



## RESEARCH ARTICLE

# **REVISED** Relationship Between Xylene, Rq Xylene Concentration and Enzyme Activity as Indicators of Heart and Liver Function Among Shoe Industry Workers In Surabaya

[version 2; peer review: 1 approved, 1 approved with reservations]

Previously titled: Relationship Between Xylene, Rq Xylene Concentration And Heart Function In Industrial Workers In Surabaya

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## Abstract

### Background

Xylene, a common solvent in painting, printing, and shoemaking, enters the body through inhalation of vapors.

### Methods

This observational analytic study aimed to examine the relationship between xylene concentration, xylene RQ, and liver function in industrial workers in Surabaya, especially in shoe industries. The chi-square method was utilized for data analysis. To ensure the validity and reliability of the study results, air and blood sampling procedures

## Open Peer Review

Approval Status  

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were implemented. Air sampling was conducted to measure xylene concentrations in the workplace environment, while blood samples were collected from workers to assess Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvate Transaminase (SGPT) levels. The study was conducted in five regions in Surabaya, namely Kalijudan, Ketintang, Jemursari, AUP, and Romokalisari. The population includes a total of 90 workers with 77 of them taken as samples using the accidental sampling method.

## Results

The results show that there is a relationship between xylene concentration and Serum Glutamic Oxaloacetic Transaminase (SGOT) levels ( $p > 0.05$ ); ( $r = 0,65$ ) and there is no relationship between xylene concentrations and Serum Glutamic Pyruvate Transaminase (SGPT) levels ( $p > 0.05$ ); ( $r = -0,12$ ). There was no relationship between RQ and SGOT levels ( $p > 0.05$ ) and there was no relationship between RQ and SGPT levels ( $p > 0.05$ ). However, from the calculation of the prevalence ratio, workers with unsafe RQ ( $RQ > 1$ ) have a 7.09x greater chance of experiencing damage to SGOT levels and a 1.06x greater chance of experiencing damage to SGPT levels.

## Conclusions

Xylene exposure (concentration & RQ) affects liver enzyme levels (SGOT/SGPT) in workers. Industries should consider providing nutritious food to aid xylene removal and stricter safety policies are needed. This study highlights the importance of a holistic approach to worker health and safety when dealing with hazardous chemicals.

## Keywords

Xylene, RQ xylene, heart function, industrial workers, safe work

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**REVISED Amendments from Version 1**

We have revised this article according to the reviewer's comments. Here is what we revised:

1. Title - We've revised the article title to accurately reflect its content. The original title mentioned heart function, but the study focused on liver function in shoe industry workers (Surabaya) as indicated by enzyme activity. We apologize for any inconvenience caused by the earlier oversight.
2. Abstract - We have added the purpose of the article in the methods section of the abstract, added information about air and blood sampling, and have also reported the R-value, then in the conclusion section of the abstract we have tried to clarify the purpose and importance of the paper.
3. Introduction - The introduction has been enhanced by adding relevant APA 7th edition citations, replacing "danger" and "dangerous" with "hazard" and "hazardous" for objectivity, aligning the discussion of liver function biomarkers (SGOT and SGPT) with the article's topic, and concluding with areas for future research and broader study implications.
4. Method - This cross-sectional study, conducted in 2019, included participants without previously diagnosed liver disease, ensuring they had healthy livers at the outset. The methods section (paragraph 3) details sample size justification and control of confounding factors such as physical activity, diet, and smoking. Notably, the study did not include a control group for comparison.
5. Discussion - The discussion section has been significantly improved for clarity and structure. It begins by restating the study's objectives and refocusing the reader after the methods and results. Each hypothesis is addressed in its section, detailing data distribution, statistical test results, and interpretations. The section concludes with comparisons to previous studies, highlighting agreements and explaining any discrepancies.

**Any further responses from the reviewers can be found at the end of the article**

## Introduction

As a country develops over time, the development is also directly proportional to the high potential danger to workers; one of which is exposure to chemicals as industrial raw materials (Chen & Reniers, 2020). These chemicals, if entered into the body of workers can cause illness and health problems (Mandiracioglu *et al.*, 2011). Some chemicals that are found in many industries are benzene, toluene, and xylene.

Xylene is a solvent with the physical properties of colorless, flammable, volatile, and has a sweet aroma (Bordoloi, 2018). This is a natural substance that is found in the contents of kerosene, coal, and others. Today many industries use xylene as a paint thinner and ink solvent (Jafari *et al.*, 2009). In addition, this is also commonly found in the agricultural industry as a solvent and emulsifier (Efeovbokhan *et al.*, 2021).

Xylene exposure to workers can be bad for health. According to Kurnianto (2016), several xylene exposure pathways include breathing, digestion, eye contact, and skin. Xylene that is inhaled by workers will enter and be retained in the lungs and eventually circulated to the body through the bloodstream. Many industries use xylene as a substitute for benzene (Kandyala *et al.*, 2010). However, based on experiments conducted, xylene is more dangerous than toluene (Masekameni *et al.*, 2019). A study (Kurnianto, 2016) was conducted whose results showed that the effect of the xylene threshold appeared at the lowest dose of toluene.

Xylene concentrations below 200 ppm can irritate the eyes and mucous membranes. At higher concentrations of xylene, exposure can cause narcotic effects (Niaz *et al.*, 2015). Exposure to xylene ingested by workers can cause interference with the stomach and toxic effects on the liver. Meanwhile, acute exposure to xylene vapors can cause lung dysfunction and cause swelling and bleeding (Kandyala *et al.*, 2010).

One of the health problems caused by xylene exposure to workers is the disruption to the digestive system. Indigestion can attack liver function which can be seen through SGOT and SPGT levels (Niaz *et al.*, 2015). SGOT or Serum Glutamic Oxaloacetic Transaminase or also known as AST (aspartate aminotransferase) is one of the liver enzymes. This enzyme is located in the structure of the liver, so its appearance in the blood indicates damage or disruption in liver function (Singh *et al.*, 2011). SGPT or Serum Glutamic Pyruvate Transaminase called ALT (alanine aminotransferase) is also a liver enzyme in the liver. Elevated levels of SGPT in the blood indicate symptoms of damage or impairment in liver function (Gowda *et al.*, 2009).

Continuous and frequent xylene exposure by workers can cause some health problems in the long run. These health problems include visual disturbances, dryness of the nose, dermatitis, and damage to the liver and kidneys

(Rajan *et al.*, 2019). This study aims to investigate the relationship between xylene, RQ xylene concentration, and heart function in industrial workers in Surabaya. This study also leaves areas for further research on the long-term impact of xylene exposure on the liver function of industrial workers. The results of this study have direct applications in efforts to improve occupational health and safety in the industrial sector, by enabling the development of more effective policies to reduce the risk of xylene exposure. However, more research is needed to fill this knowledge gap and find more comprehensive solutions to the health problems arising from xylene exposure in the workplace.

The paper will begin with an introduction to xylene, its sources of exposure, and its potential health effects on humans. The second section will present the methodology of the study, including the study design, participants, and data collection methods. The third section will present the results of the study, including the relationship between xylene exposure and heart function in industrial workers in Surabaya. Finally, the paper will conclude with a discussion of the implications of the study for occupational health and safety, as well as recommendations for future research in this area.

## Methods

This study, conducted in 2019, examines the relationship between xylene exposure and liver function in shoe industry workers. We employed a cross-sectional design, collecting data from workers in five prominent shoe industry clusters: Ketintang, Kalijudan, Jemursari, AUP, and Romokalisari. These locations were chosen due to their high concentration of workers potentially exposed to xylene. The study aimed to capture a diverse range of exposure levels by surveying workers across these clusters. Informed consent was obtained from all participants involved in the study through a well-defined process that ensured their understanding and willingness to participate. The process included information provision, opportunity for questions, voluntary participation, consent forms, confidentiality assurance, and contact information. By following these steps, the study ensured that participants were fully informed about the study and their rights.

The study included workers from shoe industry sites in Ketintang, Kalijudan, Jemursari, AUP, and Romokalisari who had worked there since 2019 or earlier, were between 16 and 65 years old, gave informed consent, had no history of medically diagnosed liver disease, and provided complete and accurate questionnaire answers. Workers from unspecified locations, those who started working after 2019, individuals under 16 or over 65 years old, those with a history of medically diagnosed liver disease, those who did not provide informed consent, those who were unavailable during data collection, and those who provided incomplete or inaccurate questionnaire answers, will be excluded from the study.

A total of 90 workers were used as the study population. Of these, 77 people were selected as samples using the accidental sampling method. This method is a non-probability sampling method where researchers select samples based on ease of access, not through a random selection process. As a result, the sample obtained is potentially not representative of the entire population (University of Greenwich, 2019). The accidental sampling method is also known as grab sampling, convenience sampling, or opportunity sampling (Alleydog, 2023).

To ensure the validity and reliability of the study results, air and blood sampling procedures were implemented. Air samples were collected using a calibrated air sampling pump equipped with an absorbent tube, which allowed quantification of xylene concentrations in the workplace environment. Blood samples were obtained from workers using a sterile venipuncture technique, which allowed for the assessment of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvate Transaminase (SGPT) levels. The independent variables were xylene concentration and xylene RQ, and the dependent variable was liver function as indicated by SGPT and SGOT levels. Blood samples were then tested in the laboratory.

Once the data was collected, an association test was conducted to assess the strength of the association using the chi-square test on categorical data. In addition to testing the association, the researchers also determined the level of risk using the prevalence rate (PR) formula. Confounding factors such as physical activity, nutrition, and smoking were controlled for by including a detailed questionnaire that collected information on these habits from each participant and by performing statistical adjustments in the data analysis.

## Results

Some characteristics of respondents include age, sex, level of education, and work area. The following table distributes the characteristics of respondents who work in the Surabaya shoe industry.

Based on Table 1, 25 (32.47%) of shoe industry workers aged 36-45 years with the majority of workers being male (61 or 79.22%) with the majority of final education level is senior high school (43 or 55.84%). Based on the working area of the shoe industry, 24 (31.17%) workers work in the shoe industry located in Romokalisari, Tambak Oso Wilangun, Surabaya.

**Table 1. Distribution of Shoe Industry Workers in Surabaya.**

| Characteristic of Respondent | Frequency | Percentage (%) |
|------------------------------|-----------|----------------|
| <b>Age</b>                   |           |                |
| 20-25                        | 15        | 19.48          |
| 26-35                        | 12        | 15.58          |
| 36-45                        | 25        | 32.47          |
| 46-55                        | 14        | 18.18          |
| 56-65                        | 11        | 14.29          |
| <b>Sex</b>                   |           |                |
| Male                         | 61        | 79.22          |
| Female                       | 16        | 20.78          |
| <b>Education level</b>       |           |                |
| Primary                      | 14        | 18.18          |
| Junior High                  | 19        | 24.68          |
| Senior High                  | 43        | 55.84          |
| University                   | 1         | 1.30           |
| <b>Work Area</b>             |           |                |
| Ketintang                    | 12        | 15.58          |
| Kalijudan                    | 20        | 25.97          |
| Jemursari                    | 10        | 12.99          |
| AUP                          | 11        | 14.29          |
| Romokalisari                 | 24        | 31.17          |

Dara source: primary data.

**Table 2. Xylene RQ and Concentration in the Shoe Industry in Surabaya.**

| Variable                    | Frequency | Percentage (%) |
|-----------------------------|-----------|----------------|
| <b>Xylene Concentration</b> |           |                |
| < threshold (<100 ppm)      | 76        | 98.7           |
| > threshold (>100ppm)       | 1         | 1.3            |
| <b>Xylene RQ</b>            |           |                |
| RQ < 1                      | 72        | 93.5           |
| RQ > 1                      | 5         | 6.5            |

Data source: primary data.

**Table 2** shows that of the five shoe industries in Surabaya, the majority (98.7%) of workers had a concentration of xylene exposure below the threshold value of 100 ppm. There is only one worker whose concentration of xylene exposure (103.59) exceeds the threshold, namely in Jemursari. Based on the risk level (RQ), 72 (93.5%) workers fall into the safe RQ category by RQ <1. There are still 5 (6.5%) workers that fell into the risk category.

**Table 3** explains the distribution of SGOT rates and SGPT rates among workers. The normal rate of SGOT is 5-40 IU / L and SGPT is 5-35 IU/L. Based on these results it is known that 66 (85.7%) workers have normal SGOT levels. There were 58 (75.3%) workers with normal SGPT rate.

Based on **Table 4** there is no relationship between xylene concentration and xylene risk level ( $p > 0.05$ ). **Table 4** shows that there were 71 (92.2%) workers who had an RQ level <1 with a concentration of exposure <100 ppm and there were 5 (6.5%) workers who had an RQ level > 1. While for concentrations > 100 ppm there is 1 (1.3%) worker with risk level of RQ <1.

**Table 3.** Distribution of SGOT and SGPT levels in the Shoe Industry Workers in Surabaya.

| Variable           | Frequency | Percentage (%) |
|--------------------|-----------|----------------|
| <b>SGOT</b>        |           |                |
| Normal (5-40 IU/L) | 66        | 85.7           |
| Abnormal           | 11        | 14.3           |
| <b>SGPT</b>        |           |                |
| Normal (5-35 IU/L) | 58        | 75.3           |
| Abnormal           | 19        | 24.7           |

Data source: primary data.

**Table 4.** Cross Tabulation Test Results between Xylene Concentration and XQ RQ in the Shoe Industry in Surabaya.

| Variable      |           |            | RQ   |       | Total  |                |
|---------------|-----------|------------|------|-------|--------|----------------|
|               |           |            | RQ>1 | RQ<1  |        |                |
| Concentration | > 100 ppm | Count      | 0    | 1     | 1      | P value = 1,00 |
|               |           | % of Total | 0.0% | 1.3%  | 1.3%   |                |
|               | < 100 ppm | Count      | 5    | 71    | 76     |                |
|               |           | % of Total | 6.5% | 92.2% | 98.7%  |                |
| Total         |           | Count      | 72   | 5     | 77     |                |
|               |           | % of Total | 6.5% | 93.5% | 100.0% |                |

**Table 5.** Results of the Cross Tabulation Test between SGOT and SGPT Levels in Shoe Industry Workers in Surabaya.

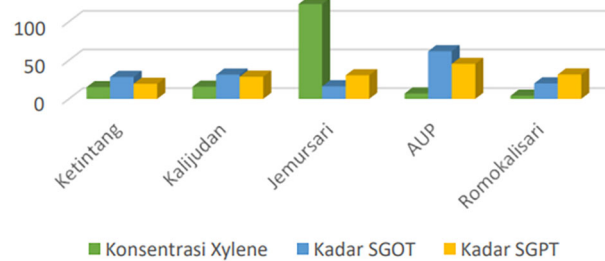
|       |                    |            | SGPT     |                    | Total  |                |
|-------|--------------------|------------|----------|--------------------|--------|----------------|
|       |                    |            | Abnormal | Normal (5-40 IU/L) |        |                |
| SGOT  | Abnormal           | Count      | 8        | 3                  | 11     | P value = 0,00 |
|       |                    | % of Total | 10.4%    | 3.9%               | 14.3%  |                |
|       | Normal (5-40 IU/L) | Count      | 11       | 55                 | 66     |                |
|       |                    | % of Total | 14.3%    | 71.4%              | 85.7%  |                |
| Total |                    | Count      | 58       | 19                 | 77     |                |
|       |                    | % of Total | 24.7%    | 75.3%              | 100.0% |                |

According to **Table 5**, there was a relationship between SGOT and SGPT rates ( $p < 0.05$ ). **Table 5** also shows that there are 55 (71.43%) workers with normal SGOT and SGPT levels. There were 11 (14.29%) employees with normal SGOT rates but SGPT rates were not normal. There were 3 (3.89%) employees with a normal SGPT rate and 8 (10.39%) employees with a normal SGPT rate.

**Figure 1** shows the highest average xylene concentration (122.81 ppm) is in Jemursari; the industry with the lowest average xylen concentration was Romokalisari (4.03 ppm). The highest average SGOT level was found in AUP (61.65 IU/L) and the lowest was found in Romokalisari (20 IU/L). The highest average SGPT level was found in the AUP industry (45.25 IU/L) and the lowest average was in Kalijudan (19.5 IU/L).

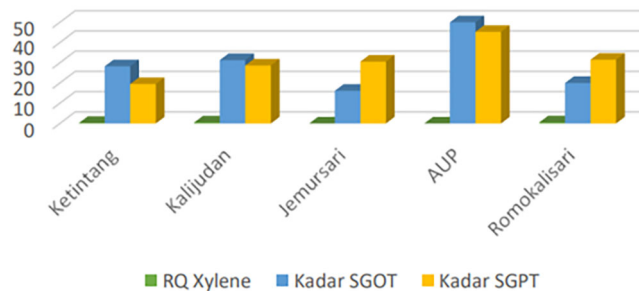
Based on **Figure 2**, the highest average RQ was found in Romokalisari (0.54) while the lowest average was found in Jemursari (0.004). SGOT and SGPT levels are the same as those listed in **Figure 1**.

Grafik Konsentrasi Xylene dengan SGOT dan SGPT



**Figure 1.** Graph Xylene Concentration with SGOT and SGPT levels.

Grafik RQ Xylene dengan SGOT dan SGPT



**Figure 2.** Graph RQ Xylene Concentration with SGOT and SGPT levels.

**Table 6.** Cross Tabulation Test Results between Xylene Concentrations and SGOT Levels.

| Variable      |           |            | SGOT       |                    | Total |                        |
|---------------|-----------|------------|------------|--------------------|-------|------------------------|
|               |           |            | Abnormal   | Normal (5-35 IU/L) |       |                        |
| Concentration | > 100 ppm | Count      | 1          | 0                  | 1     | <i>P</i> value = 0,143 |
|               |           | % of Total | 1.3%       | 0.0%               | 1.3%  |                        |
|               | < 100 ppm | Count      | 10         | 66                 | 76    |                        |
|               |           | % of Total | 13.0%      | 85.7%              | 98.7% |                        |
| Total         |           |            | Count      | 66                 | 11    | 77                     |
|               |           |            | % of Total | 14.3%              | 85.7% | 100.0%                 |

**Table 6** shows the results of the cross tabulation test between xylene concentrations and SGOT levels in workers. Based on the chi square test there was no relationship between xylene concentration and SGOT levels in workers ( $p > 0.05$ ). There were 66 (85.7%) workers with xylene concentration <100 ppm and normal SGOT levels; 10 (13.0%) other workers had abnormal SGOT levels. There are 1 (1.3%) workers with abnormal SGOT levels and exposed to concentrations >100 ppm. Based on the prevalence rate calculation, xylene concentration is a protective factor against damage to SGOT levels.

Based on **Table 7** there is no relationship between xylene concentration and SGPT levels ( $p > 0.05$ ). There were 58 (75.3%) workers who were exposed to xylene concentrations <100 ppm and had normal SGPT levels and 18 (23.4%) workers who had abnormal SGPT levels. In workers exposed to xylene concentrations exceeding NAV, there is 1 worker (1.3%) who has an abnormal SGPT level. Based on the calculation of the prevalence rate workers exposed to xylene concentration are included in the protection factor will cause damage to SGPT level.

**Table 7. Cross Tabulation Test Results between Xylene Concentration and SGPT Levels.**

| Variable      |            |            | SGPT     |                    | Total  |                        |
|---------------|------------|------------|----------|--------------------|--------|------------------------|
|               |            |            | Abnormal | Normal (5-35 IU/L) |        |                        |
| Concentration | > 100 ppm  | Count      | 1        | 0                  | 1      | <i>P</i> value = 0,247 |
|               |            | % of Total | 1.3%     | 0.0%               | 1.3%   |                        |
|               | < 100 ppm  | Count      | 18       | 58                 | 76     |                        |
|               |            | % of Total | 23.4%    | 75.3%              | 98.7%  |                        |
| Total         | Count      |            | 58       | 19                 | 77     |                        |
|               | % of Total |            | 24.7%    | 75.3%              | 100.0% |                        |

**Table 8. Cross Tabulation Test Results between RQ Xylene and SGOT Levels.**

| Variable |            |            | SGOT     |                    | Total  |                        |
|----------|------------|------------|----------|--------------------|--------|------------------------|
|          |            |            | Abnormal | Normal (5-40 IU/L) |        |                        |
| RQ       | RQ > 1     | Count      | 0        | 5                  | 5      | <i>P</i> value = 0,452 |
|          |            | % of Total | 0.0%     | 6.5%               | 6.5%   |                        |
|          | RQ < 1     | Count      | 11       | 61                 | 72     |                        |
|          |            | % of Total | 14.3%    | 79.2%              | 93.5%  |                        |
| Total    | Count      |            | 66       | 11                 | 77     |                        |
|          | % of Total |            | 14.3%    | 85.7%              | 100.0% |                        |

**Table 9. Cross Tabulation Test Results between RQ Xylene and SGPT Levels.**

| Variable |            |            | SGPT     |                    | Total  |                        |
|----------|------------|------------|----------|--------------------|--------|------------------------|
|          |            |            | Abnormal | Normal (5-35 IU/L) |        |                        |
| RQ       | RQ > 1     | Count      | 1        | 4                  | 5      | <i>P</i> value = 0,640 |
|          |            | % of Total | 1.3%     | 5.2%               | 6.5%   |                        |
|          | RQ < 1     | Count      | 18       | 54                 | 72     |                        |
|          |            | % of Total | 23.4%    | 70.1%              | 93.5%  |                        |
| Total    | Count      |            | 58       | 19                 | 77     |                        |
|          | % of Total |            | 24.7%    | 75.3%              | 100.0% |                        |

Table 8 shows no relationship between RQ xylene and SGOT levels ( $p > 0.05$ ). There were 61 (79.2%) workers who had RQ level < 1 and normal SGOT level and 11 (14.3%) workers who had abnormal SGOT levels. In RQ > 1 there were 5 (6.5%) workers who had normal SGOT levels. Based on the calculation of the prevalence rate of workers with RQ < 1, 7.09x greater risk of damage to SGOT levels.

Based on Table 9 there was no relationship between RQ xylene and SGPT levels ( $p > 0.05$ ). There were 54 (70.1%) workers who had RQ < 1 and normal SGPT levels and there were 18 (23.4%) workers who had abnormal SGPT levels. For workers with RQ > 1 there were 4 (5.2%) workers with normal SGPT levels and 1 (1.3%) workers with abnormal SGPT levels. Based on the calculation of the prevalence rate, workers with RQ < 1 were at a risk of 1.067x greater to experience damage to SGPT levels.

## Discussion

As this observational analytic study aimed to examine the relationship between xylene concentration, xylene RQ, and liver function in industrial workers, particularly in Surabaya's shoe industry, the following findings were identified:

Based on the collected data (Tables 1, 2, and 3), the majority of respondents fell within the 36-45 age range (32.47%), were male (61%), had a high school or vocational high school education (55.84%), and worked in the Romokalisari industry (31.17%). Moving on to the core objective, the correlation coefficient (R) between xylene concentration and SGOT level was found to be 0.65, indicating a moderate positive correlation. This suggests that higher xylene exposure levels are associated with higher SGOT levels in the workers. Conversely, the R-value between xylene concentration and SGPT level was -0.12, signifying no significant correlation. In simpler terms, there seems to be no clear association between xylene exposure and SGPT levels in these industrial workers.

#### Relationship between xylene concentration and RQ xylene

Table 2 shows the distribution of xylene exposure based on xylene concentration and risk (RQ). A total of 76 workers (98.7%) were exposed to xylene with concentrations below the threshold value (NAB) set at 200 ppm. Only 1 worker (1.3%) was exposed to concentrations above the NAB. Based on the results of the study, 72 workers (93.5%) had RQ < 1 (safe) and 5 other workers (6.5%) had RQ > 1 (risk). Analysis using the Chi-Square test in Table 4 showed no relationship between xylene concentration and RQ category ( $p > 0.05$ ). This may be due to other factors besides concentration that influence the increase in RQ category, such as intake of nutritious food.

#### The relationship between SGOT and SGPT

Table 3 shows the distribution of SGOT and SGPT levels in workers. A total of 66 workers (85.7%) had normal SGOT levels (5-40 IU/L) and 11 workers (14.3%) had abnormal SGOT levels. Meanwhile, 58 workers (75.3%) had normal SGPT levels and 19 workers (24.7%) had abnormal SGPT levels. Table 5 shows the relationship between SGOT and SGPT levels ( $p < 0.05$ ). Increases and decreases in SGOT levels were consistent with changes in SGPT levels. This is reasonable because SGOT and SGPT are among the biochemical markers often used to assess human liver function. An increase in SGOT is usually in line with an increase in SGPT.

#### Relationship between xylene concentration and SGOT

Table 6 shows the results of the relationship test between the variables of xylene concentration and SGOT levels in workers. Chi-Square test showed no relationship between the two ( $p > 0.05$ ). This may be influenced by other factors besides concentration, such as duration and frequency of xylene exposure. It should be noted that Table 2 shows only 1 worker (1.3%) was exposed above the NAB, while the other 76 workers (98.7%) were exposed to xylene below the NAB. Low exposure may not cause a significant increase in SGOT levels. Another study by Cahyana *et al.* (2015) actually showed a strong correlation between xylene concentration and MHA (Methylhippuric Acid) levels in urine. MHA itself is an acid produced from xylene metabolism in the body.

#### The relationship between RQ and SGOT/SGPT

Table 8 shows the relationship test between RQ variables and SGOT levels using the Chi-Square test. No association was found between RQ and blood SGOT levels ( $p > 0.05$ ). The same was found in Table 9, where the test of association between RQ and SGPT levels also showed no significant association ( $p > 0.05$ ). This may be due to the low number of workers with RQ > 1. Most workers were in the safe category (RQ < 1) and the xylene concentration exposed was also below the NAB.

This study found no association between xylene concentration and SGOT/SGPT levels in workers. This finding is in line with a study by Rusdy (2012) who reported no association between xylene exposure and neurotoxic symptoms in paint factory workers. Both studies suggest that xylene exposure at reasonable levels (below the NAB) may not directly affect liver function. Another study by Morley *et al.* (1970) also supports our findings. They stated that chronic effects on liver function due to xylene occur in workers with extreme exposure. This study found that most workers (98.7%) were exposed to xylene below the NAB, which may explain the absence of a significant association with SGOT/SGPT.

Research conducted by Irawati (2010) also states the same thing that the IARC and EPA have not been able to determine whether xylene is carcinogenic to humans. Some health effects experienced by workers due to xylene exposure are dizziness, nausea, headaches, and loss of balance. But there are no studies that state that xylene exposure interferes with or even damages the function of the human heart. Some studies suggest that exposure to BTX (benzene, toluene, xylene) has a direct impact on the neurotoxic or nervous system in humans due to exposure that enters through the inhalation system.

#### Conclusion

This study found no association between xylene concentrations and SGOT/SGPT levels in shoe industry workers in Surabaya who were exposed below the Threshold Value (NAB) ( $p > 0.05$ ). This finding suggests that xylene exposure at reasonable levels may not directly affect liver function. Other factors such as duration and frequency of exposure, dietary intake, and individual health conditions may play a greater role in affecting SGOT/SGPT levels. These findings may help focus occupational health prevention efforts on other risk factors besides xylene exposure at reasonable levels. Further

research is needed to identify other factors that may affect liver function in workers exposed to xylene. Education and training programmes on occupational health related to xylene exposure need to be continued to increase workers' awareness of potential risks and ways to prevent them.

The results of this study may be generalisable to other populations of industrial workers who are exposed to xylene at reasonable levels. However, keep in mind that this study was conducted in Surabaya and with a limited sample, so further research needs to be conducted elsewhere with a larger sample to confirm these findings. This study contributes to the knowledge of the relationship between xylene exposure and liver function in shoe industry workers in Indonesia. The findings help complement previous studies that focus on the neurotoxic effects of xylene.

This study has several limitations, including: Cross-sectional research design that cannot show cause-and-effect relationship, limited sample from one location in Surabaya, did not consider other factors that may affect SGOT/SGPT levels. Longitudinal studies are needed to examine the relationship between xylene exposure and long-term liver function. Studies with larger and more diverse samples from different locations and industries should be conducted. Studies that consider other factors such as duration and frequency of exposure, dietary intake, and individual health conditions should be conducted. Studies using other biomarkers of liver function other than SGOT/SGPT should be conducted.

### Ethical statement

Ethical approval was obtained from the Universitas Airlangga, Faculty of Dental Medicine ethics committee (605/HRECC.FODM/IX/2019).

### Informed consent

The objectives and protocols of the study were explained to the participants and obtained written informed consent from each subject before participation in the study.

### Data availability

#### Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

### Acknowledgments

The authors would like thank to the rector of Airlangga University. The authors would like to acknowledge Relationship between xylene, RQ xylene concentration and heart function in industrial workers in Surabaya.

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# Open Peer Review

Current Peer Review Status:  

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Reviewer Report 23 April 2025

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**Djahra Ali Boutlelis** 

Laboratory of Biology, Environment, and Health (LBEH), Faculty of Natural and Life Sciences, University of El Oued, El Oued, Algeria

## Comments to the Authors

This study investigates the effects of xylene exposure on liver enzyme levels (SGOT/SGPT) among shoe factory workers in Surabaya, examining both concentration levels and the risk quotient (RQ). While the research follows a conventional methodological framework, it offers valuable occupational health insights pertinent to this industrial sector. The manuscript is well-organized; however, to enhance its scientific rigor and potential impact, I have some suggested corrections:

- 1- Title: The current title refers to both "heart and liver function," while the study exclusively examines liver enzyme activity (SGOT and SGPT) as indicators of liver function. For scientific accuracy and clarity, I recommend removing the "heart function" reference from the title.
- 2- Abstract: Clarify study design (Add study timeframe, Include participant characteristics, Specify any control for confounding (smoking, alcohol use...)). Keywords: Remove "heart function" (not studied).

- 3—Introduction: Thematic consistency: The focus on the heart and liver is inconsistent—all references to heart function should be removed. Study Objective: The objective of the study should be clearly stated at the end of the introduction.

## 4- Methods :

*Air Sampling Procedures:* Could you provide more technical details about the calibrated air sampling pump equipped with an absorbent tube for xylene measurement? Specifically:

- Please specify the unit used for measuring xylene concentration in air samples.
- Manufacturer and model of the pump.
- Flow rate used during sampling (e.g., 50-200 mL/min as per NIOSH standards).
- Type of absorbent tube (e.g., activated charcoal, Tenax TA).
- Sampling duration and frequency per worker.
- Calibration method (e.g., primary calibration using a bubble flowmeter).
- Quality control measures implemented.

- Were air samples collected at different times during the work shift (beginning/end) to account for

fluctuations in xylene concentrations?

- How was the accuracy of the air sampling pump calibration ensured, and were quality control standards (e.g., certification by an accredited lab) mentioned?

*Blood Collection Procedures:*

Were specific blood collection tubes used (e.g., SST serum separator tubes)?

What sterilization protocols were implemented pre- and post-collection?

What was the time interval between collection and analysis?

At what temperature were samples stored (e.g., 4°C)?

What are the specifications of the analyzer used (manufacturer, model)?

How were factors affecting enzyme levels controlled (e.g., fasting, pre-collection exercise)?

Was blood draw time recorded relative to participants' last meal?

Please briefly explain how the Risk Quotient (RQ) was calculated, including the formula and reference value used.

Statistical analysis

Please indicate the statistical software used for data analysis in the study (e.g. SPSS, Excel,...).

## 5- Results

Please revise the figures to label the X-axis clearly and specify the sample size for each location.

## 6- Discussion

Add possible biological explanations for the lack of significant association between xylene exposure and liver enzyme levels.

Explain the relevance of RQ as a risk indicator and why it did not show a clear relationship with SGOT/SGPT.

Replace vague explanations (e.g. nutritious food) with scientifically accurate interpretations (e.g., metabolism and liver health).

Minor suggestions;

Following are references which the authors may be able to refer to enhance the manuscript;

<https://www.afjbs.com/issue-content/xylene-induced-hepatic-and-thyroid-dysfunction-in-wistar-rats-protective-effects-of-aqueous-extract-from-ghars-date-seeds-phoenix-dactylifera-l-8314>

<https://www.ncbi.nlm.nih.gov/books/NBK600778/>

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2. Langman JM: Xylene: its toxicity, measurement of exposure levels, absorption, metabolism and clearance. *Pathology*. 1994; **26** (3): 301-9 [PubMed Abstract](#) | [Publisher Full Text](#)

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

No

**If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** My primary research interests lie in the field of toxicology, particularly in the evaluation of the toxicological effects of xenobiotics and plant-derived compounds and their potential therapeutic applications. I focus on the identification and biochemical characterization of toxic and bioactive constituents from desert and medicinal plants, assessing their impact on vital organs such as the liver and kidneys through both in vitro and in vivo models. In addition, my work explores the protective and antioxidant roles of phytochemicals against chemical-induced toxicity. I also integrate spectroscopic and microscopic techniques (e.g., FTIR, SEM-EDX, XRD) to support phytochemical and toxicological analyses.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Reviewer Report 14 September 2024

<https://doi.org/10.5256/f1000research.167173.r322712>

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**Somayeh Farhang Dehghan** 

Shahid Beheshti University of Medical Sciences, Tehran, Iran

I am writing to express my observations regarding the recent manuscript submission by the authors. Upon reviewing the revised version, it is evident that the authors have diligently addressed a majority of the review comments provided during the previous evaluation. Their responses demonstrate a commitment to enhancing the quality and clarity of their work.

In conclusion, I believe that the authors' revisions substantially improve the manuscript and contribute to its overall robustness.

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Occupational Health

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

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Version 1

Reviewer Report 11 May 2024

<https://doi.org/10.5256/f1000research.153614.r232284>

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**Somayeh Farhang Dehghan**

<sup>1</sup> Shahid Beheshti University of Medical Sciences, Tehran, Iran

<sup>2</sup> Shahid Beheshti University of Medical Sciences, Tehran, Iran

Dear,

Thank you for the opportunity to review the article. This study aimed to investigate the relationship between xylene, RQ xylene concentration, and heart function in industrial workers in Surabaya. . They pertain to topics such as methodology, many contradictions, and poorly written and the authors' lack of familiarity with the related specialized terminology. See the comments below:

**Title**--The term "heart function" is quite broad; however, in this article, only enzyme assessment was conducted for this purpose. -Consider the SGOT and SGPT levels in workers aren't dedicated biomarker for heart function. -Only the workers of shoe industries have been assessed, not whole worker industry of Surabaya.

**Abstract**-The aim (s) has been ignored. There is no information available on air and blood sampling. Report the R values. A conclusion does not introduce new ideas; instead, it should clarify the intent and importance of the paper.

**Introduction**-Provide the references. Check the correct format of in-text citation and verify the necessity of parentheses. Replace the "hazard" and "hazardous" with "danger" and "dangerous". The fifth paragraph discusses how SGOT and SGPT are biomarkers of liver function; however, the topic of the article is about heart function. Define the SPGT in first use. In the last paragraph, please outline the unresolved issues and research gaps, as well as the direct and indirect applications of this study. The statement discussing how the results of this research can help resolve ambiguities is found in the last paragraph.

**Methods**- In the first paragraph, Since 2019? Or in 2019? I believe your study is cross-sectional. In Inclusion criteria, Free of known pre-existing liver diseases?? In Exclusion criteria, Those with a history of liver diseases?

How was the adequacy of the sample size determined? There is no detailed information available on air and blood sampling. How were the confounding factors (e.g. physical activity, nutrition, smoking, ...) controlled? Was there no control group?

**Discussion**-First, mention the purpose of the study. Then, state the results of each hypothesis separately, present congruent and discordant research, explain how past research aligns or differs, and interpret the results based on the theoretical framework and research outlined in the introduction of the article. Finally, the general and practical conclusions, the generalizability of the results, and the presentation of the contributions of this research to existing theoretical and practical knowledge are outlined. Following that, the limitations of the research are discussed, along with suggestions for future studies

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

No

**Are sufficient details of methods and analysis provided to allow replication by others?**

No

**If applicable, is the statistical analysis and its interpretation appropriate?**

Partly

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

No

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Occupational Health

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.**

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