ISSN-0976-0245 (Print) • ISSN-0976-5506 (Electronic)

Volume 10 | Number 7 | July 2019

Indian Journal of Public Health Research & Development

An International Journal

SCOPUS IJPHRD CITATION SCORE

Indian Journal of Public Health Research and Development Scopus coverage years: from 2010 to 2018 Publisher: R.K. Sharma, Institute of Medico-Legal Publications ISSN:0976-0245E-ISSN: 0976-5506 Subject area: Medicine: Public Health, Environmental and Occupational Health

Cite Score 2017- 0.03

SJR 2017- 0.108

SNIP 2017- 0.047

Covered by Scopus

EMBASE

Approved by MCI

Website:

www.ijphrd.com

DOI Number: 10.5958/0976-5506.2019.01688.7

Hazard Identification, Risk Assessment, and Determining Controls in Laboratories

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ABSTRACT

A laboratory is a place to carry out experiments. Working in a laboratory means having zero chance to perform reckless behaviors in performing or using equipment and materials provided in a laboratory. A laboratory as a place with high chances of hazard occurrence is required to be examined by implementing Hazard Identification Risk Assessment Determining Control (HIRADC) analysis, which also an essential element in occupational safety and health management system due to the fact that it relates to the endeavor to prevent and control hazards used to determine the objectives and intentions of occupational safety and health. HIRADC analysis in this research is expected to reduce hazard risks that are likely to be discovered in laboratories. This research is performed in 2 nutrition laboratories in the Faculty of Public Health, Universitas Airlangga. The data used are the primary data obtained from observation. The results show that there are 15 hazard identifications from two identified laboratories. The highest hazard level is medium-risk, which consists of 3 hazard identifications. Risk controls need to be continuously implemented in order to control hazards that might be occurred.

Keywords: *laboratory, HIRADC, hazard*

Introduction

A laboratory is a place to carry out an experiment. Working in a laboratory requires cautious behavior in treating or using equipment and materials in the laboratory. This is intended to scale down the possibility of occupational accidents in a laboratory. Amongst of the potential hazards that are likely to happen in a laboratory are fire, poisoning, and equipment damage.[1]

Everything that contains danger is fundamentally sustained by the risk management to control hazards that can potentially cause several risks in occupational safety and health to prevent unwanted occupational accidents comprehensively, planned, and structured under a well-managed system. The number of hazard aptitude is determined by the possibility of the occurrence of the incidental accidents as well as by the severity it may cause.[2]

According to the International Labour Organization (ILO), 2.78 millions of workers are reportedly dead each year due to occupational accidents and occupational illnesses. Approximately 2.4 million (86.3%) of these deaths are caused by occupational illnesses, while more than 380,000 (13.7%) are caused by occupational accidents.[3] Referring to the data provided by National Social Security (re BPJS Ketenagakerjaan), the number of occupational accidents in Indonesia is still massive. In 2015 alone, 110,285 cases of occupational accidents were disclosed, while in 2016, 105,182 cases were detected. In addition, until August 2017, National Social Security attained the number of 80,392 cases of occupational accidents.[4]

The big number of accidents must not be underestimated. A laboratory as a workplace in which several of hazard risks can be discovered must have control to reduce the number of occupational accidents in Indonesia. OHSAS 18001 is one of occupational safety and health management systems with an international

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standard that aims to provide safety for workers from unwanted matters that might arise from workplaces or working activities itself. In accordance with the requirements given by OHSAS 18001 clause 4.3.1, an organization must set a procedure and conduct Hazards Identification, Risk Assessment, and Determining Control, which also known as HIRADC.[5]

A laboratory as a place with high risk of danger should also be carried out by HIRADC (Hazard Identification Risk Assessment Determining Control) analysis that roles as an indispensable element in occupational safety and health management system since it directly relates to the prevention and hazard control used to determine the objectives and intentions of occupational safety and health. The carried out HIRADC analysis is expected to reduce hazard risks that might arise in a laboratory.

Method

Study Population and Analysis: This research implemented observational approach and cross-sectional. The data were analyzed descriptively by elaborating the hazard potentials in the area in which the research was conducted to obtain risk assessments and determining controls. This research was carried out in Nutrition Laboratories of Faculty of Public Health, Universitas Airlangga Surabaya, namely the Laboratory of Nutrition Processing and the Laboratory of Biochemistry and Nutrient Processing Analysis. These locations were chosen as the locations of the research due to the fact that there had not been similar research carried out. The variables used in this research were the working activities in the laboratories, hazard sources, assessment, and risk control. The data gathered from this research are known as the primary data, which were obtained by observation. In addition, the results of the observation were presented in the form of narration and table before analyzed descriptively to draw a conclusion.

Risk Assessment: There are three main focuses in HIDARC, namely the attempt to perform hazard identifications and its characteristics, which is followed by filling up the assessment, risks of existing hazards, and last, recommending control endeavors that are likely to be executed.

Hazard identification is done to monitor high-risk workloads and underline the hazards related to certain equipment. Hazards in a working environment can be categorized into three major groups, for instance, health hazards, safety hazards, and environment hazards.[6] After that, evaluate risks whether the risks are acceptable or not is measured. To measure the score level of the risk, it is important to understand two main components, namely Likelihood, and Severity.The criteria to assess Likelihood can be seen in Figure 1, while the criteria to assess Severity are presented in Figure 2.

LIKELIHOOD(L)	EXAMPLE	RATING
Most Likely	The most likely result of the hazard/ event being realized	5
Possible	Has a good chance of occurring and it is not unusual	4
Conceivable	Might be occur at sometimes in future	3
Remote	Has not been known to occur after many after	2
Inconceivable	Is practically impossible and has never occurred	1

Source: **Department of Occupational Safety and Health Malaysia** *(2011)*

Figure 1: Likelihood Criteria

SEVERITY(S)	EXAMPLE	RATING
Catastrophic	Numerous fatalities, irrecoverable property damage and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized	4
Serious	Non-fatal injury, permanent disability	3
Minor	Disabling but not permanent disability	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

Source: **Department of Occupational Safety and Health Malaysia** *(2011)*

Figure 2: Severity Criteria

After obtaining the severity level of risks, the control to suppress the risk level to become as low as possible is likely to be done.[7]

Result

According to the observation, in the Laboratory of Biochemistry and Nutrient Processing Analysis, five items of hazard identifications as displayed in Table 1 were discovered.

Table 1: Hazard Identifications in the Laboratory of Biochemistry and Nutrient Processing Analysis

No.	Activity	Hazard Source
1.	Food nutrient analysis (mixing food ingredients with reagents)	Acid reagent and concentrated base (heated up to 400° C in a fume hood)
		Heat from the fume hood
2.	Biochemistry analysis (mixing reagents and human body sample)	Reagents (Acid and strong base with high concentration)
		Droplets from human (blood, urine, saliva, hair)
3.	Biochemistry and nutrient analysis practices with a minor accident	No First Aid kit in the laboratory

Table 2: Hazard Identifications in the Laboratory of Nutrition Processing

No.	Activity	Hazard Source
1.	Peeling and cutting food ingredients to be processed	Sharp food ingredients
		Knife
		Bacteria
2.	Washing food ingredients and utensils	Bacteria
3.	Cooking foods on a stove and deep fryer	LPG
		Heat
		Hot oil
4.	Cooking foods using a microwave	Heat
		Electricity
5.	Cooking foods using an oven	Heat
6.	Food processing practices with a minor accident	No First Aid kit in the laboratory

The hazard sources discovered in both laboratories contribute to risk accidents and diseases caused by the work done in both locations. Referring to the terms proposed by AS/NZS 4360, in order to correctly measure the risk level of each hazard, the assessment of two components, Likelihood and Severity, from point 1 to 5 based on the possible risk occurrences needs to be done.[7] The information is presented in Table 3 and Table 4.

Table 3: Likelihood and Severity of the Laboratory of Biochemistry and Nutrient Processing Analysis

Hazard Source	Risk	Likelihood	Severity	Risk Level
Acid and concentrated base reagent (heated up to 400° C in a fume hood)	Fluid exposed to the skin	1	3	Low
	Fumes inhaled and enter the respiratory tract	2	3	Moderate
Heat from a fume hood	The heat from the heating devices exposed to the hands	1	2	Low
Reagents (Acid and strong base with high concentration)	Fluid exposed to the skin	1	3	Low
	Fumes inhaled and enter the respiratory tract	1	3	Low

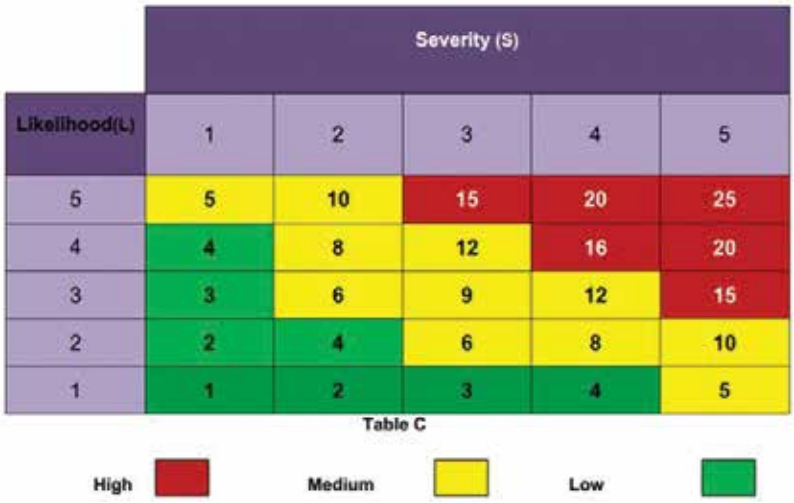
Conted…

Droplets from human (blood, urine, saliva, hair)	Droplets exposed to the skin tissues	1	1	Low
	Droplets swallowed or inhaled and enter the human body	1	2	Low
No First Aid kit in the laboratory	Injuries cannot be treated with First Aid and caused more severe wounds	2	3	Moderate

Table 4: Likelihood and Severity of the Laboratory of Nutrition Processing

Hazard Source	Risk	Likelihood	Severity	Risk Level
Sharp food ingredients	Sliced by sharp food ingredients	1	2	Low
Knife	Hands sliced by a knife	2	2	Low
Bacteria	Food contaminated by bacteria	1	1	Low
Bacteria	Food ingredients and utensils contaminated by bacteria	1	1	Low
LPG	Exploding and fire	1	4	Low
Stove heat	The heat from the stove or heat-conductor utensils exposed to the hands	2	2	Low
Hot oil	Hot oil exposed to the hands	2	2	Low
Food heat	Hot food products (burn) exposed to the hands	2	2	Low
Electricity	The electric shock when connecting the cable to the socket	1	2	Low
Oven heat	Hot oven and food products (burn) exposed to the hands	2	2	Low
No First Aid kit in the laboratory	Injuries cannot be treated with First Aid and caused more severe wounds	2	3	Moderate

The following step to be performed is assessing risk levels by alluding the risk matrix as shown in Figure 3. The meeting point of Likelihood and Severity is the one that determines whether the risk level belongs to a low, moderate, or high level. Moreover, in elaboration, if the meeting point of Likelihood and Severity is in the green area, it can be presumed that the risk level is low. However, if the meeting point is in the yellow area, it is considered as moderate and high if it belongs to the red area.[7]



Source: **Department of Occupational Safety and Health Malaysia** *(2011)*

Figure 3: Risk Matrix

The high-risk level requires immediate actions to control hazards in accordance with five hierarchy controls. The moderate-risk level, on the other hand, compels designed approach in hazard controls as well as executes alternative plans if needed. Additionally, for the low-risk level, the hazards are still likely to be accepted and not in need of further control. [7]

Discussion

Hazard Identification

1. **The Laboratory of Biochemistry and Nutrient Processing Analysis:** In the hazard identification discovered in the Laboratory of Biochemistry and Nutrient Processing Analysis, it was settled that the reagent is the main hazard in the laboratory. Other than that, the reagent liquid is believed to be dangerous if exposed to the human body. Moreover, the reagent needs to be heated. Thus, it can be presumed that beside the reagent liquid that originally contains chemical matters, instruments and utensils with high temperatures as well as fumes from the reagent heating process are also undoubtedly alarming. Unfortunately, the subjects who perform such tests seem to underestimate the consequences and resulting to inhale the alarming fume.

   Other than food substances, the Laboratory of Biochemistry and Nutrient Processing Analysis also evaluates the biochemistry taken from the human body as the sample, for instance, blood, urine, saliva, and hair. Those samples are considered as hazards since they can transmit diseases. Therefore, it can be stated that doing activities in a laboratory means living close to danger, according to the survey conducted by Education Bureau in 2011/2012 regarding accidents in school laboratories in 401 middle schools which enlisted the reported 348 cases of laboratory accidents. From the survey, the results showed that 328 people were injured, with the percentages of 39.1% of grazes, 37.6% of minor burns, 8% of accidents on the eyes, and 7.2% of exposure to chemical substances.[8] First Aid kit needs to be stacked to anticipate minor accidents. However, regrettably, there is no First Aid kit spotted in the Laboratory of Biochemistry and Nutrient Processing Analysis.

2. **The Laboratory of Nutrition Processing:** In the Laboratory of Nutrition Processing, activities to process foods are the main activities performed. The processing equipment that is most likely to cause danger is a knife, providing it has a sharp side that can be a cause of grazes. Additionally, stoves and ovens in high temperatures that can cause burns and LPG that may explode. Other than that, food ingredients such as pineapples, shrimps, and fish can also be considered as the potential hazard sources. If food ingredients are contaminated with bacteria due to unclean washing process or un-fresh ingredients, the bacteria itself may transfer to the laboratory workers. Moreover, heated oil is presumably causing accidents, for example, hands splashed by hot-temperature oil. The Laboratory of Nutrition Processing, unfortunately, does not provide First Aid kit, resulting in minor accidents cannot be immediately treated.

Risk Assessment

1. **The Laboratory of Biochemistry and Nutrient Processing Analysis:** The average hazard level discovered in the Laboratory of Biochemistry and Nutrient Processing Analysis is the low-risk level, providing the occurrences hardly arise when doing such activities in the laboratory. Even so, the score of 2 in Likelihood aspect is given for fumes inhaled when processing food ingredients and untreated minor accidents due to the absence of First Aid kit in the laboratory.

   As for the Severity aspect, the average point given for the Laboratory of Biochemistry and Nutrient Processing Analysis is 3. Likewise, the risk of droplets exposed to skin tissues causing blisters, bruises, wounds, and worries resulting those hazards be given the Severity point of 1. As for the risk of hands exposed to the heat from a fume hood and droplets swallowed, the hazards be scored 2 points of Severity aspect since it may cause non-permanent disabilities.

   From the elucidation above, it can be concluded that there are only two hazards that are considered as moderate, namely fume reagents inhaled during food nutrient analysis and the absence of a First Aid kit.

2. **The Laboratory of Nutrition Processing:** The danger of processing equipment in the Laboratory

of Nutrition Processing such as knives, stoves, and ovens be given the score of 2 in Likelihood aspect. The same score is also given to hot oil, food heat, and the absence of First Aid kit. The explosion of LPG and electric shock accident records are nowhere to be found, causing both hazards to be given the score of 1 in Likelihood aspect.

For the Severity aspect, the highest score of Severity, 4, is attained from the explosion of LPG since it may be resulting in fatal injuries and the damage of properties. In contrast, the lowest Severity score is obtained by the bacteria in food ingredients and processing equipment, which each gets a score of 1. The Severity level with the score of 3 is only spotted in the risk caused by the absence of First Aid kit. As for the other hazards, the score given is 2 due to the fact that it does not cause any severe injury.

In broad, it can be stated that all hazard risks in the Laboratory of Nutrition Processing on average, attained the score of the low-risk level. Hence, one point that cannot be ignored is the absence of First Aid kit, which belongs to the moderate risk level.

Risk Control

Control actions are needed to prevent occupational accidents that can result to fatal injuries.[9] Amongs of the actions that can be executed are:

a. Administering briefing concerning on the proper and safe experiment instructions before each experiment (Standard Operating Procedure of the experiment and Experimental Instructions)

b. Administering briefing on how to properly and safely process food ingredients

c. Administering briefing on how to properly use knives or hazard-possible instruments that it can be safely used by the users

d. Administering briefing on proper personnel and equipment hygiene sanitation

e. Making regulations to wear Personal Protective Equipment (*APD)* such as rubber gloves, masks, goggles, and a laboratory coat

f. Placing LPG that are far from flammable substances and in a stable temperature

g. Procuring First Aid kits as needed to treat minor injuries caused by minor accidents when doing activities in the laboratory

h. Procuring Personal Protective Equipment, such as heat resistant gloves to minimize the possibility of hand exposed to hot equipment

Some of the elaborated suggestions above are reckoned to be considered in order to control hazards in laboratories to prevent occupational accidents and severe occupational illnesses.

Conclusion

The Laboratory of Biochemistry and Nutrient Processing Analysis and the Laboratory of Nutrition Processing in the Faculty of Public Health, Universitas Airlangga come with different types of hazards. The Laboratory of Nutrition Processing has more potential hazards (10 hazards) than the ones in the Laboratory of Biochemistry and Nutrient Analysis (5 hazards). Nonetheless, the risk levels discovered in the Laboratory of Biochemistry and Nutrient Analysis in moderate-level are reported more with the number of two, obtained from the risk of inhaling reagent fumes while analyzing food substances and the absence of First Aid kit in the laboratory. On the other hand, the Laboratory of Nutrition Processing only has one category of moderate-risk level: the absence of First Aid kits. Thus, it can be assumed that both Nutrition Laboratories in the Faculty of Public Health are considered quite safe inasmuch as no high-risk level of hazards discovered. As a matter of fact, only a few are scored a moderate-risk level. However, risk controls are still essential to be done in order for the hazards to be controlled.

Ethical Clearace: Taken

Source of Funding: Sponsored by University

Conflict of Interest: None

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