, total particle suspension will enter the respiratory tract. The intake value through breathing is calculated using the following equation:

$$I = \frac{C \times R \times tE \times fE \times Dt}{Wb \times tavg}$$

Information:

- I : Intake (mg/kg/day).
C : Concentration of risk agent (mg/m³)
R : Inhalation rate (m³/hour)
tE : Exposure time (hours/day)
fE : Frequency of exposure (days/year)
Dt : Duration of exposure (years)
Wb : Body weight (kg)
t_{avg} : Average time period (Dt x 365 days/year)

4. To see the level of risk, it is expressed by the risk quotient (RQ). Characterization of the risk of non-carcinogenic effects is calculated by comparing the intake value of each risk agent with its reference dose (RfC) using Equation [6].

$$RQ = \frac{Ink}{RfD \text{ atau } RfC}$$

Information:

- RQ : Risk Quotient
Ink : Non carcinogenic intake
RfD : Reference Dose
RfC : Reference Concentration

$$THQ = \frac{fE \times Dt \times R \times C}{RfC \times Wb \times Tavg} \times 10^{-3}$$

Information:

- THQ = Total Hazard Quotient
f_E = Exposure Frequency
Dt = Exposure Duration
R = Inhalation Rate
C = Concentration (Nitrogen Dioxide, Lead and Total Suspended Particles)
RfC = Reference Concentration
Wb = Body Weight
AT = Average time period

The exposure risk level value is expressed as RQ ≤ 1 and RQ ≥ 1. If RQ ≤ 1, then the risk level is declared safe, while RQ ≥ 1 means the risk level is declared unsafe or poses a risk to public health and needs to be controlled using risk management.

ETHICS PERMIT: Ethics clearance certificate was obtained from the institutional ethics permit committee of the Faculty of Public Health, Hasanuddin University, Makassar, Indonesia (ref Number: 2673/UN4.14.1/TP.0102/2023). This written consent was obtained before the respondent carried out data collection.

3. Results

The results of respondent characteristics show that the largest gender is female with a total of 42 respondents with a percentage of 61.8%. The majority of respondents' body weight was 61-76 kg, 36 respondents or 52.94%. Meanwhile, in the age variable, the highest number of respondents was aged 20-38 with a total of 42 respondents or 61.75%. Meanwhile, in the characteristics results, it was found that the minimum age of respondents was 23 years and the maximum was 52 years with a minimum body weight of 45 kg a maximum of 69 kg and the maximum length of work was 4 years and the lowest was 1 year.

Table 1 shows the characteristics of respondents based on time of exposure to street vendors in Bumi Tamalanrea Permai in 2023. It shows that for the duration of exposure, the average value is 2.49 with a median value of 2 and a standard deviation of 0.819. For time of exposure, the average value is 11.74 with a median value of 12 with a standard deviation of 1.492. Meanwhile, for the exposure frequency variable, the average value is 351.74; the median

value is 351 and the standard deviation value is 8.685.

Table 2 shows that the average value of air temperature is 32.04, and the median value is 32.11 with a standard deviation value of 2.09. For humidity, the average value is 65.12 with the median value being 69.65 and the standard deviation value being 8.01. Meanwhile, for angina speed, the mean value is 4.07; the median value is 4.20 and the standard deviation value is 1.15.

Table 3 shows the average value of *nitrogen dioxide measurement results*, namely 1.45 with a median value of 1.33 and a standard deviation value of 0.83. The average value of *carbon monoxide measurement results* is 12634 with a median value of 7953 and a standard deviation value of 13795. Meanwhile, the total suspended particle value is 9.21 on average, with an 8.97 median and a 3.14 standard deviation.

Based on graph 1, in general, looking at the humidity measurement results in the morning, it shows that the highest humidity is at point 4 (BTP Telkomas Axis) namely 71.70 RH and the lowest is at point 3 (BTP Tamalarea Exit Gate). For wind speed, the highest wind measurement results are at the BTP Exit Gate (Tamalanrea) which is 6 m/s and the lowest is at point 4 (Telkomas BTP Axis) which is 3.1 m/s. For temperature measurements, the results showed that the highest temperature was at point 2 of SMP 30 in Front of Bubur Ayam Vantafa, namely 33.5 °C, and the lowest was at point 4, Axis BTP Telkomas, Front of Yudi Salon, namely 27.2 °C.

Table 1. Characteristics of Respondents based on Duration of Exposure, Time of Exposure and Frequency of Exposure to Street Vendors in Bumi Tamalanrea Permai in 2023

Variable	Mean	Min	95 % CI	elementary school	Kolmogorov-sminov Sig	Shapiro Wilk Sig	Data Distribution
	Median	Max					
Duration of Exposure (Dt) (Year)	2.49	1	2.29	0.819	0,000	0,000	Abnormal
	2.00	4	2.68				
Exposure Time (tE) (hours/Day)	11.74	8	11.37	1,492	0,000	0,000	Abnormal
	12.00	14	12.10				
Exposure Frequency (fE) (day/Year)	351.74	321	349.63	8,685	0,000	0,000	Abnormal
	351,000	358	353.84				

Source: Primary Data, 2023

Table 2. Distribution of Temperature, Humidity and Wind Speed Measurement Results on Tamalanrea Permai Earth in 2023

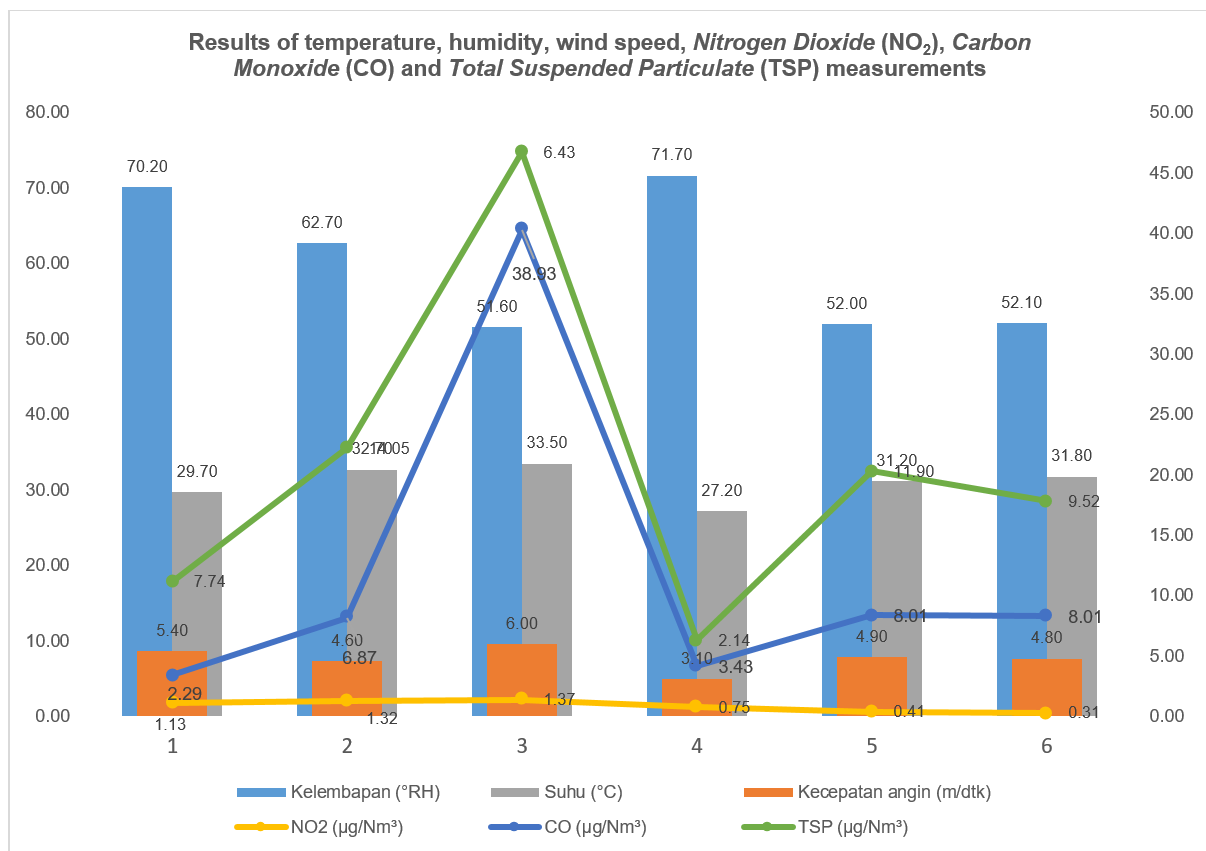
Measurement results	Mean	Min	Standard Deviation	NAB (Permenkesn1077/MENKES/2011)
	Median	Max		
Temperature (°C)	32.04	27,20	2.09	18-30 °C
	32.11	35.45		
Humidity (%RH)	65.12	51.60	8.01	40-60%
	69.65	76.7		
Wind Speed (m/s)	4.07	1.90	1.15	0-0.25 m/sec
	4.20	6.00		

Source: primary data, 2023

Table 3. Distribution of Measurement Results for *Nitrogen Dioxide (NO₂)*, *Carbon Monoxide (CO)* and *Total Suspended Particulate (TSP)* on Bumi Tamalanrea Permai in 2023

Measurement results	Mean Median	Min Max	Standard Deviation	NAB (PP No. 41 of 1999)
<i>Nitrogen Dioxide (NO₂)</i>	1.45 1.33	0.31 3.33	0.83	400 µg/Nm ³
<i>Carbon Monoxide (CO)</i>	12634 7953	2290 46786	13795	30000 µg/Nm ³
<i>Total Suspended Particulate (TSP)</i>	9.21 8.97	2.14 14.05	3.14	230 µg/Nm ³

Source: primary data, 2023



Source: Primary Data 2023

Graph 1. Results of Measurement of Temperature, Humidity, Wind Speed, *Nitrogen Dioxide (NO₂)*, *Carbon Monoxide (CO)* and *Total Suspended Particulate (TSP)* in the Morning at Bumi Tamalanrea Permai Makassar City in 2023

For the NO₂ concentration measurement results, it was found that the highest measurement for NO₂ concentration was at point 3 (BTP Tamalanrea Exit Gate) namely 1.37 µg/Nm³ and the lowest was at point 6, namely the Daya Border Beauty Road, namely 0.31 µg/Nm³. For CO concentration, the highest measurement results were at point 3 (BTP Tamalanrea Exit Gate) namely 38.93 µg/Nm³ and the lowest was in front of SMA 21 Makassar, namely 2.29 µg/Nm³.

Based on graph 2, in general, looking at the results of humidity measurements at night shows that the highest humidity is at point 5 (Grrbang BTP/NHP) namely

76.70 %RH and the lowest is at point 2 (SMP 30 Makassar) namely 56.55 %RH. For wind speed, the highest wind measurement results were at the BTP/Telkomas exit, namely 4.8 m/s and the lowest was at point 2 (SMP 30 Makassar), namely 1.9 m/s. For temperature measurements, the results showed that the highest temperature was at point 2 of SMP 30 Makassar, namely 35.45 °C, and the lowest was at point 4, Poros BTP Telkomas, namely 31.34 °C.

For the NO₂ concentration measurement results, it was found that the highest measurement for NO₂ concentration was at point 3 (BTP Tamalanrea Exit Gate) namely 3 µg/Nm³ and the lowest was at point 6, namely the Daya

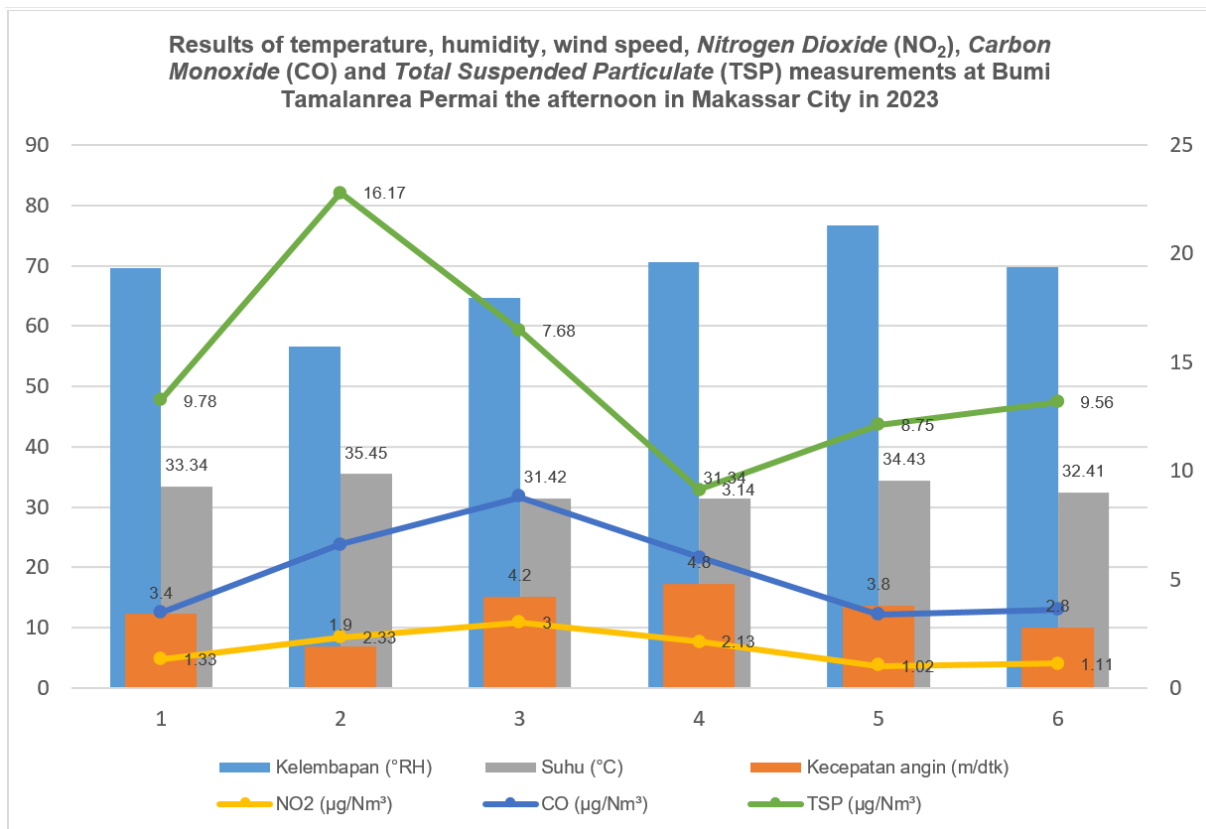
Border Beauty Road, namely $1.11 \mu\text{g}/\text{Nm}^3$ For CO concentration, the highest measurement results were at point 3 (BTP Tamalanrea Exit Gate) namely $5.78 \mu\text{g}/\text{Nm}^3$ and the lowest was in front of SMA 21 Makassar or at point 1, namely $2.12 \mu\text{g}/\text{Nm}^3$ For the TSP measurement results, the highest measurement results were obtained at point 2, namely in front of SMP 30 Makassar, namely $16.17 \mu\text{g}/\text{Nm}^3$ and the lowest was at point 4 of the Telkomas BTP Axis, namely $3.14 \mu\text{g}/\text{Nm}^3$

Based on table 4, the results of calculations to calculate the intake stated in the Environmental Health Risk Analysis Guidelines (ARKL), the results obtained in table 4 for the Nitrogen Dioxide variable mean intake value in the morning is $1.04\text{E}-04$ and intake in the day is $2.37\text{E}-05$. For the Carbon Monoxide variable, the mean value in the morning is $2.89\text{E}-02$ and in the day it is $3.99 \text{E}-02$. In the Total Suspended Particulate (TSP) variable, the mean intake value in the morning is $1.07\text{E}-04$ and in the day it is $1.02\text{E}-04$.

Based on table 5, the results of RQ and THQ calculations, both real time and life span, for Carbon

Dioxide (CO) exposure, the results show that the average real time RQ value in the morning is $7.70\text{E}-03$ and in the day is $1.06\text{E}-02$. For the RQ Life Span value, the average value in the morning is $3.57\text{E}-01$ and in the day it is $4.94\text{E}-01$. The average Real Time THQ value in the morning is $7.30\text{E}-07$ and in the day is $1.01\text{E}-06$. The average THQ Life Span value in the morning is $2.19\text{E}-05$ and in the day it is $3.72\text{E}-04$. From the results of the overall RQ calculation, both Real Time RQ and Life Span RQ, the results were less than 1, which means the existing risk level is still in the safe category.

Based on Table 6, the results showed that the real time RQ value in the morning was $4.41\text{E}-05$ and in the day it was $4.22\text{E}-05$, while the average RQ value life span in the morning is $1.24\text{E}-03$ and in the day is $1.19\text{E}-03$. The average real time THQ value in the morning is $4.18\text{E}-09$ and the day is $4.00\text{E}-09$, while the average THQ life span value in the morning is $1.25\text{E}-07$ and in the day is $1.38\text{E}-06$. So, from the calculation results for both RQ and THQ, all results are less than 1, which means that the potential risks are still in the safe category.



Source: Primary Data 2023

Graph 2. Results of measurements of temperature, humidity, wind speed, Nitrogen Dioxide (NO₂), Carbon Monoxide (CO) and Total Suspended Particulate (TSP) in the afternoon at Bumi Tamalanrea Permai, Makassar City in 2023

Table 4. Intake Calculation Results on Street Vendors in Bumi Tamalanrea Permai Due to Nitrogen Dioxide (NO₂), Carbon Monoxide (CO) and Total Suspended Particulate (TSP)

Variable	Intake (Real time)			Intake (Real time)		
	Morning					
	Min	Max	Mean	Min	Max	Mean
NO ₂	4.16E-05	2.00E-04	1.04E-04	9.54E-06	4.58E-05	2.37E-05
CO	9.89E-03	5.63E-02	2.89E-02	1.37E-02	7.78E-02	3.99E-02
TSP	4.07E-05	1.95E-04	1.07E-04	3.90E-05	1.87E-04	1.02E-04

Source: Primary Data 2023

Table 5. Risk Quotient (RQ) and Target Hazard Quotient Calculation Results (THQ) Street Vendors in Bumi Tamalanrea Permai Due to Carbon Monoxide Exposure

Calculation	Morning			Afternoon		
	Max	Min	Mean	Max	Min	Mean
RQ (Real Time)	1.50E-02	2.64E-03	7.70E-03	2.08E-02	3.65E-03	1.06E-02
RQ (Life Span)	4.24E-01	2.32E-01	3.57E-01	5.87E-01	3.21E-01	4.94E-01
THQ (Real Time)	1.50E-06	2.41E-07	7.30E-07	2.08E-06	3.33E-07	1.01E-06
THQ (Life Span)	4.50E-05	7.22E-06	2.19E-05	4.67E-04	2.85E-04	3.72E-04

Source: Primary Data, 2023

Table 6. Risk (RQ) and Target Hazard Quotient Calculation Results (THQ) in Street Vendors in Bumi Tamalanrea Permai Due to Total Suspended Particulate Exposure

Calculation	Morning			Afternoon		
	Max	Min	Mean	Max	Min	Mean
RQ (Real Time)	8.07E-05	1.68E-05	4.41E-05	7.73E-05	1.61E-05	4.22E-05
RQ (Life Span)	1.47E-03	8.05E-04	1.24E-03	1.41E-03	7.70E-04	1.19E-03
THQ (Real Time)	8.07E-09	1.30E-09	4.18E-09	7.73E-09	1.24E-09	4.00E-09
THQ (Life Span)	2.42E-07	3.89E-08	1.25E-07	1.74E-06	1.06E-06	1.38E-06

Source: Primary Data, 2023

4. Discussion

The results of respondent characteristics show that the largest gender is female with a total of 42 respondents with a percentage of 61.8%. The majority of respondents' body weight was 61-76 kg, 36 respondents or 52.94%. Meanwhile, in the age variable, the highest number of respondents was aged 20-38 people with a total of 42 respondents or 61.75%. Meanwhile, in the characteristics results, it was found that the minimum age of respondents was 23 years and the maximum was 52 years with a minimum body weight of 45 kg, the maximum of 69 kg and the maximum length of work was 4 years and the lowest was 1 year. The variables that are very important in influencing how much dose of a risk agent that a person will receive is the anthropometric characteristics and activity patterns of a person. What is meant here is body

weight. According to toxicology studies, a person's body weight is inversely proportional to the toxic effects on the body, because the higher a person's weight, the wider the distribution of toxic substances or toxins in the human body so that the average value of toxic substances per kilogram of body weight will decrease. Apart from that, the fat content of someone who has a high body weight also has an effect on capturing toxic substances that enter the human body [7]. The way to measure body weight is by measuring directly using a scale. The results obtained showed that the average body weight of the respondents interviewed was 61 kg. When referring to the body weight standards set by the USEPA, the results show that the body weight obtained is still below the normal adult body weight, namely 70-80kg. However, when compared with the average body weight of normal adults in ASIA, namely 55 kg, this means that the results obtained are not much

different.

Activity Patterns (Time, Frequency and Duration of Exposure) related Activity pattern information, namely exposure time, frequency exposure, and duration of exposure to respondents were obtained from each respondent by interview, namely by asking directly related to habits carried out, for example, how many hours sell in a day, how long does it take to leave each year (settlement or returning home, recreation) and how long it will take. In fact (real time), the respondent was at the location where the exposure occurred until the time the survey was conducted. Exposure time is one of the observed activity patterns in this research. Exposure time to street vendors selling at Bumi Tamalanrea Permai is divided into 2, namely 8-11 hours and 12-15 hours. One of the factors that influences traders to trade longer is how busy the visitors are. An additional factor that impacts is the trader's physical capabilities. Most older traders limit their trading activities.

For the variable frequency of exposure in units of days/year, from the results of the interviews, it was found that almost all respondents did not remember in detail the dates when they did not trade. So, what is used as a benchmark is the existence of religious holidays such as Ramadan, Eid al-Fitr, Eid al-Adha and Christmas, where the highest frequency results were 351 days with 35 respondents. Meanwhile, for the duration of exposure in years, the longest duration of exposure was approximately more than 2 years, involving 42 people. This is in accordance with Arista's research which obtained a minimum exposure duration of 1 year and a maximum duration of 12 years when conducting research on 84 street vendors at the Palembang Ampera terminal [8].

In calculating *intake*, it is known that exposure time, exposure frequency and exposure duration are directly proportional to the intake value, meaning that the greater the time, frequency and duration of a person's exposure to a *risk agent*, the greater the *intake value* that person receives and the greater the risk of exposure. Health problems are due to exposure to these *risk agents*.

When determining the concentrations of carbon monoxide (CO), nitrogen dioxide (NO₂), and total suspended particulate matter (TSP). For *Carbon Monoxide measurements* (CO) were obtained from the results of measurements by the Makassar Health Laboratory using an impinge device for 1 hour at each point, which was carried out at 6 points. The imprinter works by sucking air through a suction pump, which will enter the imprinter tube containing a CO absorber or capture solution where the level of contaminants in the air will then be calculated, based on the amount of air pumped from the results of measurements using a *spectrophotometer*.

The highest measurement result was at the BTP Tamalanrea Exit Gate, 38.93 µg/Nm³ and the lowest was in front of SMA 21 Makassar, namely 2.29 µg/Nm³. Meanwhile, in the afternoon the highest measurement result was at the BTP Tamalanrea Exit Gate, namely 5.78

µg/Nm³ and the lowest was in front of SMA 21 Makassar, namely 2.12 µg/Nm³. If this is related to humidity, the humidity factor influences the amount of CO concentration. This is in accordance with previous research where the research results show the influence of humidity on the amount of CO obtained because in humid air, pollutants do not easily move vertically upwards and are more difficult to dilute [9].

The measurement results for NO₂ concentration showed that the highest measurement for NO₂ concentration was at the BTP Tamalanrea Exit Gate, namely 1.37 µg/Nm³ and the lowest was at the Daya Border Beauty Road, namely 0.31 µg/Nm³. And at night the results showed that the highest measurement for NO₂ concentration was at the BTP Tamalanrea Exit Gate, namely 3 µg/Nm³ and the lowest was on Jalan Beauty Border Daya, namely 1.11 µg/Nm³. The average value of NO₂ measurements is higher in the afternoon. This is in line with research Hasdar [3], the average value of NO₂ measurements in the afternoon (16.08 µg/Nm³). Based on the measurement results obtained, it is still categorized as safe because it is still below the NO₂ quality standard value for ambient air, namely 200 µg/Nm.

The survey results showed that activity patterns in the morning were still lacking, and in the afternoon activity patterns appeared to be more densely packed with motorized vehicles. It was found from the results of interviews that home office hours were one of the reasons found, apart from that, the many alternative sales along Jalan Bumi Tamalanrea Permai made the research location busier. This is related to the sources of CO, NO₂ and TSP which are influenced by the number of vehicles as well as wind direction and wind speed. What was also found in previous research was that the concentration of CO and NO₂ was higher in the afternoon than in the morning [3].

The differences in concentration obtained can be influenced by the climate conditions at the time the measurements were made or the number of busy vehicles in the afternoon [10]. In terms of TSP concentration, the results obtained were that in the morning. It was found at point 2, namely in front of SMP 30 Makassar, namely 14.04 µg/Nm³ and the lowest was at point 4 Axis BTP Telkomas, namely 2.14 µg/Nm³. Meanwhile, in the afternoon, for the TSP measurement results, the highest measurement results were obtained at point 2, namely in front of SMP 30 Makassar, namely 16.17 µg/Nm³ and the lowest was at point 4 Poros BTP Telkomas, namely 3.14 µg/Nm³. From these results, it was concluded that the TSP concentration in Bumi Tamalanrea Permai was still below the set threshold value (NAB), namely 200 µg/Nm³. Measurement results Wind speed, temperature and air humidity also have a significant influence on TSP measurement results.

To calculate the Risk Level (*Risk Quotient*) or determine the risk characteristics, you will determine whether a substance or compound has risks or not for the body. Non-carcinogenic health risks are expressed by the Risk

Quotient (RQ). RQ is obtained by dividing the intake value by the reference concentration (RfC). The intake value will be divided by the reference dose value of NO₂, CO and TSP, namely 0.02 mg/kg/day, 7.667 mg/kg/day and 0.0082 mg/kg/day. When the result is >1, then it can be said that the respondent is in an unsafe condition or threatened by health risks; while the result is < 1, it can be said that the respondent is still in a safe condition or there is no threat of significant health risk.

The calculation of the RQ value is carried out using two calculation methods, namely real time and life span. This is so that if in current conditions (real time) the quotient of the intake value and the reference dose is still below one, it is necessary to test what the projections will be when exposure occurs continuously in the future. Therefore, for life span calculations, the US-EPA sets the projected duration for carcinogenic effects at 30 years.

a. Nitrogen Dioxide (NO₂)

From the calculation results, it was found that the average RQ value for NO₂ in the morning was 5.18E-03 and in the day it was 1.19E-03. Meanwhile, for predictions for the next 30 years, the average value of RQ in the morning is 6.33E-02 and in the day it is 1.45E-02. So, the calculation results obtained for both *real time* and *lifespan values* for NO₂ do not show a value < 1, which means that all street vendors selling along Jalan Bumi Tamalanrea Permai until now and in the next 30 years are still in the safe category.

The results obtained are in line with Prasetyo's research regarding risk analysis for epe banana traders due to exposure to NO₂ gas on Jalan Penghibur, Makassar City. The research results show that the *Risk Quotient* (RQ) value does not exceed 1 with a maximum value of 0.25, which means a health risk due to exposure to NO₂ in Epe banana traders on Jalan Entertainer, Makassar City, and it is still in the safe category [10]. Another similar research was carried out by Alkadri in 2013 which stated that the RQ of street vendors in Malengkeri, Makassar City, had no risk of exposure either now or in the next 30 years.

In environmental health risk analysis, there are several ways to minimize the risk level value, including modifying the concentration and modifying the length of exposure, but in this study, the concentration of Nitrogen dioxide was still below environmental quality standards, but in principle, control must still be carried out to reduce the existing RQ value.

b. Carbon Monoxide (CO)

Risk is a measure of the possibility of adverse effects felt by individuals or society due to the process of exposure to an agent under certain conditions [11].

From *real-time RQ* and *RQ lifespan* calculations, it shows that *the real-time Mean RQ (Risk quotient)* value in the morning is 7.03E-07 and *the real-time RQ (Risk quotient)* in the day is 1.06 E-02. Meanwhile, the RQ (*Risk quotient lifespan*) calculation obtained a mean RQ (*Risk*

quotient lifespan value in the morning of 3.57-01 and RQ (*Risk quotient*) in the day of 4.94-01. So, it can be concluded that the value of the RQ results from now to the next 30 years will still be in the mana category or >1. In line with research conducted by Shafarina [12] at the Pulogadung Terminal, Surabaya, where the average intake value for street vendors showed a result of ≤ 1, which means that all traders were still in the safe category. The study results of Lestari [13] shows that about 30% of people with severe carbon monoxide poisoning have fatal effects.

This RQ value is different due to different CO levels, activity patterns and anthropometric data of respondents. Meanwhile, the *lifetime RQ* value shows an RQ value < 1 for all respondents. This is due to differences in exposure duration used for calculations. This is in line with the research of Parhusip [14] where the RQ value in this research is above the safe limit, namely RQ > 1.

c. Total Suspended Particulate (TSP)

From *real-time RQ* and *RQ lifespan* calculations, it shows that *the real-time Mean RQ (Risk quotient)* value in the morning is 4.41E-05 and *the real-time RQ (Risk quotient)* in the day is 4.22 E-05. Meanwhile, by calculating RQ (*Risk quotient lifespan*), the mean value of RQ (*Risk quotient lifespan*) in the morning was 1.24-03 and RQ (*Risk quotient*) in the day was 1.19E-03.

Based on the calculation results obtained, the TSP concentration with the *real-time RQ* and *RQ lifespan variables* at all points (morning and day measurements) shows that the average risk level (RQ) is < 1, so exposure to TSP concentration in each individual indicates there is no health risk.

In line with the results of *Realtime Intake* calculations [15] in TSP concentration, the highest *Realtime Intake value was obtained* at location 2, namely 0.0180 – 0.2210 mg/kg/day with an average of 0.013307 mg/kg/day and *lifetime intake*, namely 0.0675 – 0.1980 mg/kg/day with an average 0.123200 mg/kg/day. Based on the risk level (RQ) on *real-time* and *lifetime* TSP concentrations, it was found that RQ ≤ 1 means there is no risk or it is still safe for people living in the Bullide limestone mining area.

Other research conducted by Dyan [16] shows that the average TSP concentration at Informal Furniture locations has exceeded the Threshold Limit Value (NAB), and based on ARKL calculations, it shows that all worker intakes, both *real time* and *lifetime*, are still below the reference dose and the estimated risk of workers being exposed to TSP is RQ.

The high and low RQ values can be influenced by the respondent's weight and the concentration of risk agents [17]. Because the greater the individual's body weight, the smaller the internal dose received. Apart from that, other individual factors that are a very big risk agent for an individual are exposure patterns and age [18]. Body weight will also influence the risk value and theoretically the greater a person's weight, the smaller the risk of

experiencing health problems [19].

Length of exposure was obtained through questions in the questionnaire regarding the length of time worked each day at the research location. On average, 28 respondents worked 13 hours/day. The longer workers are at the research location, the greater the risk they will receive. Length of work has a close relationship with impaired lung function, which is in line with research conducted by KAY Ardam [20] where workers with exposure to more than 8 hours a day were found to experience more lung function disorders.

For calculating THQ measurements, there are several same variables used when calculating intake, so when we calculate intake and RQ, we can also calculate the THQ value for a person. By calculating THQ, we know the term permitted concentration or tolerable value, namely 1. When the value is > 1 , it can be said that the person is at a risk of experiencing health problems.

Based on the results of data analysis, the average THQ value for real-time NO_2 is obtained, namely NO_2 is $8.70\text{E-}07$; CO is $3.02\text{E-}07$ and TSP is $4.09\text{E}09$ and for the THQ lifetime value of NO_2 which is $1.97\text{E-}04$, CO which is $2.79\text{E-}05$ and TSP which is $7.55\text{E-}07$. So, the THQ distribution of the 68 respondents is known to have 100% $\text{THQ} \leq 1$ and no respondents have $\text{THQ} > 1$. This means that the entire sample of individuals from the at-risk population will not experience adverse health effects.

Research is in line with which carried out by Prasetyo [10] on 80 Epe banana traders who sell at Jalan Entertainer, Makassar City, where the results of the THQ calculation revealed that none of the respondents showed a value of > 1 . Just like the RQ value, the magnitude of the risk of bad effects caused by pollutants in 82 street vendors is greatly influenced by the concentration of NO_2 and CO where the threshold value for each substance is still below the established quality standard, so that the THQ value obtained is below the value of one.

5. Research Limitations

1. When measuring Nitrogen Dioxide, Carbon Monoxide, and Total Suspended Particles at the research location, the weather conditions were drizzling so the results obtained were not optimal.
2. Only measurements were taken for 1 hour, and no measurements were taken for 8 hours.
3. Measurement time is only divided into 2 times (namely morning and evening).
4. Risk analysis was only carried out as a whole for the adult age group, and risk analysis was not carried out for children and gender groups.
5. Don't have policy implication for this study as it seems that there is no risk.

6. Conclusions

1. The concentration of *Nitrogen Dioxide* (NO_2) in Bumi Tamalanrea Permai, Makassar City, from the results of measurements for 1 hour, at 07.00-08.00 and 17.00-18.00 is still below the threshold value based on PP No. 41 of 1999.
2. *Carbon Monoxide* (CO) Concentration in Bumi Tamalanrea Permai, Makassar City, from the results of measurements for 1 hour, at 07.00-08.00 and 17.00-18.00 it is still below the threshold value based on PP No. 41 of 1999.
3. *Total Suspended Particulate (TSP)* Concentration in Bumi Tamalanrea Permai, Makassar City, from the results of measurements for 1 hour, at 07.00-08.00 and 17.00-18.00 it is still below the threshold value based on PP No. 22 of 2021.
4. Based on the Real-time Risk Level (RQ) and lifespan values for exposure to CO, TSP, and NO_2 , it can be concluded that street vendors in Bumi Tamalanrea Permai who weigh between 40 and 80 kg and are exposed for 12 to 15 hours a day, with a frequency of exposure of 351 days, are not at risk of developing health issues as a result of these exposures.
5. In light of the target hazard quotient (THQ) in real-time and the lifespan values of street vendors in Bumi Tamalanrea Permai who have a body weight of 40–80 kg and are exposed to 12–15 hours per day, with a frequency of exposure of 351 days, it can be concluded that these vendors do not face a health risk from exposure to carbon monoxide (CO), nitrogen dioxide (NO_2), and suspended particulate matter.

7. Suggestions

For the government, especially the Environmental Service, especially Makassar City, to collaborate with related parties, it is hoped that they will implement an emissions monitoring system on public vehicles and monitor potential risks periodically in densely populated locations. Apart from that, encourage the public through outreach to carry out regular inspections, maintenance and emission tests of their vehicles so that the combustion of their vehicle engines does not cause high emissions. And don't forget to always advise street vendors selling at Bumi Tamalanrea Permai to always wear a mask when selling.

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