



RESEARCH ARTICLE

**REVISED** Peak expiratory flow rate and chronic respiratory symptoms among restaurant workers: a cross-sectional study from Thailand [version 2; peer review: 3 approved]

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**Abstract**

**Background:** Cooking fumes are a major source of indoor air pollution affecting millions of people worldwide. To date, there has been no epidemiological study to show the variation in health effects resulting from work at different kinds of restaurants in Thailand. This study determines lung function and chronic respiratory symptoms of workers in four types of eateries commonly found in Thailand.

**Methods:** This is a cross-sectional study of 321 people working in four common types of restaurants in Thailand: ‘tamsang’ restaurants (from the Thai word , a restaurant that makes a variety of foods to order) (170 people), papaya salad restaurants (51 people), noodle restaurants (50 people), and barbecue stalls (50 people). The restaurant workers’ demographic data as well as information on their working conditions was collected using a questionnaire administered in a face to face interview. Each worker’s peak expiratory flow rate was measured using a portable peak flow meter.

**Results:** This study found that compared to the other three types of restaurants, working in a ‘tamsang’ restaurant has more adverse health effects. Participants from ‘tamsang’ restaurant were at greater of poor lung function (OR = 2.59, 95% CI 1.33–5.06) and moderate dyspnea symptoms (OR = 3.79, 95% CI 1.63–8.79) compared to participants from papaya salad restaurant. The study also found that each of the following were associated with poor lung function and/or chronic respiratory symptoms: cooking with palm oil, having irritated teary eyes while cooking, cooking without a ventilation hood, long past experience working at restaurants, and working in a small cooking area (1–6 m<sup>2</sup>).

**Conclusions:** Work in different kinds of restaurants with variations in cooking methods and work conditions produces diverse effects on airway and lung function. Regulatory organizations should pay careful attention to protecting the health of restaurant workers, especially those working in ‘tamsang’ restaurants.

**Keywords**

Indoor air pollution, cooking smoke, restaurant workers, peak expiratory flow rate, chronic respiratory symptoms, lung function

**Open Peer Review**

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**REVISED Amendments from Version 1**

First, I would like to thank you all the reviewers for their respected suggestions. To increase the clarity and informativeness of the original manuscript, some parts have been revised, and additional data has been provided. In the introduction section, a recent relevant article was referenced, and the terms 'cooking smoke' and 'cooking oil fumes' have both been replaced with "cooking fumes". The study objectives have been restated in a conceptual way instead of as operational criteria, as suggested by the reviewers. Information on participant selection and sampling method were revised with improved explanations. Description of the data analysis has also been amended. In the study results, data on 'cooking at home' was added to Table 1, and odds ratio on the combination effect of 'enclosed kitchen' and 'use of ventilation hood' was added to Table 3. Table 2 text was also revised for ease of understanding. A few existing points were discussed further, e.g. the concentration of pollutants from Thai cooking style vs. other cooking styles, the healthy worker effect (HWE), oil boiling point effects on pollutants. Finally, the sentence 'These findings are relevant for anyone concerned with the health and welfare of restaurant workers' was added to the conclusion.

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

**Introduction**

Recently cooking fumes have received increased public attention as an indoor and outdoor source of air pollution. The World Health Organization estimated that in 2018 inefficient cooking using solid fuels (biomass, kerosene and coal) caused premature death of about 4 million people worldwide<sup>1</sup>. Besides smoke from burning fuel, high temperature treatment of food will generate fumes from the degradation of sugars and fats, as well as from pyrolysis of proteins and amino acids. Previous studies have clearly established that cooking fumes commonly contain fine particulate matter and many other toxic compounds, including volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), aldehydes, alkanolic acids, nitrogen dioxide (NO<sub>2</sub>), and carbon monoxide (CO)<sup>2-4</sup>. The exact composition and concentration of cooking fumes depend on several factors, including cooking temperature, cooking methods, and cooking oil/fuel type<sup>5</sup>. Other research has reported that the cooking method releasing the most particles, especially in the ultrafine size range, is deep frying, followed by regular frying, stir frying, boiling, and steaming<sup>6,7</sup>. Concentrations of volatile organic compounds can vary from 257.5 to 3,494.0 µg/m<sup>3</sup>, depending on cooking style<sup>3</sup>. A study of two Chinese cooking styles found concentrations of fine particles, mostly fatty acids, to be 1,406.3 ± 293.4 µg/m<sup>3</sup> for Hunan cooking and 672.0 ± 295.8 µg/m<sup>3</sup> for Cantonese cooking<sup>4</sup>. It has been estimated that cooking with natural gas could add 21–30% to weekly average indoor concentrations of CO and 25–39% to those of NO<sub>2</sub> depending on ventilation and season of the year<sup>8</sup>.

People working in a kitchen, whether at home or in a restaurant setting, are at risk of exposure to cooking fumes and related health consequences. A study of people using natural gas to cook at home without a ventilation hood predicted that they would be exposed to NO<sub>2</sub>, CO, and formaldehyde at 62%, 9%, and 53% above established safety limits, respectively<sup>8</sup>. Lai *et al.*<sup>9</sup> reported a close correlation between levels of toxic chemicals in

restaurant air and levels of those same chemicals in the urine of chefs. Exposure to cooking fumes can result in various kinds of respiratory problems. A recent study from Taiwan reported an increased risk of lung cancer among chefs cooking Chinese food<sup>10</sup>. In places that tend to have modern kitchens, such in Norway, an elevated level of respiratory complaints and chronic bronchitis was also found among professional chefs, especially those who performed a lot of frying<sup>11</sup>. Studies from various parts of the world have reported an elevated prevalence of both acute and chronic respiratory symptoms and diseases among people involved in cooking<sup>12-18</sup>.

Lung function is another effect that has been associated with cooking fumes. A large study of elementary school children found reductions of peak expiratory flow up to 3.4% among children in families cooking with gas<sup>19</sup>. A study of Chinese restaurants in Hong Kong reported that workers cooking with gas had poorer lung function than those cooking with electricity<sup>13</sup>. A similar result was also observed in a study from India<sup>2</sup>. In Nigeria, workers exposed to wood smoke and oil fumes from a local style of grilled meat called "mai suya" have lower forced expiratory volume in one second (FEV1) and lower forced vital capacity (FVC) compared to an unexposed control group<sup>18</sup>.

In Thailand, four common types of eateries are: 'tamsang' restaurants (a kind of Thai restaurant that makes a variety of foods to order, from the Thai word ร้านอาหารตามสั่ง), noodle restaurants, papaya salad restaurants, and roadside barbecue stalls<sup>20</sup>. The kinds of food available at these four sorts of eateries are not the same. Of the four, 'tamsang' restaurants sell the widest variety of food, mainly popular Thai dishes, including red curry, basil stir fry, fried rice and numerous other fried dishes. Most of the food from 'tamsang' restaurants is cooked at high temperatures, creating a lot of oily steam and pungent vapors from frying chili peppers and other spicy ingredients. In noodle restaurants, much of the food is boiled but some noodle restaurants also make fried dishes, like phat Thai and other fried noodle dishes. At roadside barbecue stalls, various kinds of meat (beef, pork, chicken, and seafood) are grilled, usually over charcoal, producing abundant smoky vapors. In papaya salad restaurants, the salad is often served with some side dishes, such as sour soup, spicy meat salad, and grilled chicken. Therefore, papaya salad restaurants do employ a variety of cooking methods, including boiling, frying, grilling, but there is relatively less frying than at a 'tamsang' restaurant and less grilling than at a barbecue stall<sup>20</sup>.

To date, there has been no epidemiological study to show the variation in health effects resulting from work at different kinds of restaurants in Thailand. A previous study did find a higher occurrence of respiratory symptoms among restaurant workers in general, but due to small sample size, the study was not able to reveal a statistically significant difference in health effects between different types of restaurants<sup>17</sup>. The current study investigates peak expiratory flow rate (PEFR) and chronic respiratory symptoms among workers at different types of restaurants in Thailand. The study results are useful for the prevention and control of occupational health problems among

restaurant workers. The purpose of this study is to investigate if cooks working in different types of kitchens have different rates of impaired lung function and occurrence of respiratory symptoms.

## Methods

This study is a cross-sectional study.

### Study site

Phitsanulok is a medium size province in northern Thailand, about 400 km from Bangkok, with a population of 865,368 in 2017, and its largest city is Phitsanulok City. In 2017, Phitsanulok City reported that there were 2,511 restaurants within the city limits (personal communication, December 15, 2017).

### Study participants

In this study, a cluster sampling technique was employed by first divided restaurant types into four groups ('tamsang' restaurant, noodle restaurant, papaya salad restaurant, and barbecue stall), and then, individual restaurants were chosen using the consecutive sampling technique, where all the restaurants meeting the criteria were selected until the required sample size was reached. A total of 321 participants (170 from 'tamsang' restaurants, 50 from noodle restaurants, 51 from papaya salad restaurants, and 50 from barbecue stalls) were selected, this proportion roughly representing the frequency with which each restaurant type is encountered in the city. At each restaurant, one worker, preferably a chef who was at least 20 years old and willing to participate in the study, was interviewed and measured for PEFR.

The sample size calculation for a proportion or descriptive study was used to calculate the necessary sample size which found to be 322 using [OpenEpi](#) (version 3.0). The sample size calculation employed the following assumptions: population size = 2,500 (based on data from Phitsanulok City Hall), proportion of population with outcome = 0.40 (based on the previous study of the author, which found a prevalence of respiratory symptoms to be about 12% to 54%<sup>17</sup>, confidence interval = 95%, and standard error = 0.05.

### Study questionnaire

A questionnaire administered by interviewers was used to collect data in face-to-face interviews with restaurant workers (provided as extended data in English and Thai<sup>21</sup>). The interviews took place in a restaurant. The data was collected during the period of January–March 2018, when the weather is dry and mild in Thailand and therefore is unlikely to affect the respiratory health of the participants. The questionnaire was identical to that in a previous study by the current author on respiratory symptoms among restaurant workers<sup>17</sup>. The questionnaire was not validated but before use, it was tested for question sequencing and understanding. In addition to demographic data, the study also collected information on cooking fuel, cooking oil, kitchen size (approximated by interviewer) and types, use of ventilation hood, and frequency of tears while cooking (TWC), tearing eyes caused by smoke exposure.

The questions asked on chronic respiratory symptoms were developed based on British Medical Research Council (Medical Research Council Questionnaire, MRCQ)<sup>22</sup> and American

Thoracic Association (ATS-DLD-78) questionnaires<sup>23</sup>. Information on respiratory symptoms that were collected in this study included: chronic cough, chronic phlegm, wheeze, moderate dyspnea, and severe dyspnea. People with 'chronic cough' refers to those who cough with or without phlegm at least 4 to 6 times a day for 4 or more days out of the week. 'Chronic phlegm' refers to people who have sputum for at least twice a day for 4 or more days per week. 'Wheeze' refers to those who breathe with a whistling sound whether or not they have a cold. 'Moderate dyspnea' refers to people with shortness of breath when walking briskly or exercising. 'Severe dyspnea' refers to people with shortness of breath even when undertaking ordinary daily activities.

After each questionnaire interview, the peak expiratory flow rate (PEFR) of each participant was measured using a portable peak flow meter from MicroPeak (MPE8200EU), Care-Fusion Company, United Kingdom. The meter can measure flow rates in the range of 60–900 L/min, with an accuracy of  $\pm 5\%$  (10 L/min). The PEFr of each study participant was measured three consecutive times, and the highest reading was selected to be their PEFr record. This figure was then used to compare with a standard PEFr of Thai people, and study participants with a PEFr of less than 80% of the standard are considered to have abnormal lung function<sup>24</sup>.

The study data was collected by two graduate students from Naresuan University's Environmental Sciences master degree program.

### Data analysis

Data was analyzed using IBM [SPSS](#) (version 19) software. Frequency distribution of the data on demographics, cooking fumes exposure, PEFr, and chronic symptoms was analyzed using descriptive analysis. The associations between restaurant types and PEFr/ respiratory symptoms were analyzed using multiple logistic regression. The analysis was adjusted for gender (male, female), age (continuous), body mass index (BMI) (continuous), tobacco use (current smoker, ex-smoker, never smoked), and cooking at home (almost always, sometimes, rarely). All analyses were two-sided, with a 95% confidence interval, and a p-value of  $<0.05$  was considered to be statistically significant.

### Ethical statement

Written informed consent was obtained from each study participant before the interviewing process. At that time, study participants were informed of the study's purposes, the data collection procedure, and their right to refuse participation in the study. This study was approved in advance by the Naresuan University Board of Ethics (Certificate of Approval (COA) number: 033/2018).

### Results

Most of the study participants were female cooks with a similar mean age across all four types of restaurants studied. Most of the participants had been working for more than one year. Less than 20% of the participants were current cigarette smokers. Additional information on the demographic data is shown in [Table 1](#) and underlying data<sup>25</sup>.

**Table 1. Demographic data.**

	'Tamsang'	Noodle	Papaya Salad	Barbecue stall	P-value**
No of participants (n = 321)	170	50	51	50	
<b>Gender</b>					0.004*
Men	38 (22.4))	19 (38.0)	10 (19.6)	22 (44.0)	
Women	132 (77.6)	31 (62.0)	41 (80.4)	28 (56.0)	
<b>Age, years</b>					0.003*
20–29	9 (5.3)	9 (18.0)	2 (3.9)	6 (12.0)	
30–39	48 (28.2)	11 (22.0)	17 (33.3)	14 (28.0)	
40–49	34 (20.0)	15 (30.0)	17 (33.3)	6 (12.0)	
50–59	56 (32.9)	13 (26.0)	11 (21.6)	15 (30.0)	
60–69	22 (12.9)	2 (4.0)	4 (7.8)	6 (12.0)	
70–79	1 (0.6)	0 (0.0)	0 (0.0)	3 (6.0)	
Mean ± SD	46.52 ± 11.67	42.04 ± 11.42	44.02 ± 9.81	46.34 ± 13.20	0.08
<b>Marital status</b>					0.60
Single	26 (15.3)	9 (18.0)	11 (21.6)	9 (18.0)	
Married	122 (71.8)	39 (78.0)	36 (70.6)	36 (72.0)	
Divorced/spouse passed away/separated	22 (12.9)	22 (4.0)	4 (7.8)	5 (10.0)	
<b>Body mass index (BMI) kg/m<sup>2</sup></b>					0.046*
<18.5	7 (4.2)	4 (8.2)	1 (2.0)	4 (8.2)	
18.5–22.9	48 (28.6)	17 (34.7)	17 (33.3)	15 (30.6)	
23.0–24.9	41 (24.4)	5 (10.2)	8 (15.7)	3 (6.1)	
25.0–29.9	45 (26.8)	17 (34.7)	13 (25.5)	22 (44.9)	
≥30	27 (16.1)	6 (12.2)	12 (23.5)	5 (10.2)	
Mean ± SD	25.10 ± 4.79	24.68 ± 4.28	26.07 ± 5.21	25.09 ± 4.40	0.49
<b>Education completed</b>					
No school	2 (1.2)	0 (0.0)	5 (9.8)	2 (4.0)	0.003*
Primary school	73 (42.9)	13 (26.0)	17 (33.3)	19 (38.0)	
High school	85 (50.0)	27 (54.0)	22 (43.1)	23 (46.0)	
University/college	10 (5.9)	10 (20.0)	7 (13.7)	6 (12.0)	
<b>Tobacco use</b>					0.90
Current smoker	29 (17.1)	7 (14.0)	7 (13.7)	9 (18.0)	
Ex-smoker	11 (6.5)	5 (10.0)	2 (3.9)	3 (6.0)	
Never smoked	130 (76.5)	38 (76.0)	42 (82.4)	38 (76.0)	
<b>Job description</b>					0.04*
Cook	154 (90.6)	50 (100.0)	49 (96.1)	49 (98.0)	
Other (waitperson, chef assistant)	16 (9.4)	0	2 (3.9)	1 (2.0)	
<b>Years of working</b>					0.11
<1	4 (2.4)	4 (8.0)	4 (7.8)	6 (12.0)	
1–4	35 (20.6)	16 (32.0)	14 (27.5)	18 (36.0)	
5–9	39 (22.9)	8 (16.0)	9 (17.6)	8 (16.0)	
10–20	57 (33.5)	15 (30.0)	13 (25.5)	12 (24.0)	
21 or more	35 (20.6)	7 (14.0)	11 (21.6)	6 (12.0)	
<b>Cooking at home</b>					<0.001*
Almost always	101 (59.4)	19 (38.0)	19 (38.0)	26 (51.0)	
Sometimes	54 (31.8)	21 (42.0)	13 (26.0)	19 (37.3)	
Rarely	15 (8.8)	10 (20.0)	18 (36.0)	6 (11.8)	

\*Significant difference between types of restaurants with p&lt;0.05 (2-sided)

\*\*Chi-square test for category data, and ANOVA for continuous variable

It was found that restaurant workers had a high variation in lung function performance with the lowest average peak expiratory flow rate (PEFR) of  $278 \pm 113$  among those working in ‘tamsang’ restaurants and the highest PEFR of  $356 \pm 107$  among workers in noodle restaurants (Table 2). Compared to standard PEFR values of Thai people, 41.2%–64.7% of restaurant workers had a poor PEFR, defined as PEFR (measured)/PEFR (standard) less than 80%, and the prevalence of poor PEFR varied significantly across the types of restaurants ( $p < 0.001$ ). Many of the workers reported having chronic cough, phlegm, wheezing, moderate dyspnea, and severe dyspnea, but only moderate dyspnea showed a variation among types of restaurants.

Further analysis using multiple logistic regression showed that those who worked in ‘tamsang’ restaurants are at a significantly higher risk ( $p < 0.05$ ) of having poor PEFR (OR = 2.59, 95% CI 1.33–5.06), and moderate dyspnea (OR = 3.79, 95% CI 1.63–8.79) compared to papaya salad restaurant workers (Table 3). A higher risk of poor PEFR and/or chronic respiratory symptoms were also significantly associated ( $p < 0.05$ ) with the use of palm oil for cooking, with having frequent TWC, use of a ventilation hood, and with working in 1–6 m<sup>2</sup> kitchen. All analyses were carried out using the following covariates: age, gender, BMI, cigarette smoking, and cooking at home.

## Discussion

This study revealed that a large proportion of restaurant workers have poor PEFR, with the highest frequency of 64.7% found in ‘tamsang’ restaurants and the lowest rate of 41.2% in papaya salad restaurants (Table 2). Compared to workers in papaya salad restaurants, workers in ‘tamsang’ restaurants are more likely to have a low PEFR (OR = 2.59, 95% CI 1.33–5.06) and moderate dyspnea symptoms (OR = 3.79, 95% CI 1.63–8.79) (Table 3). These results are consistent with previous literature, which has reported that cooking fumes contains pollutants, such as fine particulate matter, acrolein, formaldehyde, and NO<sub>2</sub>, that can cause airway irritation<sup>2,26,27</sup>. Although no relevant

data from Thailand appears to exist, it is expected that Thai style cooking might generate more of these pollutants than other literature has reported in some other styles of cooking, because Thai cooking more often involves stir frying at high temperature, which is similar to Chinese cooking, but Thai cooking often uses more spices and other pungent ingredients. These pollutants are found more often in high temperature frying than in boiling or steaming<sup>3,28</sup>, which poses a real hazard to workers at ‘tamsang’ restaurants, since, as mentioned earlier, ‘tamsang’ restaurants do a lot of frying. More pollutants can also be expected from barbecue stalls, which usually grill meat with charcoal. However, this type of eatery is usually located outdoors in the open air, therefore exposure can be greatly reduced by the wind. Also somewhat surprising in this study, ‘tamsang’ restaurant workers were found to have a lower risk of severe dyspnea (OR = 0.45, 95% CI 0.20–0.99). This might be the result of the so called ‘healthy worker effect’ (HWE), in which people who have severely illness are excluded from the job<sup>29</sup>. Similar findings were also observed in the association between working as a cook and prevalence of severe dyspnea (OR = 0.33, 95% CI 0.11–0.98) (Table 3). This bias is likely limited to the more severe symptoms like severe dyspnea rather than other symptoms with milder health effects.

This study surprisingly found that compared to cooking with lard, cooking with palm oil is associated with an elevated risk of poor PEFR (OR = 5.38, 95% CI 1.43–20.31) but soybean oil was not (Table 3). This finding seems to contradict information that palm oil and lard contain mostly saturated and monounsaturated fats, and that both are similarly resistant to oxidation and have a high boiling point<sup>28,30</sup>. Compared with soybean oil which has a lower boiling point, lard and palm oil would be expected to produce fewer harmful pollutants when cooked. However, a study by Lee *et al.*<sup>31</sup> also found a negative effect from palm olein in the form of higher levels of aldehyde when frying chicken with palm olein compared to other cooking oils, despite similar amounts of fatty acids. At

**Table 2. Prevalence of poor peak expiratory flow rate (PEFR) and chronic respiratory symptoms of workers in different types of restaurants.**

	‘Tamsang’	Noodle	Papaya salad	Barbecue	P-value
N	170	50	51	50	
PEFR, Mean ± SD	278.05 ± 113.80	356.73 ± 107.96	331.75 ± 86.54	337.43 ± 125.54	<0.001*
PEFR <80%, n (%)	110 (64.7)	22 (44.0)	21 (41.2)	25 (50.0)	0.004**
<b>Chronic symptoms</b>					
Cough	33 (19.4)	12 (24.0)	14 (27.5)	6 (12.0)	0.24
Phlegm	27 (15.9)	4 (8.0)	4 (7.8)	7 (14.0)	0.31
Wheezing	29 (17.1)	4 (8.0)	6 (11.8)	10 (20.0)	0.28
Moderate dyspnea	69 (40.6)	7 (14.0)	8 (15.7)	13 (26.0)	<0.01*
Severe dyspnea	27 (15.9)	7 (14.0)	13 (25.5)	11 (22.0)	0.32

\*Significant difference between types of restaurants, with  $p < 0.05$  (2-sided), ANOVA test

\*\*Significant difference between types of restaurants, with  $p < 0.05$  (2-sided), Chi-square test

**Table 3. Odd ratio (OR)<sup>a</sup> with 95% confidence interval of low peak expiratory flow rate (PEFR)/chronic respiratory symptoms, by predictive factors.**

	Low PEFR	Cough	Phlegm	Wheezing	Moderate Dyspnea	Severe Dyspnea
<b>Restaurant type</b>						
Tamsang	2.59 (1.33–5.06)	0.64 (0.30–1.37)	2.18 (0.70–6.85)	1.69 (0.65–4.42)	3.79 (1.63–8.79)	0.45 (0.20–0.99)
Noodle	0.91 (0.39–2.10)	0.72 (0.28–1.88)	0.84 (0.18–3.92)	0.65 (0.17–2.56)	0.96 (0.31–2.98)	0.49 (0.17–1.42)
Barbecue	1.48 (0.63–3.45)	0.34 (0.11–1.04)	1.69 (0.41–6.94)	1.95 (0.60–6.31)	2.20 (0.76–6.33)	0.59 (0.21–1.65)
Papaya Salad	1.0	1.0	1.0	1.0	1.0	1.0
<b>Cooking oil<sup>b</sup></b>						
Soybean	0.98 (0.30–3.22)	0.53 (0.13–2.13)	1.35 (0.22–8.50)	0.68 (0.16–2.86)	0.36 (0.10–1.23)	1.23 (0.24–6.48)
Palm	5.38 (1.4–20.31)	0.65 (0.16–2.68)	2.97 (0.46–19.27)	0.74 (0.17–3.22)	0.99 (0.28–3.53)	0.73 (0.12–4.41)
Lard	1.0	1.0	1.0	1.0	1.0	1.0
<b>Tears while cooking (TWC)<sup>b</sup></b>						
Often	3.07 (1.09–8.63)	10.28 (2.61–40.46)	3.21 (0.68–15.09)	4.08 (1.10–15.22)	3.42 (1.20–9.70)	1.59 (0.46–5.48)
Sometimes	2.80 (1.29–6.06)	1.60 (0.50–5.14)	1.51 (0.44–5.18)	1.46 (0.49–4.35)	1.74 (0.78–3.70)	0.42 (0.14–1.26)
Rarely	1.0	1.0	1.0	1.0	1.0	1.0
<b>Job description</b>						
Cook	1.23 (0.45–3.34)	1.12 (0.30–4.13)	NA	0.74 (0.20–2.80)	0.58 (0.21–1.56)	0.33 (0.11–0.98)
Other	1.0	1.0	1.0	1.0	1.0	1.0
<b>Use of ventilation hood</b>						
Not used	0.90 (0.52–1.55)	2.25 (1.03–4.94)	1.02 (0.45–2.31)	1.00 (0.48–2.07)	0.86 (0.48–1.52)	2.58 (1.14–5.86)
Used	1.0	1.0	1.0	1.0	1.0	1.0
<b>Kitchen location<sup>b</sup></b>						
Enclosed	1.32 (0.66–2.65)	1.41 (0.59–3.41)	0.52 (0.17–1.56)	2.42 (0.99–5.90)	1.30 (0.65–2.58)	0.47 (0.17–1.32)
Outdoor	1.0	1.0	1.0	1.0	1.0	1.0
<b>Ventilation and kitchen location<sup>b</sup></b>						
Enclosed and use ventilation hood	0.72 (0.18–2.96)	NA	NA	2.42 (0.43–13.60)	0.41 (0.07–2.23)	NA
Outdoor and not use ventilation hood	1.0	1.0	1.0	1.0	1.0	1.0
<b>Kitchen area<sup>b</sup>, m<sup>2</sup></b>						
1–6	2.22 (1.13–4.36)	0.71 (0.30–1.66)	1.20 (0.46–3.18)	1.63 (0.69–3.92)	0.74 (0.38–1.43)	0.62 (0.25–1.55)
≥7	1.0	1.0	1.0	1.0	1.0	1.0
<b>Years of working</b>						
11 or more	0.98 (0.48–1.99)	1.21 (0.45–3.22)	1.12 (0.31–4.10)	4.74 (1.22–18.46)	0.61 (0.27–1.39)	0.62 (0.26–1.47)
5–10	0.85 (0.44–1.65)	1.37 (0.57–3.26)	2.33 (0.77–7.11)	2.75 (0.82–9.18)	0.55 (0.24–1.25)	1.01 (0.46–2.26)
1–4	1.0	1.0	1.0	1.0	1.0	1.0

<sup>a</sup>Adjusted for: Gender (male vs. female), age (continuous), body mass index (BMI) (continuous), tobacco use (current smoker, ex-smoker, never smoked), cooking at home (almost always, sometimes, rarely)

<sup>b</sup>Analysis using only data from 'tamsang' restaurant workers

NA = Data not available due to small sample size

present, data on health effects of palm oil is limited. Further research is therefore needed to investigate this issue.

The current study also found that low PEFR is correlated with tears while cooking (TWC), which refers to tearing eyes caused by smoke exposure, in a dose-response fashion, with an OR of 3.07 (95% CI 1.09–8.63) for those who often had TWC and an OR of 2.80 (95% CI 1.29–6.06) for those who only occasionally had TWC (Table 3). TWC was also significantly correlated with many chronic symptoms, including cough, wheezing, and moderate dyspnea. This result confirms that TWC is a good marker for cooking fumes. In a previous study of the current author, TWC was also found to be correlated with respiratory symptoms<sup>17</sup>.

This study also showed that not using a ventilation hood is significantly associated with an increased risk of chronic cough (OR = 2.25, 95% CI 1.03–4.94) and severe dyspnea (OR = 2.58, 95% CI 1.14–5.86) (Table 3). This finding was consistent with general thinking and previous research that has found that ventilation hoods, even when operating inefficiently, can significantly reduce cooking fumes exposure<sup>8,32</sup>. On the other hand, regarding kitchen location, there were no significant associations found. A study in Ghana similarly found that concentrations of PM<sub>2.5</sub> and black carbon did not significantly differ across outdoor, enclosed, and semi-enclosed kitchens<sup>5</sup>.

Inside ‘tamsang’ restaurants, people working in a smaller kitchen area of 1–6 m<sup>2</sup> have an increased risk of abnormal PEFR (OR = 2.22; 95% CI 1.13–4.36), compared to those working in a larger kitchen area of ≥7 m<sup>2</sup> (Table 3). One possible explanation is that restaurants with a larger kitchen area tend to have and use ventilation hoods more often than restaurants with a smaller kitchen area. Another possible explanation is that because a large kitchen area has more space, there is a greater volume of air to dilute the pollutants. Further analysis revealed that, in fact, large kitchens use ventilations hoods *less* frequently than small kitchens (27.5% vs. 44.3%, respectively). Thus, the first idea can be rejected.

### Study limitations

This study employs a cross-sectional design, in which data on both cooking fumes exposure and health outcome were collected at the same time. Thus, a causal association between the two cannot be drawn. Further study using an alternate design would be useful. Study results might also be adversely affected by small sample size and non-probabilistic sampling technique. This study used data of restaurants located in only one municipality area which may not represent all the restaurants in the whole country. However, all communities in each province of Thailand have similar types of restaurants and cooking style. Although the study data was collected locally and external validity cannot be presumed, the study results would likely be similar in other parts of Thailand, because they present the adverse health effects of a very common Thai cooking style that is widespread throughout the country.

Although the questionnaire was developed with reliable questions from respected medical associations, there is a chance of information bias regarding respiratory symptoms, which were reported by study participants rather than with confirmation from medical doctors.

Apart from cooking fumes, restaurant workers might also be exposed to roadside air pollution, and this could skew results. However, based on data from the Pollution Control Department of Thailand, all six criteria pollutants (PM<sub>10</sub>, Pb, CO, NO<sub>x</sub>, SO<sub>2</sub>, O<sub>3</sub>) in the Phitsanulok area were within safe air standards.

### Conclusion

Working in a Thai restaurant increases risk of abnormal lung function and chronic respiratory symptoms. Compared to working in a papaya salad restaurant, working in a ‘tamsang’ restaurant is associated with a lower PEFR, and higher rates of moderate dyspnea. Use of palm oil, having frequent tears while cooking, not using a ventilation hood, and working in a small kitchen area are significant predictors of poor lung function and/ or chronic respiratory symptoms. These findings are relevant for anyone concerned with the health and welfare of restaurant workers. Relevant regulatory organizations need to address these dangers in order to protect the health of restaurant workers, particularly those in ‘tamsang’ restaurants.

### Data availability

#### Underlying data

Figshare: PEFR and chronic respiratory symptoms. <https://doi.org/10.6084/m9.figshare.8980592.v2><sup>25</sup>

This project contains the following underlying data:

- PEFR\_Chronic\_symptoms.sav (Collected demographic and respiratory data)
- Data Dictionary.docx (Word document containing dictionary for study dataset)

#### Extended data

Figshare: Questionnaire-PEFR-chronic respiratory symptoms. <https://doi.org/10.6084/m9.figshare.9114503.v1><sup>21</sup>

This project contains the following extended data:

- Questionnaire-English.docx (Study questionnaire, English)
- Questionnaire-Thai.docx (Study questionnaire, Thai)

### Acknowledgments

The author is grateful to all the restaurant workers who took time to participate in this study and provided their valuable information. Thank you very much to Ms. Jintana Peangkhramrak and Ms. Waraporn Uraisri, graduate students in the Environmental Science program, for collecting so much data. Thank you also to Mr. Paul Freund of Naresuan University’s Writing Clinic (DIALD) for editing assistance.



## References

1. World Health Organization: **Household air pollution and health**. 2018. [Reference Source](#)
2. Singh A, Kesavachandran CN, Kamal R, *et al.*: **Indoor air pollution and its association with poor lung function, microalbuminuria and variations in blood pressure among kitchen workers in India: a cross-sectional study**. *Environ Health*. 2017; **16**(1): 33. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
3. Cheng S, Wang G, Lang J, *et al.*: **Characterization of volatile organic compounds from different cooking emissions**. *Atmos Environ*. 2016; **145**: 299–307. [Publisher Full Text](#)
4. He LY, Hu M, Huang XF, *et al.*: **Measurement of emissions of fine particulate organic matter from Chinese cooking**. *Atmos Environ*. 2004; **38**(38): 6557–64. [Publisher Full Text](#)
5. Van Vliet ED, Asante K, Jack DW, *et al.*: **Personal exposures to fine particulate matter and black carbon in households cooking with biomass fuels in rural Ghana**. *Environ Res*. 2013; **127**: 40–8. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
6. See SW, Balasubramanian R: **Chemical characteristics of fine particles emitted from different gas cooking methods**. *Atmos Environ*. 2008; **42**(39): 8852–62. [Publisher Full Text](#)
7. Buonanno G, Morawska L, Stabile L: **Particle emission factors during cooking activities**. *Atmos Environ*. 2009; **43**(20): 3235–42. [Publisher Full Text](#)
8. Logue JM, Klepeis NE, Lobscheid AB, *et al.*: **Pollutant exposures from natural gas cooking burners: a simulation-based assessment for Southern California**. *Environ Health Perspect*. 2014; **122**(1): 43–50. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
9. Lai CH, Jaakkola JJ, Chuang CY, *et al.*: **Exposure to cooking oil fumes and oxidative damages: a longitudinal study in Chinese military cooks**. *J Expo Sci Environ Epidemiol*. 2013; **23**(1): 94–100. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
10. Lin PC, Peng CY, Pan CH, *et al.*: **Gender differences and lung cancer risk in occupational chefs: analyzing more than 350,000 chefs in Taiwan, 1984–2011**. *Int Arch Occup Environ Health*. 2019; **92**(1): 101–9. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
11. Svedahl SR, Hilt B, Svendsen K: **Work environment factors and respiratory complaints in Norwegian cooks**. *Int Arch Occup Environ Health*. 2019; 1–8. [PubMed Abstract](#) | [Publisher Full Text](#)
12. Svendsen K, Sjaastad AK, Sivertsen I: **Respiratory symptoms in kitchen workers**. *Am J Ind Med*. 2003; **43**(4): 436–9. [PubMed Abstract](#) | [Publisher Full Text](#)
13. Wong TW, Wong AH, Lee FS, *et al.*: **Respiratory health and lung function in Chinese restaurant kitchen workers**. *Occup Environ Med*. 2011; **68**(10): 746–52. [PubMed Abstract](#) | [Publisher Full Text](#)
14. Duflo E, Greenstone M, Hanna R: **Cooking Stoves, Indoor Air Pollution, and Respiratory Health in India** | The Abdul Latif Jameel Poverty Action Lab. J-PAL. 2010. [Reference Source](#)
15. Kurmi OP, Semple S, Simkhada P, *et al.*: **COPD and chronic bronchitis risk of indoor air pollution from solid fuel: a systematic review and meta-analysis**. *Thorax*. 2010; **65**(3): 221–8. [PubMed Abstract](#) | [Publisher Full Text](#)
16. Kilabuko JH, Nakai S: **Effects of cooking fuels on acute respiratory infections in children in Tanzania**. *Int J Environ Res Public Health*. 2007; **4**(4): 283–8. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
17. Juntarawijit C, Juntarawijit Y: **Cooking smoke and respiratory symptoms of restaurant workers in Thailand**. *BMC Pulm Med*. 2017; **17**(1): 41. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
18. Adewole OO, Desalu OO, Nwogu KC, *et al.*: **Respiratory symptoms and lung function patterns in workers exposed to wood smoke and cooking oil fumes (mai suya) in Nigeria**. *Ann Med Health Sci Res*. 2013; **3**(1): 38–42. [PubMed Abstract](#) | [Free Full Text](#)
19. Moshammer H, Hutter HP, Neuberger M: **Gas cooking and reduced lung function in school children**. *Atmos Environ*. 2006; **40**(18): 3349–54. [Publisher Full Text](#)
20. It's better in Thailand: **Thai food guide to different restaurant types - It's better in Thailand**. 2019. Retrieved July 26, 2019. [Reference Source](#)
21. juntarawijit c: **Questionnaire-PEFR-chronic respiratory symptoms**. *figshare*. Dataset. 2019. <http://www.doi.org/10.6084/m9.figshare.9114503.v1>
22. Cotes JE, Chinn DJ: **MRC questionnaire (MRCQ) on respiratory symptoms**. *Occup Med (Chic Ill)*. 2007; **57**(5): 388. [Publisher Full Text](#)
23. Tennant S, Szuster F: **Nationwide monitoring and surveillance question development: Asthma**. Working Paper Series No. 2. 2003; (2). [Reference Source](#)
24. Dejsomritrutai W, Nana A, Maranetra KN, *et al.*: **Reference spirometric values for healthy lifetime nonsmokers in Thailand**. *J Med Assoc Thai*. 2000; **83**(5): 457–66. [PubMed Abstract](#)
25. juntarawijit c: **PEFR and chronic respiratory symptoms**. *figshare*. Dataset. 2019. <http://www.doi.org/10.6084/m9.figshare.8980592.v2>
26. Amaral AF, Ramasamy A, Castro-Giner F, *et al.*: **Interaction between gas cooking and GSTM1 null genotype in bronchial responsiveness: results from the European Community Respiratory Health Survey**. *Thorax*. 2014; **69**(6): 558–64. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
27. Paulin L, Hansel N: **Particulate air pollution and impaired lung function [version 1; peer review: 3 approved]**. *F1000Res*. 2016; **5**: pii: F1000 Faculty Rev-201. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
28. Peng CY, Lan CH, Lin PC, *et al.*: **Effects of cooking method, cooking oil, and food type on aldehyde emissions in cooking oil fumes**. *J Hazard Mater*. 2017; **324**(Pt B): 160–7. [PubMed Abstract](#) | [Publisher Full Text](#)
29. Shah D: **Healthy worker effect phenomenon**. *Indian J Occup Environ Med*. 2009; **13**(2): 77–9. [PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
30. Sarwar A, Vunguturi S, Ferdose A: **A Study on Smoke Point and Peroxide Values of different widely used Edible Oils**. 2016. [Reference Source](#)
31. Lee CY, Zhou WB, Bansal G: **Determination of the Aldehyde Levels in Frying Oil Using p-Anisidine Test**. *Glass*. 2007. [Reference Source](#)
32. Delp WW, Singer BC: **Performance assessment of U.S. residential cooking exhaust hoods**. *Environ Sci Technol*. 2012; **46**(11): 6167–73. [PubMed Abstract](#) | [Publisher Full Text](#)

# Open Peer Review

Current Peer Review Status:   

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## Version 2

Reviewer Report 14 January 2020

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**Jan G.C. van Amsterdam** 

Department of Psychiatry, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

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

**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.**

Reviewer Report 18 December 2019

<https://doi.org/10.5256/f1000research.23661.r57354>

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**Bjørn Hilt**

Department of Occupational Medicine, St. Olavs Hospital, Trondheim, Norway

The manuscript now shows considerable improvements and is, in my view, almost ready for indexing.

Just very few minor points:

Why is “tamsang” written in bold both in the abstract and the intro?

The table text of Table 1 could be more self-explanatory than only “Demographic data”.

In table 1 I am also still a bit unsure as to the meaning of the p-values. For such background data I would not do any significance testing at all, but also understand if the author wants to include it. But, for most variables like gender, age and so on, there is a p-value given as an overall assessment, while for

education the p-value is given for the category “no school”.

For table 2 it is still not clear to me for what differences the p-value is given. In the text it says that it is for the differences between Tamsang and Papaya Salad, and that should also be made clear in the footnotes in the table.

I still think that the first sentence of the conclusion should be omitted since that is not what the results show if Thai restaurant means all four types of restaurants studied.

After having reviewed the first version of the manuscript, I felt left with a question of what is so special with the tamsang restaurants, and am no pleased to find the explanation in the second last para of the introduction.

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

**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.**

Reviewer Report 10 December 2019

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**Satoshi Nakai** 

Graduate School of Environment and Information Sciences, Yokohama National University, Yokohama, Japan

No comments

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

**Reviewer Expertise:** Environmental Epidemiology, Exposure Sciences, Health Risk assessment

**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 12 November 2019

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**Jan G.C. van Amsterdam**

Department of Psychiatry, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

The study of Juntarawijit describes adverse health effects among employees working in four common types of restaurants in Thailand. Main results are that employees of 'tamsang' restaurants are more affected by cooking smoke than those working in papaya salad restaurants.

This is a nice study which suffers from some methodological errors.

#### Main points

The selection method was poorly described. Did all invited participants agree to participate? Part of the participants was no cook. What was their function? Were they also exposed to cooking smoke? What proportion of the participants were allergic? E.g. mites or pollen? Why were for example waiters (not exposed to cooking smoke not used as comparison group? The group 'Other job' (Table 1) should be deleted from data analysis, because they are ill characterized and group size is too small.

#### Minor points

##### Abstract:

Please describe that much less adverse effects were seen in the participants in the other three groups.  
3rd line: replace 'health effects' by 'adverse health effects'.

##### Introduction:

Please distinguish the effects of cooking smoke vs. methods of heating (coal, gas).  
Give in paragraph 3 some indication of effect sizes observed.

##### Methods:

Study participants, Line 5-6: please specify 'each restaurant worker' and use singular in this sentence. Why was only one worker per restaurant included? Any data of homogeneity in effects per restaurant? Data from the Pollution Control Department showed that pollutants in the Phitsanulok area were within safe air standards. However, did they vary during the study period? To which extent was traffic related air pollution involved in the outcome? Was any restaurant situated near a busy road (probably it was!)?

##### Results:

Define TWC when first time used. Was TWC related to allergy? Was TWC due to irritating smoke or rather an allergic reaction?  
Please present the results of the combination: 'Use of ventilation' and 'enclosed location'. There may be an adding effect as both affect the indoor air quality.

##### Discussion:

Probably palm oil and lard give a different heating temperature (frying temperature without burning; 'boiling point'). Suggest to include this difference to explain the differences found in adverse effects. Similar for soy bean oil.

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

Yes

**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?**

Yes

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

Yes

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

Partly

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

Yes

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

**Reviewer Expertise:** Pharmaco-toxicology

**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.**

Author Response 24 Nov 2019

**Chudchawal Juntarawijit**, Naresuan University, Phitsanulok, Thailand

Comment:

Main points: The selection method was poorly described. Did all invited participants agree to participate? Part of the participants was no cook. What was their function? Were they also exposed to cooking smoke? What proportion of the participants were allergic? E.g. mites or pollen? Why were for example waiters (not exposed to cooking smoke not used as comparison group? The group 'Other job' (Table 1) should be deleted from data analysis, because they are ill characterized and group size is too small.

Response:

Participant selection method was completely revised.

Yes, all invited participants agree to participate.

Nearly all of the participants are chefs and the rest are waitperson or chef assistant.

Sorry, we have no data on allergies among participants.

The research data showed that all workers in a restaurant are exposed to cooking smoke. The number of waitperson is not also enough to be a comparison group.

At first, we plan to collect data from everyone working in a restaurant but the idea reject by the restaurants' owner. After a negotiation, they allow us to collect data from one worker.

Yes, data on 'other job' is too small. However, it is an actual field data and we prefer to present it.

Comment:

Minor points:

Abstract:

Please describe that much less adverse effects were seen in the participants in the other three groups. 3rd line: replace 'health effects' by 'adverse health effects'.

Response: Abstract was amended as suggestion and the term was revised.

Comment:

Introduction:

Please distinguish the effects of cooking smoke vs. methods of heating (coal, gas).

Give in paragraph 3 some indication of effect sizes observed.

Response:

To avoid confusion, the term "cooking fumes" has been used instead of 'cooking smoke' and 'cooking oil fume'. Cooking fumes are usually from both burning fuel (heating by using coal, gas), and cooking oil fume (COFs), which caused by overheating cooking oil. However, fumes from these two sources cannot be distinguished in field study.

Comment:

Methods:

Study participants, Line 5-6: please specify 'each restaurant worker' and use singular in this sentence. Why was only one worker per restaurant included? Any data of homogeneity in effects per restaurant?

Data from the Pollution Control Department showed that pollutants in the Phitsanulok area were within safe air standards. However, did they vary during the study period? To which extent was traffic related air pollution involved in the outcome? Was any restaurant situated near a busy road (probably it was!)?

Response:

The mistakes were corrected and the whole section has been revised.

At the beginning, we planned to collect data from everyone working in a restaurant but the idea was rejected by restaurants' owners. After a negotiation, they allowed us to collect data from only one worker.

We believe that ambient air and traffic pollution will not much affect the health outcomes even though most of the restaurants situated in a main road. Besides, the fact that level of pollution is still within standard limit, the main purpose of this study was to compare health of workers working in between types of restaurants, which located in the same area.

Comment:

Results:

Define TWC when first time used. Was TWC related to allergy? Was TWC due to irritating smoke

or rather an allergic reaction?

Please present the results of the combination: 'Use of ventilation' and 'enclosed location'. There may be an adding effect as both affect the indoor air quality.

Response:

The term TWC has been defined as suggested.

In this study, TWC refers to an acute reaction caused by smoke exposure rather than allergic reaction.

Results of the combination effects of 'use of ventilation' and 'enclosed location' has been analyzed as suggested. However, it was not found to be significantly associated with PEFR and chronic symptoms. The data was added to Table 3.

Comment:

Discussion:

Probably palm oil and lard give a different heating temperature (frying temperature without burning; 'boiling point'). Suggest to include this difference to explain the differences found in adverse effects. Similar for soy bean oil.

Response:

Actually, palm oil and lard did not have a different boiling point. Both have high boiling point as compare to soybean oil. Therefore, it was expected to see similar low health impacts from cooking with palm oil and lard, but more from soybean.

However, issue is interesting, and the discussion has been amended to clarify these points.

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

Reviewer Report 11 November 2019

<https://doi.org/10.5256/f1000research.22024.r54898>

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**Bjørn Hilt**

Department of Occupational Medicine, St. Olavs Hospital, Trondheim, Norway

With certain limitations, this is an interesting and well-written manuscript focusing on the health of cooks in different types of kitchen in Thailand. The main limitation is of course the cross-sectional design, the description of the selection of participants, and to some extent also the local approach (see below).

The introduction is very good and covers most of the adequate knowledge in the field. If the author want to seem entirely up to date, they could also have included this very recent reference: Sindre Rabben Svedahl, Bjørn Hilt, Kristin Svendsen. Work environment factors and respiratory complaints in Norwegian

Cooks. *Int Arch Occup Environ Health*. 2019 Sep 17. doi: 10.1007/s00420-019-01473-w. [Epub ahead of print].

As is common, the author use operational criteria in the description of the objectives of the study. The research question is not whether cooks differ in PEFr, but if they have impaired lung function related to work-exposures. A better and a more conceptual way to state the objectives would in my view be: "To investigate if cooks working in different types of kitchen have impaired lung function and an increased occurrence of respiratory symptoms". Then to use PEFr as a measure for lung function is legitimate and purely operational.

The description of the selection of study participants is not absolutely crystal-clear (last para on p3 and first on p4). Somehow, it does not quite make sense. In the very first sentence there seems to be a misprint in "... by first divided..." which in my eyes should be "...by first dividing...". Please forgive my ignorance, but what is a "consecutive sampling technique"? Then the reader (at least this one) gets confused about who was selected from which restaurants. Was it one worker from each restaurant fulfilling certain criteria employees was interviewed? And, it should preferably be a chef. This does not quite make sense to me. Does it mean that they visited 321 restaurants and interviewed one person in each? This needs to be made clearer so that even this reader can understand it easily.

Another thing with the selection of subjects is that it might have led to a selection of respiratory healthy cooks free from asthma, COPD and emphysema which again has strengthened the so called "healthy worker effect" that the author come back to in the discussion.

Some other (mostly minor) points as they occur:

Introduction last para: Was it for statistical reasons that the previous study failed to demonstrate a significant difference? I would rather say that it was due to small numbers that the study failed to unveil a statistically significant difference.

P4, 2<sup>nd</sup> para: When we do power assessments we do not calculate the "optimal" sample size, but the "necessary" sample size. What does the last sentence of the para mean? Please clarify.

In the introduction the author use both "cooking oil fumes (COF)" and "cooking smoke". Is there a difference between them? For my part I am used to the term "cooking fume".

Were the PEFr measurements done at random times of the day? I mean, if all measurements from one type of restaurants were done in the morning and the measurement from another in the evening, it could possibly have biased the results due to circadian differences in lung function.

Do the author have a literature reference for the expected lung function values for the Thai people? Instead of a dichotomized (>< 80 %) variable for PEFr they could also have given us the actual percentages. In table 2 they give the actual mean values without any adjustments. For those figures with three main figures, I think it is unnecessary to put it with two decimals.

For table 1 and 2 the reader needs to know the meaning of the column with p-values. For what comparison?

Table text for table 2 needs to be more comprehensive and explanatory.



Since table 3 is divided in two, it needs to be stated that it will be continued at the bottom of the first part. For table 3 it is not necessary to explain in a footnote for the reader that a 95% confidence interval that not includes the value 1 is statistically significant on a 5% level.

I see tears while cooking more at another effect that a real predictor/determinant of the other effects. In the same time it is of course correct to say that if the exposure is so strong that you have the symptom TWC, you can also have other, and worse effects.

A better reference and explanation of the tables should be given in the text.

In the first para of the discussion the so called healthy worker effect is noting but selection bias and no phenomenon on its own. Selection bias may well have been introduced since the participants apparently should be free from respiratory diseases.

The paras on study limitations are insightful and well written. The fact that the study is quite local and that the external validity (generalizability) is limited could also have been included. Even so, it is worthwhile to report on deleterious health effects from professional and domestic cooking from different parts of the world with different cooking methods.

For the conclusion I believe that the term Thai restaurants is a term for all the four types of restaurants included, while it was in “tamsang” restaurants that the effects were found. Perhaps the first sentence of the conclusion could be omitted and that they only start with “This study shows that employees in “tamsang” restaurants in Thailand have.....”

The consequences of the results are not worth the attention for “regulatory organizations” only, but for everyone concerned with the health and welfare of restaurant workers.

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

Yes

**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?**

Yes

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

Yes

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

Yes

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

**Reviewer Expertise:** Occupational medicine and epidemiology

**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.**

Author Response 24 Nov 2019

**Chudchawal Juntarawijit**, Naresuan University, Phitsanulok, Thailand

Comment: The introduction is very good and covers most of the adequate knowledge in the field. If the author want to seem entirely up to date, they could also have included this very recent reference: Sindre Rabben Svedahl, Bjørn Hilt, Kristin Svendsen. Work environment factors and respiratory complaints in Norwegian Cooks. *Int Arch Occup Environ Health*. 2019 Sep 17. doi: 10.1007/s00420-019-01473-w. [Epub ahead of print].

Response: Thank you. The reference was added to the manuscript.

Comment: As is common, the author use operational criteria in the description of the objectives of the study. The research question is not whether cooks differ in PEFR, but if they have impaired lung function related to work-exposures. A better and a more conceptual way to state the objectives would in my view be: "To investigate if cooks working in different types of kitchen have impaired lung function and an increased occurrence of respiratory symptoms". Then to use PEFR as a measure for lung function is legitimate and purely operational.

Response: Thank you for this helpful insight. The study objective was restated as suggested.

Comment:

The description of the selection of study participants is not absolutely crystal-clear (last para on p3 and first on p4). Somehow, it does not quite make sense. In the very first sentence there seems to be a misprint in "... by first divided..." which in my eyes should be "...by first dividing...". Please forgive my ignorance, but what is a "consecutive sampling technique"? Then the reader (at least this one) gets confused about who was selected from which restaurants. Was it one worker from each restaurant fulfilling certain criteria employees was interviewed? And, it should preferably be a chef. This does not quite make sense to me. Does it mean that they visited 321 restaurants and interviewed one person in each? This needs to be made clearer so that even this reader can understand it easily.

Response:

The description of participant selection was completely revised.

The term "by first divided" was change to "by first dividing".

Yes, all 321 restaurants were visited and one person was interviewed at each shop.

Actually, the study wanted to interview every worker in a restaurant, but most restaurants refused to do that way. After negotiation, only one participant, preferring to be a chef, was interviewed. Most of restaurants in Thailand are small size and they usually have only one chef, the rest is waitperson and chef assistance.

Another thing with the selection of subjects is that it might have led to a selection of respiratory healthy cooks free from asthma, COPD and emphysema which again has strengthened the so

called “healthy worker effect” that the author come back to in the discussion.

I agree. From the field experience, we found no workers with those chronic diseases and thus, to be excluded from this study. Therefore, we decide to delete the criteria to avoid confusion.

Comment:

Introduction last para: Was it for statistical reasons that the previous study failed to demonstrate a significant difference? I would rather say that it was due to small numbers that the study failed to unveil a statistically significant difference.

Response: The sentence has been revised as suggested.

Comment: P4, 2<sup>nd</sup> para: When we do power assessments we do not calculate the “optimal” sample size, but the “necessary” sample size. What does the last sentence of the para mean? Please clarify.

Response: Thank you for the reminding. The word “optimal” has been replaced with “necessary”.

Comment:

In the introduction the author use both “cooking oil fumes (COF)” and “cooking smoke”. Is there a difference between them? For my part I am used to the term “cooking fume”.

Response:

You are right. The term “cooking smoke” and cooking oil fume (COFs) has been replaced with “cooking fumes”.

Comment:

Were the PEFR measurements done at random times of the day? I mean, if all measurements from one type of restaurants were done in the morning and the measurement from another in the evening, it could possibly have biased the results due to circadian differences in lung function.

Response:

Yes, the PEFR measurements of each type of restaurants were done at random times of the day, and the bias should be minimal.

Comment:

Do the author have a literature reference for the expected lung function values for the Thai people? Instead of a dichotomized (>< 80 %) variable for PEFR they could also have given us the actual percentages. In table 2 they give the actual mean values without any adjustments. For those figures with three main figures, I think it is unnecessary to put it with two decimals.

Response:

Yes, we do have a reference for expected lung function of Thai people. To measure PEFR percentage, participants have to perform lung function test and the measured PEFR was then compared with PEFR standard which depend on gender, age, and height of the participant.

We agree that more data should be presented. So, we decide to add data on average standard PEFR, and data on distribution of PEFR percent.

The decimals was deleted.

Comment:

For table 1 and 2 the reader needs to know the meaning of the column with p-values. For what comparison?

Response:

More information on p-values was added to make sure that the readers know what the comparisons are.

Table text for table 2 needs to be more comprehensive and explanatory.

The table text was completely revised.

Comment:

Since table 3 is divided in two, it needs to be stated that it will be continued at the bottom of the first part. For table 3 it is not necessary to explain in a footnote for the reader that a 95% confidence interval that not includes the value 1 is statistically significant on a 5% level.

Response: All the suggestions were taken, and the footnote was deleted.

Comment: I see tears while cooking more as another effect that is a real predictor/determinant of the other effects. In the same time it is of course correct to say that if the exposure is so strong that you have the symptom TWC, you can also have other, and worse effects.

Response: I agree that TWC can be either effect of its own or a predictive factor. However, in this study, TWC was used as a marker of smoke exposure.

Comment: A better reference and explanation of the tables should be given in the text.

Response: Thank you for the suggestion. The paper was revised in many places, e.g. table 2 text.

Comment:

In the first para of the discussion the so called healthy worker effect is noted but selection bias and no phenomenon on its own. Selection bias may well have been introduced since the participants apparently should be free from respiratory diseases.

Response:

I agree that by using the selection criteria the bias was introduced. However, healthy worker effect is difficult to avoid unless control group with similar health was used as a comparison group. As in this study, health of workers in different types of restaurant was compared to each other, thus HWE will have not much an effect to the study result.

Comment:

The paras on study limitations are insightful and well written. The fact that the study is quite local and that the external validity (generalizability) is limited could also have been included. Even so, it is worthwhile to report on deleterious health effects from professional and domestic cooking from different parts of the world with different cooking methods.

Response: Thank you for your thoughtful and generous notion. The idea was added to the limitation statement.

Comment: For the conclusion I believe that the term Thai restaurants is a term for all the four types of restaurants included, while it was in “tamsang” restaurants that the effects were found. Perhaps the first sentence of the conclusion could be omitted and that they only start with “This study shows that employees in “tamsang” restaurants in Thailand have.....”

Response: It may not true that the effects were found only in “tamsang” restaurant. The study results showed that 41.2% to 64.7% of the workers have poor PEFR. However, the problem was more pronounce in “tamsang” restaurant.

Comment: The consequences of the results are not worth the attention for “regulatory organizations” only, but for everyone concerned with the health and welfare of restaurant workers.

Response: Thank you for the insightful suggestion. The idea was added to the conclusion.

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

Reviewer Report 16 September 2019

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**Satoshi Nakai**

Graduate School of Environment and Information Sciences, Yokohama National University, Yokohama, Japan

The author discussed the health effects of cooking smoke at restaurants to workers. It has interesting views and it is valuable to index the manuscript. It should be useful to evaluate and control the indoor air environment of cooking places in restaurants, even though the study information may be limited to Thailand.

However, several things shown in the following comments should be revised:

1. Some sentences are incomplete. Please check the manuscript again.
2. The reviewer considers that papaya salad restaurants are referenced, so the author had better set the salad restaurants at the end of the list. Readers can understand which type of restaurants the reference is.
3. Does the author have some quantitative information about the concentration inside restaurants in Thailand? The author mentioned the other countries' situation, but no one can image the environment of Thailand. It is very useful for the readers.  
If not, the author must discuss the environment of the restaurant, and the similarity and difference between Thailand and other countries.

4. Are interviewers and examiners of lung function the same persons? Are the interviews and PEFR test conducted at the same time?
5. Second line of "Data analysis": What are "frequency variables"? Unclear.
6. The author uses "abnormal lung function", "poor PEFR", "low PEFR" in this manuscript. The reviewer considers these are the same. Please consider the usage of these terms.
7. The author shows the covariates in the analysis at "Results". These should be shown in "Methods".
8. The author writes "cooking at home" in the covariate list, but no data related to cooking at home are shown. Why? The author discussed the effects other than cooking smoke in restaurants. The above information should be important.
9. Why did the author not include "years of working" in this analysis? The reviewer considers it is related to exposure duration and important as an exposure index.
10. The author mentioned the healthy worker effect for severe dyspnea. Why not the other outcomes related to HWE? Please add some comments.

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

Yes

**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?**

Yes

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

Partly

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

Yes

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

Yes

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

**Reviewer Expertise:** Environmental Epidemiology, Exposure Sciences, Health Risk assessment

**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.**

Author Response 24 Nov 2019

**Chudchawal Juntarawijit**, Naresuan University, Phitsanulok, Thailand

1. Some sentences are incomplete. Please check the manuscript again.

The manuscript was rechecked and the errors were corrected.

2. The reviewer considers that papaya salad restaurants are referenced, so the author had better set the salad restaurants at the end of the list. Readers can understand which type of restaurants the reference is.

The list was rearranged and papaya salad restaurants were presented last.

3. Does the author have some quantitative information about the concentration inside restaurants in Thailand? The author mentioned the other countries' situation, but no one can image the environment of Thailand. It is very useful for the readers.

If not, the author must discuss the environment of the restaurant, and the similarity and difference between Thailand and other countries.

Unfortunately no specific information about concentration of smoke pollutants inside restaurants in Thailand appears to exist. However, discussion about the environment of the restaurants was added to the discussion.

4. Are interviewers and examiners of lung function the same persons? Are the interviews and PEFR test conducted at the same time?

Yes, the interviewers and examiners of lung function are the same persons, and the interviews and PEFR test was conducted at the same time.

This information was added to the method section.

5. Second line of "Data analysis": What are "frequency variables"? Unclear.

The "Data analysis" was duly revised and the term no longer needed to be used.

6. The author uses "abnormal lung function", "poor PEFR", "low PEFR" in this manuscript. The reviewer considers these are the same. Please consider the usage of these terms.

The inconsistency issue was corrected by using only one term, "poor PEFR".

7. The author shows the covariates in the analysis at "Results". These should be shown in "Methods".

Thank you for the reminder. The statement was added to "Methods"

8. The author writes "cooking at home" in the covariate list, but no data related to cooking at home are shown. Why? The author discussed the effects other than cooking smoke in restaurants. The above information should be important.

Data on "cooking at home" was added to Table 1.

9. Why did the author not include "years of working" in this analysis? The reviewer considers it is related to exposure duration and important as an exposure index.

Actually, “years of working” is included in the analysis (Table 3), and it was found to have significant association only to wheezing symptoms.

10. The author mentioned the healthy worker effect for severe dyspnea. Why not the other outcomes related to HWE? Please add some comments.

That is a good point. The reason may be that severe dyspnea is a relatively obvious and serious symptom, comparing with the other symptoms. So, severe dyspnea is more likely to affect their job performance.

This comment was added to the discussion.

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

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