# The Proportion of Work-Related Asthma among Tertiary Care Hospital Workers Exposed to Cleaning Agents

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## Abstract

**Objective:** Work-related asthma (WRA) is a common type of asthma among the working-age population. Patients with WRA often experience symptoms that impair job performance. Cleaning agents are one of the irritant agents that can cause WRA. While cleaners are typically exposed, other jobs may also be at risk of similar exposure. This study aims to determine the proportion of WRA among hospital workers exposed to cleaning agents.

**Methods:** This descriptive study was conducted at Srinagarind Hospital, Khon Kaen University. A total of 341 healthcare workers who reported exposure to any cleaning agents were included in the study. The European Community Respiratory Health Survey (ECRHS) questionnaire was used to screen for asthma-like symptoms. Participants were further assessed and monitored using Mini-Wright peak flow meters, with results analyzed by the OASYS program.

**Results:** The results showed that 27 participants exhibited asthma-like symptoms. Of these, 19 (5.5%) out of 341 participants were classified as having possible WRA, while 8 (2.3%) were classified as probable WRA. No participants were classified as definite WRA. Among those with symptoms, all had either direct or indirect exposure to cleaning agents in the workplace. The clinical symptoms were consistent with irritant-induced asthma resulting from chronic low-concentration exposure. There was no statistically significant difference in the risk of WRA between those with direct and indirect exposure (OR 3.24; 95% CI: 0.84-2.11).

**Conclusion:** Work-related asthma (WRA) can be caused by irritant compounds in cleaning agents, which are suspected to be a primary cause due to chronic low-concentration exposure. Physicians should prioritize obtaining detailed exposure histories and conducting early screenings to enable timely intervention. The most effective strategy for mitigating the risk of WRA is to minimize workers' exposure to

cleaning agents by implementing the hierarchy of controls. Selecting non-irritant cleaning agents, or at least those with lower irritant properties, is essential for reducing occupational respiratory risks.

**Keywords:** work-related asthma; cleaning agents; hospital workers

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# สัดส่วนของโรคหืดเกี่ยวเนื่องจากการทำงานในบุคลากรโรงพยาบาลตติยภูมิขั้นสูง ที่สัมผัสกับสารทำความสะอาด

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**บทคัดย่อ**

**วัตถุประสงค์:** โรคหืดเกี่ยวเนื่องจากการทำงาน (Work-related asthma หรือ WRA) เป็นประเภทของโรคหืดที่พบได้บ่อยในกลุ่มประชากรวัยทำงาน ส่งผลกระทบต่อการทำงานและคุณภาพชีวิต โดยมีลักษณะอาการของโรคที่สัมพันธ์กับการทำงาน หนึ่งในสาเหตุสำคัญของ WRA คือ การสัมผัสกับสารทำความสะอาด การศึกษานี้มีวัตถุประสงค์เพื่อหาสัดส่วนของโรคหืดที่เกี่ยวข้องกับการทำงานในกลุ่มผู้ที่ทำงานสัมผัสกับสารทำความสะอาด

**วิธีการศึกษา:** การศึกษาเชิงพรรณนาในผู้ทำงานสัมผัสสารทำความสะอาดในโรงพยาบาลศรีนครินทร์ มหาวิทยาลัยขอนแก่น ที่มีการทำงานสัมผัสกับสารทำความสะอาดทั้งทางตรงและทางอ้อมจะถูกนำมาเข้าร่วมในการศึกษา ใช้แบบสอบถามคัดกรองอาการของโรคหืดของ The European Community Respiratory Health Survey (ECRHS) เพื่อคัดกรองผู้ที่มีอาการของโรคหืด จากนั้นจะมีการซักประวัติเพิ่มเติมโดยแพทย์ และติดตามผลด้วยเครื่องมือวัดสมรรถภาพปอด (Mini-Wright peak flow meters) และนำมาแปลผลด้วยโปรแกรม OASYS

**ผลการศึกษา:** ผู้เข้าร่วมวิจัยทั้งสิ้น 341 คน ที่สัมผัสกับสารทำความสะอาดทั้งทางตรงและทางอ้อม มี 27 คน (7.9%) ถูกจัดอยู่ในกลุ่มผู้ที่มีอาการของโรคหืด (asthma-like symptoms) 19 คน (5.5%) ถูกจัดอยู่ในกลุ่มที่เป็นไปได้ว่าจะเป็นโรคหืดเกี่ยวเนื่องจากการทำงาน (Possible WRA) และ 8 คน (2.3%) ถูกจัดอยู่ในกลุ่มที่น่าจะเป็นโรคหืดเกี่ยวเนื่องจากการทำงาน (Probable WRA) ไม่มีผู้เข้าร่วมวิจัยคนใดถูกวินิจฉัยว่าเป็นโรคหืดเกี่ยวเนื่องจากการทำงาน (Definite WRA) ทั้งนี้ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติระหว่างผู้ที่สัมผัสสารทำความสะอาดทางตรงและทางอ้อม

**สรุป:** โรคหืดเกี่ยวเนื่องจากการทำงานสามารถเกิดได้จากสารระคายเคืองของส่วนผสมในสารทำความสะอาด โดยสาเหตุเกิดจากการรับสัมผัสในความเข้มข้นที่ต่ำแต่ระยะเวลานานพอจะก่อโรค บุคลากรในโรงพยาบาลมีความเสี่ยงในการสัมผัสสารเหล่านี้โดยไม่รู้ตัว แพทย์ควรมีความตระหนักในการซักประวัติการสัมผัสสารกระตุ้นโรคหืดและการคัดกรองเบื้องต้นเพื่อให้การวินิจฉัยได้ทันท่วงที วิธีที่ดีที่สุดในการป้องกันคือการปกป้องบุคลากรจากการสัมผัสกับสารทำความสะอาดโดยใช้มาตรการควบคุมที่เหมาะสม การเลือกใช้สารทำความสะอาดที่ไม่ระคายเคืองและไม่ก่อภูมิแพ้หรืออย่างน้อยเลือกใช้สารที่มีคุณสมบัติระคายเคืองต่ำที่สุดในการทำความสะอาดเป็นสิ่งสำคัญ

**คำสำคัญ :** โรคหืดเกี่ยวข้องจากการทำงาน; สารทำความสะอาด; บุคลากรในโรงพยาบาล

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## Background

Asthma is a chronic inflammatory disorder of the lower respiratory tract, characterized by symptoms such as wheezing, dyspnea, chest tightness, and coughing, with variable frequency and severity. Globally, asthma affects approximately 334 million individuals and remains a significant contributor to morbidity and diminished quality of life among the working-age population. Among adults, work-related asthma (WRA) constitutes a substantial proportion of new-onset asthma cases, particularly in industrialized nations, where occupational exposures account for an estimated 10-20% of all adult asthma cases[1-2].

WRA is classified into two primary categories: occupational asthma (OA) and work-exacerbated asthma (WEA). Occupational asthma arises due to direct exposure to workplace sensitizers or irritants, whereas work-exacerbated asthma refers to the aggravation of pre-existing asthma symptoms due to occupational environmental conditions.

The pathophysiology of occupational asthma is primarily categorized into two mechanisms. The first is sensitizer-induced asthma, which is predominantly mediated by an immunoglobulin E (IgE) immune response and often requires prolonged exposure before symptom onset. The second mechanism is irritant-induced asthma, which is independent of an IgE-mediated response. Unlike sensitizer-induced asthma, irritant-induced asthma can manifest acutely following exposure to high concentrations of irritants, such as chemical fumes. Furthermore, chronic exposure to low Concentration of irritants may contribute to persistent airway inflammation, leading to airway remodeling and the subsequent development of asthma[1].

Numerous occupational asthmagens are present across various industries, including exposure to animal dander, latex, glutaraldehyde, and isocyanates[3]. Significant signs of work-related asthma (WRA) include asthma-like symptoms that worsen during work days and improve during days off. Cleaning agents are recognized as significant occupational asthmagens capable of inducing asthma or asthma-like symptoms in the workplace. Cleaning agents are widely utilized across multiple settings, including households, commercial enterprises, and healthcare facilities. In hospital environments, these agents are essential for infection control due to the presence of diverse pathogens. Consequently, hospital cleaning agents are frequently employed to maintain

hygiene standards. Healthcare workers, including cleaning personnel, nurses, and support staff, are routinely exposed to these substances as part of their occupational duties. While previous research has established an association between cleaning agents and occupational asthma among healthcare workers[4-5], there is a paucity of data from Thailand regarding the prevalence of WRA in this occupational group[6].

This knowledge gap is crucial, as early detection and preventive interventions for WRA can substantially enhance workers' quality of life and reduce healthcare expenditures. Despite the extensive use of cleaning agents in hospitals, awareness and implementation of protective measures to mitigate chronic exposure to these respiratory irritants remain inadequate. This study aims to determine the prevalence of WRA among hospital workers exposed to cleaning agents at Srinagarind Hospital, a tertiary care center in Thailand. Evaluating the extent of WRA within this context will facilitate the development of enhanced occupational health and safety protocols, highlighting the necessity of preventive strategies such as the adoption of non-irritant cleaning formulations and the utilization of appropriate personal protective equipment.

## METHODOLOGY

This cross-sectional descriptive study was conducted between February and October 2022 at a tertiary university hospital in Northeastern Thailand. The study population comprised 3,417 hospital workers who were exposed to cleaning agents either directly or indirectly. The direct exposure group included workers who personally mixed and used cleaning agents, while the indirect exposure group consisted of workers who may have been exposed to cleaning agents in the workplace without directly handling or using them. The participants included cleaners, nurses, nurse assistants, and other healthcare professionals. WINPEPI program (version 11.65) was used to determine the required sample size of this study. Based on a study by Pechter et al., which reported a prevalence of work-related asthma (WRA) of 16% among hospital workers[7] at a 5% significance, the required sample size was determined to be 489 individuals. Participants were selected using systematic sampling with an interval of six from the total population. Inclusion criteria included individuals aged over 20 years and those with a working duration of more than 3 months, ensuring sufficient exposure to potentially cause asthma. Exclusion criteria included any

underlying pulmonary diseases that could interfere with pulmonary function testing. The majority of participants were cleaners, due to the high number of such workers in the hospital.

The European Community Respiratory Health Survey (ECRHS) questionnaire, a user-friendly tool, was utilized in this study. It has a reported sensitivity of 75.1% and specificity of 80.1%[8]. Asthma-like symptoms were identified if participants reported any one of seven symptoms: 1) wheezing or whistling, 2) chest tightness, 3) shortness of breath, 4) nighttime coughing, 5) asthma attacks, 6) asthma medication, or 7) nasal allergies. In addition, work-related question was used to determine possible workplace relation including 1) history of lower respiratory symptoms get better when away from work, 2) history of lower respiratory symptoms get worse when work, 3) identify sensitize or irritant agents induce asthma in workplace, 4) history of exposes sensitize or irritant agents induce asthma in workplace.

**Table 1** Symptoms Questionnaire by The European Community Respiratory Health Survey

| Symptom | Question |
|---|---|
| Wheezing or whistling | Have you experienced wheezing or whistling in the chest in the last 12 months? |
| Chest tightness | Have you felt tightness in your chest in the last 12 months? |
| Shortness of breath | Have you experienced shortness of breath in the last 12 months? |
| Nighttime coughing | Have you been woken by coughing in the last 12 months? |
| Asthma attack | Have you had an asthma attack in the last 12 months? |
| Asthma medication use | Are you currently using asthma medication? |
| Nasal allergies | Do you have nasal allergies, including hay fever? |

For participants who reported or were suspected of having asthma based on the screening questionnaire, Mini-Wright peak flow meters were distributed to facilitate serial peak expiratory flow (PEF) measurements. Although spirometry was not performed to diagnose asthma in the participants, peak expiratory flow (PEF) measurements were used as an alternative, as variability in PEF can be indicative of asthma. Participants were instructed to record PEF values at least four times per day, including upon waking, at the start of the work shift, 4-7 hours after commencing work, and before bedtime[9]. Each measurement consisted of three consecutive blows, with the highest value recorded. Peak expiratory flow (PEF) was recorded over a period of three weeks, including at least one week during which participants refrained from work for two days. Follow-up assessments were conducted every two weeks after participants received the peak flow meter.

The Occupational Asthma System (OASYS) software, initially developed by Gannon et al. in 1995[10], was employed to analyze serial PEF measurements. This computer-based tool evaluates daily variations and work-related patterns in PEF recordings to aid in the diagnosis of occupational asthma. A positive diagnosis was considered if OASYS scores were ≥ 2.5, ABC scores were ≥15 L/min/hr, or if a positive time-point analysis was obtained. The sensitivity and specificity of the OASYS program for detecting WRA were reported to be 75% and 90%, respectively[10-11].

In this study, WRA was categorized into three classifications based on the level of diagnostic certainty: possible WRA, probable WRA, and confirmed WRA. Possible WRA was defined as the presence of asthma-like symptoms along with at least one positive response to the four work-related symptom questions, but without a positive serial PEF result. Probable WRA was characterized by asthma-like symptoms with at least one positive response to the four work-related symptom questions, in conjunction with a positive serial PEF result, or all four work-related symptom questions being positive without a corresponding positive serial PEF result. Confirmed WRA was diagnosed when asthma-like symptoms were present, all four work-related symptom questions were positive, and a positive serial PEF result was obtained[12].

Following an explanation of the study's objectives specifically, to determine the prevalence of WRA among hospital

workers exposed to cleaning agents and after obtaining informed consent, data collection was conducted. Participants were assured of confidentiality, with data usage strictly limited to research purposes and no direct consequences resulting from participation. The data collection process involved administering the ECRHS questionnaire through face-to-face interviews conducted by the research team. For participants reporting asthma-like symptoms, serial peak expiratory flow (PEF) measurements were obtained and analyzed using the OASYS program. The questionnaire included a detailed history of exposure to cleaning agents, and serial PEF data were utilized to evaluate workplace factors contributing to WRA.

All collected data, including questionnaire responses and serial PEF results, were entered into Microsoft Excel using a double-entry approach to ensure accuracy. Statistical analyses were conducted using SPSS version 28.0. Demographic data, exposure characteristics, symptoms, and serial PEF results were analyzed and presented as frequencies and percentages (n, %), means with standard deviations (mean, SD), or medians with interquartile ranges (median, IQR), depending on the nature of the data. Associations between asthma-like symptoms, OASYS analysis results, and exposure characteristics were examined using Chi-square tests, Student's t-tests, or Mann-Whitney U tests, as appropriate.

This study was reviewed by the Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines. With an approval number HE641578.

**Result**

Among the 463 participants initially approached, 341 consented to participate in the study, yielding a response rate of 73.6%. The majority of participants were female (308 participants, 90.3%) and worked as cleaners (222 participants, 65%). The median duration of employment was 5.5 years (IQR: 15). Detailed demographic data are presented in table 2.

**Table 2** Symptoms Questionnaire by The European Community Respiratory Health Survey

| Demographic data | N (%) |
|---|---|
| **Sex** | |
| - Male | 33 (9.7) |
| - Female | 308 (90.3) |
| **Duration of exposure** | |
| - Years (median, IQR) | 5.5 (15) |
| **Job title** | |
| - Cleaner | 222 (65.1) |
| - Registered Nurse | 50 (14.7) |
| - Nurse assistant | 35 (10.3) |
| - Hospital housekeeping | 28 (8.2) |
| - Office workers | 6 (1.8) |

27 out of 341 participants (7.9%) reported asthma-like symptoms. These symptoms according to the ECRHS questionnaire.These symptoms included chest tightness (3, 11.1%), being woken by an attack of shortness of breath (6, 22.2%), and nasal allergies (20, 74%),. four participants reported experiencing more than one symptom.

Among the participants who reported asthma-like symptoms, 17 (5.0%) reported direct exposure to cleaning agents, including hydrochloric acid (12 participants, 44.4%), ammonia (12 participants, 44.4%), and quaternary ammonium compounds (QACs) (10 participants, 37%). Additionally, 10 participants (2.9%) reported indirect exposure to these agents in their workplace environment. The ECRHS results and chemical exposure characteristics are summarized in table 3.

**Table 3** ECRHS Results and Exposure Characteristics of Participants

| Outcome/Exposure | N (%) |
|---|---|
| **ECRHS Positive (Asthma-like symptoms)** | 27 (7.9%) |
| **Exposure route** | |
| - Direct exposure | 17 (5.0%) |
| - Indirect exposure (workplace exposure) | 10 (2.9%) |
| **Chemical compound** | |
| - Ammonia | 12 (3.5%) |
| - Hydrochloric acid | 12 (3.5%) |
| - Quaternary Ammonium Compounds | 10 (2.9%) |

Among those who reported asthma-like symptoms, 19 (5.6%) reported workplace related symptoms including one of this, 1) history of lower respiratory symptoms get better when away from work, 2) history of lower respiratory symptoms get worse when work, 3) identify sensitize or irritant agents induce asthma in workplace, 4) history of exposes sensitize or irritant agents induce asthma in workplace. After analyzing the serial peak expiratory flow data using the OASYS program, the results revealed that 19 participants (5.6%) were classified as having "Possible WRA," while 8 participants (2.3%) were classified as having "Probable WRA." Notably, none of the participants were classified as having "Definite WRA."

**Table 4** Diagnosis WRA

| Work related asthma diagnosis | N (%) |
|---|---|
| Possible WRA | 19 (5.6%) |
| Probable WRA | 8 (2.3%) |
| Definite WRA | 0 |

Characteristics of the 19 participants (5.6%) diagnosed with possible work-related asthma (WRA) were analyzed. Among them, 14 (4.1%) were cleaners, three were hospital housekeeping staff, and two were office workers. Only the two office workers were not directly exposed to cleaning agents. Cleaners and hospital housekeeping staff had similar tasks, which involved mixing and using cleaning agents daily, with working hours varying from 2 to 4 hours per day. None of the participants had adequate personal protective equipment (PPE), as they only used surgical masks instead of respirators with appropriate filters. The duration of exposure ranged from a minimum of 4 years to a maximum of 34 years. The most commonly reported symptom was nasal allergy, and all participants experienced symptoms that correlated with their work schedule, with symptoms worsening during work and improving when away from the workplace. Show in table 5.

The study analyzed factors related to work-related asthma (WRA), classified as possible and probable cases, among participants. Male participants were significantly more likely to report WRA compared to females, with six males and thirteen females affected. The odds of males developing WRA were five times higher than females (OR: 5.0, 95% CI: 1.64-14.12, p=0.006). Participants directly exposed to cleaning agents had a higher prevalence of WRA (17 cases, 6.8%) compared to those with workplace exposure (2 cases, 2.2%), though this difference was not statistically significant (OR: 3.24, 95% CI: 0.84-21.11, p=0.101).

No significant associations were found between WRA and allergic rhinitis, smoking history, or secondhand smoke exposure. Participants with allergic rhinitis and secondhand smoke exposure showed a trend toward reduced odds of WRA, though these findings were not statistically significant.

**Table 5** Characteristic of possible WRA

| | Job | Duration of exposer (years) | Direct using cleaning agents | PPE | Asthma like symptom | Smoking | Work related symptom | OASYS |
|---|---|---|---|---|---|---|---|---|
| **No.1** | Cleaner | 18 | Yes | No | N | No | Yes | Positive |
| **No.2** | Cleaner | 4 | Yes | No | S, N | No | Yes | Negative |
| **No.3** | Cleaner | 6 | Yes | No | S | No | Yes | Negative |
| **No.4** | Cleaner | 34 | Yes | No | S | No | Yes | Negative |
| **No.5** | Cleaner | 20 | Yes | No | C, N | No | Yes | Negative |
| **No.6** | Cleaner | 20 | Yes | No | S | Yes | Yes | Negative |
| **No.7** | Cleaner | 28 | Yes | No | N | No | Yes | Negative |
| **No.8** | Cleaner | 18 | Yes | No | C | No | Yes | Negative |
| **No.9** | Cleaner | 24 | Yes | No | N | No | Yes | Positive |
| **No.10** | Cleaner | 27 | Yes | No | S, N | No | Yes | Negative |
| **No.11** | Cleaner | 14 | Yes | No | N | No | Yes | Negative |
| **No.12** | Cleaner | 12 | Yes | No | N | No | Yes | Negative |
| **No.13** | Cleaner | 19 | Yes | No | C | No | Yes | Positive |
| **No.14** | Cleaner | 23 | Yes | No | N | No | Yes | Negative |
| **No.15** | Hospital housekeeping | 11 | Yes | No | N | No | Yes | Negative |
| **No.16** | Hospital housekeeping | 15 | Yes | No | N | No | Yes | Negative |
| **No.17** | Hospital housekeeping | 14 | Yes | No | S, N | No | Yes | Negative |
| **No.18** | Office worker | 4 | No | No | N | No | Yes | Negative |
| **No.19** | Office worker | 7 | No | No | N | No | Yes | Negative |

Asthma like symptom: “S” mean shortness of breath.

“N” mean nasal allergy.

“C” mean chest tightness.

**Table 6** Related Factors and Work-Related Asthma (Possible and Probable) Among Participants

| Factors | WRA (Yes) | WRA (No) | OR (95%CI) | p-value |
|---|---|---|---|---|
| **Sex** | | | | |
| - Male<br>- Female | 6<br>13 | 27<br>295 | 5.0<br>(1.64, 14.12) | 0.006# |
| **Types of exposure** | | | | |
| - Direct exposure (N, %)<br>- Indirect exposure (N, %) (workplace exposure) | 17, 6.8<br>2, 2.2 | 233, 93.2<br>89, 97.8 | 3.24<br>(0.84, 21.11) | 0.101$ |
| **Duration of exposure (years), median (IQR)** | 14 (IQR:9- 20) | 10 (IQR:5-15) | | 0.173* |
| **Age (years), median (IQR)** | 43 (IQR:36- 54) | 39 (IQR:32- 47) | | 0.046* |
| **Job title** | | | | |
| - Cleaner<br>- Nurse<br>- Assistance nurse<br>- Hospital housekeeping<br>- Office worker | 14 (6.3%)<br>0<br>0<br>3 (10.7%)<br>2 (33.3%) | 208<br>50<br>35<br>25<br>4 | | 0.004$ |
| **Allergic rhinitis** | | | | |
| Yes<br>No | 1<br>18 | 67<br>255 | 0.21<br>(0.01, 1.2) | 0.078# |
| **History of smoking** | | | | |
| Yes<br>No | 1<br>18 | 16<br>306 | 1.062<br>(0.05, 6.46) | 0.632# |
| **secondhand smoking** | | | | |
| Yes<br>No | 2<br>17 | 82<br>240 | 0.35<br>(0.05, 1.33) | 0.111# |

"#" means Fisher's exact test was used, "$" means Pearson Chi-square was used, and "*" means Mann-Whitney U test was used.

## Discussion

This cross-sectional study aims to determine WRA among hospital workers who exposed to the cleaning agents in their workplace due to lack of information about the situation in Thailand. An objective is to demonstrate a magnitude of the problem as well as to generate hypothesis about the risk factors for further research about workplace factors on WRA.

ECRHS questions was used in this study as it is valid and reliable as well as serial PEF that easy to used and performed in our settings. Many previous studies were conducted and found that OASYS analysis were one of the most reliable programs to determine workplace factors of WRA.

This study found that possible work-related asthma (WRA) among hospital workers was 5.6% (n = 19), probable WRA was 2.3% (n = 8), and no cases of definite WRA were identified. This finding showed that exposure to cleaning agents in the healthcare settings were significant hazards in workplace that may be cause a problem in some population although they were exposed to this hazards at low level[13]. This is because pathophysiology of asthma not dose-response relationship. Definition of asthma according to GINA guideline was 1) reversible airway obstruction 2) airway hyperresponsiveness. Patients who have asthma may have airway hyperresponsiveness which exposed to a small amount of agents may cause a severe symptoms. Exposure to cleaning agents including, hydrochloric acid, ammonia, and QAC which have an irritant properties[14], even though at low doses but in a long-term, may induce chronic airway inflammation, remodeling and cause asthma associated with workplace which called work-related asthma[15].

However, our study demonstrated a lower incidence of WRA cases compared to many previous studies. For instance, a study in Brazil by Maçãira et al. found that 11% of cleaners were diagnosed with WRA according to the specific inhalation challenge (SIC)[16]. Similarly, a study in Belgium by Vandenplas et al. reported that 39% of participants who experienced asthma symptoms upon exposure to cleaning agents developed asthmatic symptoms when challenged with the same agents used at work. This study included workers with past exposure to cleaning agents[3]. Additionally, a study from France showed, there are no association between tasks involving cleaning agents and current asthma in both men and women, regardless of the assessment method used[17]. There are multiple explanations for a lower incidence in our study.

Firstly, unlike sensitizer induced asthma which is non dose-response relationship. The pathophysiology of irritant induced asthma was associated with the concentration of agents, which means the higher concentration of irritant agents, the higher severity of symptoms trend to occurred[18]. Almost all cleaning agents that used in this study are irritant agents, so the lower exposure to irritant agents must cause lower symptoms[19] that participant were not suffering about it. Due to good occupational health and safety practice, hazards in workplace were assessed and controlled including for cleaning agents. Workers who work with cleaning agents has a work instruction, practice, and supervision system to use cleaning agents at an appropriate concentration to terminate infectious agents in healthcare sectors. Therefore, they trend to use cleaning agents that lower concentration than previous found. This lower exposure level lower may be the cause of lower WRA.

Secondly, unlike our study, which utilized more specific diagnostic tools, some studies relied on self-reported questionnaires and expert assessments to determine asthma symptoms, which may have lower specificity. This methodological difference might explain the lack of observed relationship between cleaning agent use and asthma symptoms in the French study.

Finally, both direct and indirect exposure to cleaning agents were identified as important related factors in this study. However, there was no significant difference in the prevalence of work-related asthma (WRA) between the two exposure groups. A possible explanation is that workers may have been able to partially protect themselves or limit the duration of exposure. This may account for the lack of a significant difference in WRA prevalence between the directly and indirectly exposed groups, as the actual exposure time may not have differed substantially.

## Conclusion

There were 19 (5.5%) classified as having possible WRA and 8 (2.3%) out of 341 participants classified as probable WRA. Hospital workers still were at high risk for exposure to asthmagens, whether through direct or indirect exposure (workplace exposure), and this risk extends to various job roles, not just cleaners. Physicians should be vigilant, as thorough history taking and recognition of clinical symptoms are crucial in aiding the diagnosis of work-related asthma.

**Limitation**

This study has several limitations. Firstly, the data were collected through questionnaires and physician history taking, which may introduce reporting bias and recall bias. However, the physician history taking aimed to mitigate these biases. Secondly, there is a potential selection bias known as the "healthy worker effect" Workers who experienced asthma-like symptoms may have left their jobs before the data were collected, potentially leading to an underestimation of the true prevalence of work-related asthma related many study[20]. Other factors, such as household environmental exposures and secondary occupations, may have influenced the results and contributed to positive findings; however, these factors were not explored in this study. Lastly, the use of serial peak flow measurements may be limited by the skill of the patients performing the peak expiratory flow tests. To address the reporting bias from the respondent-reported questionnaires, we attempted to reduce this bias by having physicians take detailed histories and symptoms from the respondents.

**Recommendation**

Our findings demonstrate that exposure to cleaning may contribute to the WRA among hospital workers. Therefore, preventive measures should be implemented for those who were working with those agents. Additionally, due to multiple asthmagens in the healthcare sectors, surveillance of WRA should be implemented to early identification workers who may suffer from asthma. Early identification and treatment of asthma may reduce the risk of developing severe asthma attack and further disability. Further research in the field of industrial hygienist and analytical study should benefit for the future direction.

Future studies should consider incorporating industrial hygiene information, such as quantitative environmental air measurements, to obtain more accurate results and further enhance workplace safety.

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