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The relation between H_2SO_4 content on latex and irritant contact dermatitis on workers in plantation area company of sumber tenggulun Jember

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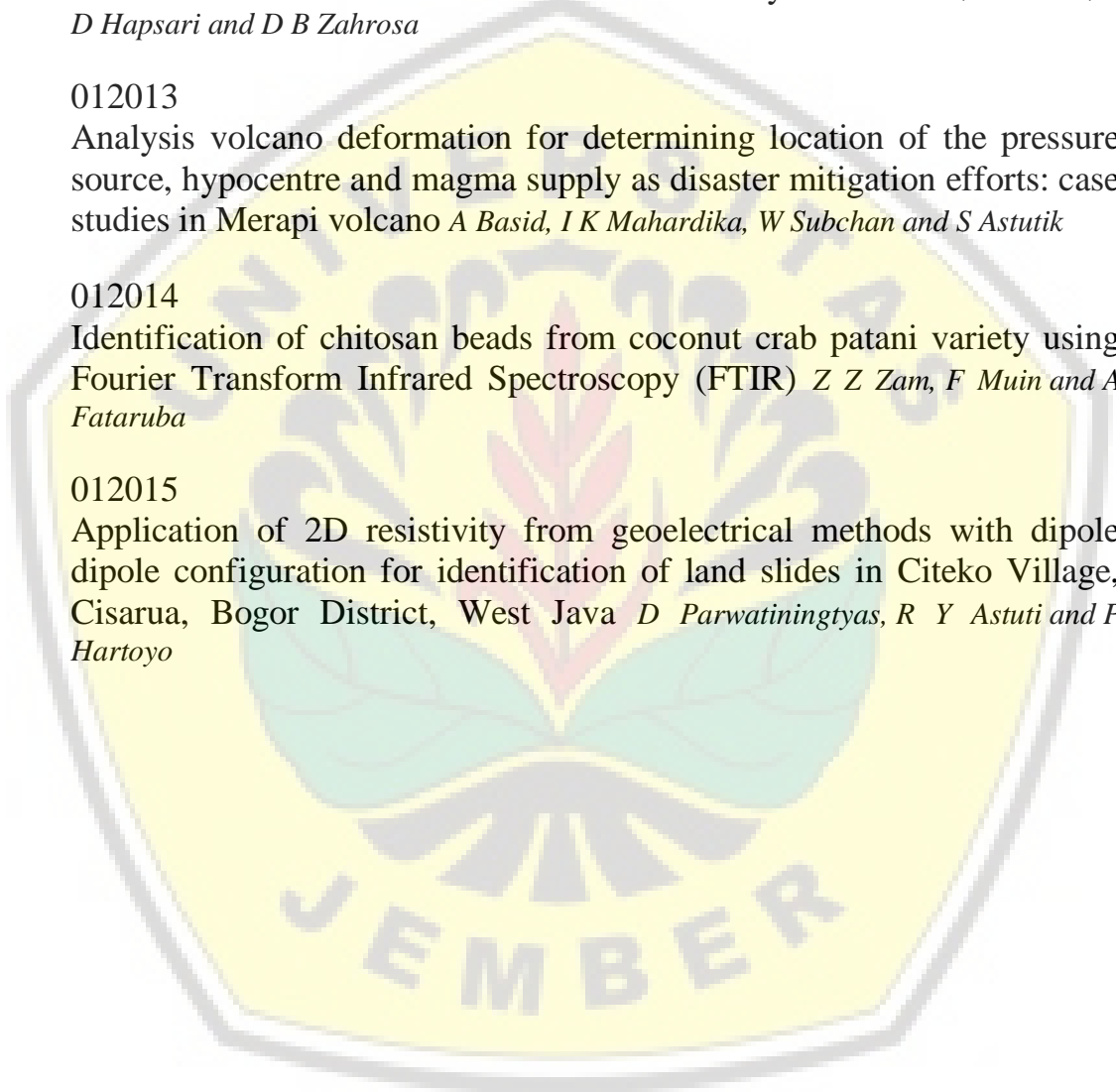
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The relation between H₂SO₄ content on latex and irritant contact dermatitis on workers in plantation area company of sumber tenggulun Jember

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Abstract. Dermatitis was a type of skin disease which caused by skin inflammation. The Irritant Contact Dermatitis (ICD) was a reaction which appeared when the skin got contact to toxic chemicals which caused to inflammation. The aim of this research was to examine characteristics of workers and H₂SO₄ content which were related to the case of irritant contact dermatitis on rubber plantation workers in a plantation area company of Sumber Tenggulun Tanggul Jember. The research design was descriptive quantitative research which would figure out the causal relationship of contact dermatitis disease to the workers, particularly in the relation with chemicals. The research population was taken from all workers in the plantation area company of Sumber Tenggulun Jember. The data sampling exerted total sampling technique on 35 samples. The data analysis was logistic regression method which aimed to analyze the data by describing or illustrating the collected data as it should be without drawing any general conclusion or generalization. The research finding referred that factors of age, gender, genetics, chemicals use, and exposure characteristic affected insignificantly to the case of irritant contact dermatitis. The plantation should recommend the workers to wear personal protective equipment as an earlier protection from the dangers of accident and occupational disease.

1. Introduction

Dermatitis is a skin disease which caused by skin inflammation. The characteristics of this disease are sub-acute, acute, and chronic. The condition of this disease is indicated by several factors as inflammation, redness, skin dryness, and itchy complaint on the affected skin area. Generally, there are two kinds of dermatitis diseases, atopic dermatitis and contact dermatitis. The contact dermatitis is consisted of two categories as Irritant Contact Dermatitis (ICD) and Allergic Contact Dermatitis (ACD). The irritant contact dermatitis was a reaction which appears when the skin get contact to toxic chemicals and causes to inflammation. The first exposure includes the irritant which is able to cause irritation response on the skin [7].

The main factor which affects to the occupational dermatitis is contact with chemicals. A number of factors which can affect the occurrence of contact dermatitis [9], they are human factor, occupational factor, and environmental factor[14], three factors which can affect this contact dermatitis are contact length, contact frequency, and personal protective equipment use. Based on three opinions above, it is concluded to the factors of gender, age, race, skin area and atopic record, working length, contact frequency, environment, and personal protective equipment. Commonly, the contact dermatitis is a condition of non-infectious inflammation on skin which is caused by certain contact compounds to the skin. There are two types of contact dermatitis, as Irritant Contact Dermatitis (ICD) is a non-immunological response and Allergic Contact Dermatitis (ACD) which is caused by a specific immunological mechanism [4]. The incident of occupational skin disease is found and caused by contact dermatitis 92,5%, skin infection 5,4%, and other types of skin disease 2,1%.



The epidemiological data in Indonesia has shown that 97% of 389 cases are the contact dermatitis case, especially the Irritant Contact Dermatitis (ICD) 66,3% and Allergic Contact Dermatitis (ACD) 33,7% [5].

The factor which can affect contact dermatitis occurrence is divided into two factors, they are direct and indirect factor. The direct factor is comprised of chemical type and contact length, while the indirect factor is comprised of age, gender, work length, race, temperature and humidity, allergic history, personal hygiene, and personal protective equipment use. The main cause of irritant contact dermatitis and occupational disease is chemicals. The contact to chemicals is the biggest causal factor of irritant contact dermatitis. Moreover, the chemicals which frequently affects to irritant contact dermatitis in this research is chemicals which are used in the process of rubber latex processing, sulfuric acid (H_2SO_4) [12].

The sulfuric acid is the strongest kind of mineral acids (inorganic substance). This substance is soluble. The sulfuric acid has chemical formula of H_2SO_4 and molar mass 98,08 g/ mol. The sulfuric acid exists as hygroscopic, oily, colorless, and unscented fluid. This sulfuric acid is frequently named as vitriol oil. Moreover, sulfuric acid has melting point in about $10^\circ C$ (283 K) and boiling point in about $337^\circ C$ (610 K). This type of acid is corrosive. The sulfuric acid is the strongest type of unscented mineral acids with a high corrosive characteristic. The sulfuric acid is water soluble in several proportions. The sulfuric acid is very dangerous when it harms on skin tissue because of its corrosive characteristic, and by its characteristic as the strongest dehydrator, it will affect injury as burn on the skin tissue. The higher concentration level of sulfuric acid will increase the danger. Although the sulfuric acid is watery, it is able to hydrate a paper when the drop of sulfuric acid is left on the paper for a long time. The step which must be done when the skin got contact to the sulfuric acid is to flush the body part which is exposed to sulfuric acid with running water for 10-15 minutes. This step is aimed to cool down the skin tissue around the acid burns area and avoid secondary damage. The cloth which is exposed to sulfuric acid must be also taken off soon and flushed by water on the part exposed by the sulfuric acid in the cloth.

The exposure of latex antigen is occurred through a direct contact with skin mucosa membrane which is brought by the protein particles of latex gloves powder. The absorption of latex protein on skin is the main track of sensitization and responsible to the appearance of urticarial local manifestation which then turns into systemic manifestation. This incident is related to the wear of latex gloves in a long time [13].

In the plantation area company of Sumber Tenggulun Tanggul Jember, the workers wear personal protective equipment while they are working, although the wear is still incomplete and not in accordance with safety standard. The workers do not completely wear boot when they are rustling the sap, wear hand gloves and other personal protective equipment. The plantation should recommend the use of personal protective equipment as an earlier protection strategy from danger of accident and occupational disease. The use of personal protective equipment is basically the last alternative for the company to protect their labors from dangerous factor and potential. To put in an outline, the incident of work accident is caused by two factors, human action which does not fulfill work safety standard (unsafe act) and unsafe environmental conditions (unsafe condition).

The researchers are interested to identify further about the characteristics of worker and dermatitis disease in the worker community by relating the characteristics and dermatitis case. This research is aimed to identify the characteristics of worker and H_2SO_4 content which is related to the case of irritant contact dermatitis on rubber plantation workers in the plantation area company of Sumber Tenggulun Tanggul Jember.

2. Literature Reviews

Personal protective equipment is a defensive equipment which worn by a worker to protect his self from environmental contamination. Regarding to the word “personal” in personal protective equipment (PPE), each equipment which is worn by the worker must be able to protect its wearer. The personal protective equipment is ranged from the simple to relatively complete design. The personal protective equipment is the most basic preventive solution from all kinds of contamination and danger because of chemical factors [2], the personal protective equipment which must be worn by the workers personally when they were in the hazardous workplace. The standardized self-protection equipment for harmful chemicals is covered to head protector, eye protection, face shield, hand and foot protection [8], the rules which must be fulfilled in the selection of personal protective equipment will listed below :

1. It can offer an adequate protection from specific dangers or other harmful probabilities which may be faced by the workers
2. The equipment heaviness should be as light as possible and this equipment will not cause to excessive inconvenience.
3. It must be worn flexibly.
4. The custom must be attractive enough.
5. Resistant for a long-term use.
6. It will not cause further risks for the wearer because of improper custom and danger in the equipment wear.
7. The personal protective equipment must fulfill the standard.
8. The equipment does not restrict the wearer’s movement and sensory perception.
9. The spare part must be easily acquired in order to ease the maintenance.

The research done by Sumarni and Rukmansari (2018) has shown that the tannery workers with contact dermatitis are about 18 respondents or (51,5%). It refers to a significant relation between contact length and contact dermatitis case. The workers who have contact frequency in more than five times a day will have probability 0,6500 times higher to get contact dermatitis than the workers who have contact frequency in less than five times a day. Therefore, the relation between personal protective equipment and dermatitis occurrence is found. It is summed up that the relation between contact length, frequency, and personal protective equipment and contact dermatitis. This research has also suggested that the VPC Company must switch to the process of tannery in eco-friendly system and exertion of organic chemicals as the substitute of sulfuric acid and formic acid.

Sulfuric acid is a colorless fluid, which looks like oil and hygroscopic with the density of 1,838. The pure and commercial concentrated acid is the mixture which has a constant boiling point with boiling point of 338o and acid content 98%. The process of sulfuric acid and water mixture is very exothermic, thus, on the process of dilution, the concentrated sulfuric acid must be poured slowly into the water and vice versa, and while it was stirring continuously. The undiluted pure sulfuric acid cannot be found naturally in this earth because of its hygroscopic character. Even though, the sulfuric acid is the main component of acid rain which occurs because of sulfur dioxide oxidation in the atmosphere with water presence (sulfuric acid oxidation). The sulfur dioxide is the main byproduct of fuel burning as coal and oil which contain of sulfur. The sulfuric acid 98% is more stable to be saved and the most common form of sulfuric acid. The sulfuric acid 98% is commonly called as concentrated sulfuric acid.

The sulfuric acid also has many advantages in chemical industry. For instance, the sulfuric acid is the acid catalyst which is commonly used to change *cyclohexanoxime* to *caprolactam* that is functioned to form nylon, it is also mostly used to form chloric acid from salt. A lot of H₂SO₄ is used in the petroleum refinery, for example as catalyst for the isobutene and isobutylene reaction which results to isooctane. Dermatitis is the skin inflammation on epidermal and dermis layer as a response to the effect of exogenous or endogenous factor, with a clinical abnormality as polymorphic efflorescence like erythema, edema, papules, vesicle, *skuama*, *lichenification*, and itchy complaint.

The polymorphic symptoms are not always appeared simultaneously, but it may be only some or *oligomorphic*. The dermatitis tends to residue and chronic [4]. The contact dermatitis itself is a kind of skin inflammation which can be followed by intercellular edema on epidermis, due to the skin interaction with chemicals. Based on the cause, the contact dermatitis is divided into irritant contact dermatitis and allergic contact dermatitis [1].

The causes of chronic irritant contact dermatitis can be from solvent, detergent, lubricant, acid, alkali, and sawdust. The irritant contact dermatitis can turn into severe due to several factors, not only the factors of irritant substance molecule and contact length, the exposure frequency is also influential to the level of severity [4]. Approximately 80-90% of irritant contact dermatitis cases, they are caused by chemicals and solvent exposure. The inflammation can appear after one time exposure or repeated exposure of irritant contact dermatitis which may appear after the first exposure, it is called as an acute irritant contact dermatitis and usually caused by a solid irritant, as strong acid, strong alkali, salt, heavy metal, aldehyde, aromatic and polycyclic compound.

The dermatitis is caused by endogenous and exogenous factors. The endogenous factor is consisted of chemicals, exposure, and environment. A chemical material which is contained within latex is H_2SO_4 . This substance will irritate the skin immediately if the workers do not use any personal protective equipment, since the character of H_2SO_4 is corrosive and causes to dermatitis disease. The following factor is exogenous, this factor is related to worker characteristics as age, gender, genetics, race, and location.

3. Research Methods

The research design was descriptive quantitative research which aimed to figure out causal factors of contact dermatitis disease on the workers, especially when it was related to chemicals. The population in this research was taken from all workers in the plantation area company of Sumber Tenggulun who worked in the latex processing department, the total respondents were 35 workers who have a direct contact to chemicals. The data sampling used total sampling technique, so all workers in the department of latex processing were included into the research sample.

The data of research was consisted of two types, primary data and secondary data. The primary data was derived directly from the research counselor by exerting question lists. In this research, the data was in form of questionnaire. The data was related to the occurrence of dermatitis disease in the plantation area company of Sumber Tenggulun Tanggul Jember. While, the secondary data was derived from documents or files which were concerning to the programs as data of worker, personal protective equipment, profile of plantation area company of Sumber Tenggulun Tanggul Jember.

The analysis in this research employed logistic regression method which was aimed to analyze the data by describing or illustrating the collected data as it was without drawing to any general conclusion or generalization. This analysis was only in a descriptive form of basic data accumulation which referred that the research did not search or explain the interrelation, test hypothesis, make prediction, or even draw conclusion. This descriptive statistical analysis technique which could be used in this research was data analysis in SPSS program.

3.1 Research Flow

The research flow can be seen in the chart below :

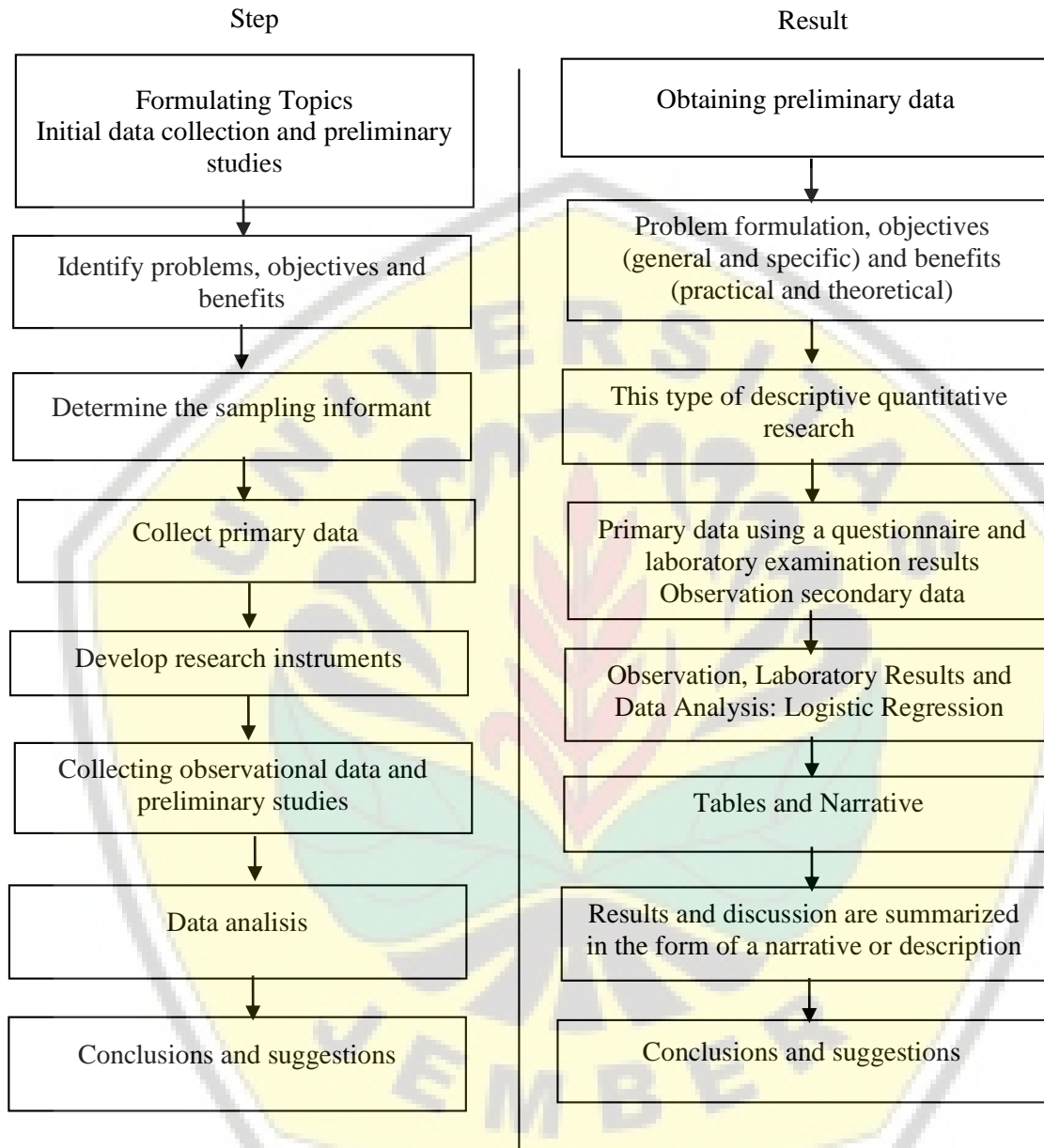


Figure 1. Research Design

4. Result And Discussion

4.1 Result

The respondent characteristics in this research were comprised of age, gender, and genetics as it would be presented on the table below.

Table 1. Respondent Characteristics of Age, Gender, and Genetics in Plantation Area Company of Sumber Tenggulun Tanggul Jember

Characteristic	Criteria	Frequency (individual)	Percentage (%)
Age	20-35 years old	16	45,7
	36-45 years old	13	37,1
	46-55 years old	6	17,1
Gender	Male	23	65,7
	Female	12	34,3
Genetics	Record of disease	10	28,6
	No record of disease	25	71,4
Total		35	100

Based on the respondent characteristic of age, this research found that the majority of respondents were in range of 20-35 years old (45,7%). The respondent characteristic of gender showed that the majority of respondents were male or man (65,7%). While, the respondent characteristic of disease record (genetics) indicated that the majority of research respondents did not have record of disease (71,4%). The factors which could affect irritant contact dermatitis were age, gender, genetics, chemicals, exposure characteristic, H₂SO₄ content, personal protective equipment, and knowledge factors. The bivariate testing result (χ^2) was presented below:

Table 2. Chi-quadrat Test Result on Relation between factors of age, gender, genetics, chemicals, exposure characteristic, H₂SO₄ content, personal protective equipment, and knowledge and case of irritant contact dermatitis in the plantation area company of Sumber Tenggulun Tanggul Jember

Variable	Criteria	Case of Irritant Contact Dermatitis				Total Frequency	%	Testing outcome
		Dermatitis		Not dermatitis				
		Frequency	%	Frequency	%			
Age	25-35 years old	8	22,9	8	22,9	16	45,8	$\chi^2 = 4,565$ p = 0,102
	36-45 years old	4	11,4	9	25,7	13	37,1	
	46-55 years old	5	14,3	1	2,9	6	17,1	
Gender	Male	13	37,1	10	28,6	23	65,7	$\chi^2 = 1,697$ p = 0,193
	Female	4	11,4	8	22,9	12	34,3	
Genetics	Record of disease	3	8,6	7	20,0	10	28,6	$\chi^2 = 1,933$ p = 0,164
	No record of disease	14	40,0	11	31,4	25	71,4	
Chemicals	≥ 1000 dlt	9	25,7	5	14,3	14	40,0	$\chi^2 = 2,307$ p = 0,129
	< 1000 dlt	8	22,9	13	37,1	21	60,0	
Exposure characteristic	None	7	20,0	12	34,3	19	54,3	$\chi^2 = 2,289$ p = 0,130
	Personal Protective Equipmen	10	28,6	6	17,1	16	45,7	

Variable	Criteria	Case of Irritant Contact Dermatitis				Total Frequency	%	Testing outcome
		Dermatitis Frequency	%	Not dermatitis Frequency	%			
H ₂ SO ₄	Concentrated	10	28,6	3	8,6	13	37,1	$\chi^2 = 6,655$ $p = 0,010$
	Not concentrated	7	20,0	15	42,9	22	62,9	
Personal Protective Equipment	Incomplete	14	40,0	5	14,3	19	54,3	$\chi^2 = 10,493$ $p = 0,001$
	Complete	3	8,6	13	37,1	16	45,7	
Knowledge	Less	4	11,4	0	0,0	4	11,4	$\chi^2 = 12,595$ $p = 0,002$
	Sufficient	11	31,4	6	17,1	17	48,6	
	Good	2	5,7	12	34,3	14	40,0	

Based on the bivariate testing on relation between age factor and irritant contact dermatitis case, the data referred that the majority of research respondents were in range of 36-45 years old and no identification of irritant contact dermatitis case (25,7%), male gender and identification of irritant contact dermatitis case (37,1%), no record of disease and no identification of irritant contact dermatitis (40,0%), assumption of chemical use in less than 1000 dalton and no irritant contact dermatitis case (37,1%), assumption of no personal protective equipment use and no identification of irritant contact dermatitis (34,3%), opinion of H₂SO₄ content was not concentrated and no irritant contact dermatitis case (42,9%), assumption of incomplete use of personal protective equipment and identification of irritant contact dermatitis case (40,4%), knowledge acquisition with good category and no identification of irritant contact dermatitis case (34,3%).

Statistically, the bivariate testing result showed that there was not a significant relation between irritant contact dermatitis case and factors of knowledge ($p = 0,102$), gender ($p = 0,193$), genetics ($p = 0,164$), chemicals use ($p = 0,129$), and exposure characteristic ($p = 0,130$). On the other hand, the research indicated a significant relation between irritant contact dermatitis case and factors of H₂SO₄ content use ($p = 0,010$), personal protective equipment ($p = 0,001$), and knowledge ($p = 0,002$).

Table 3. Result of Omnibus Test and Nagelkerke R² on Effect of Factors which Influence the Irritant Contact Dermatitis Case in Plantation Area Company of Sumber Tenggulun Tanggul Jember

		χ^2	df	Sig.	-2 Log Likelihood	Cox & Snell R ²	Nagelkerke R ²
Step 1	Step	30,905	8	0,000			
	Block	30,905	8	0,000	17,587	0,586	0,782
	Model	30,905	8	0,000			

The result of omnibus test referred that the χ^2 value was 30,905 with significance value 0,000. This significance value was fewer than α (0,05). It was meant that based on the confidence level of 95%, there was minimally a factor which affected to the occurrence of irritant contact dermatitis. The calculation result showed that Nagelkerke R² value was 0,782. This value referred that the predisposition factor is able to define the irritant contact dermatitis case in about 78,2% and the rest was affected by other factors out of this model.

The result of partial testing on factors which affected the case of irritant contact dermatitis referred that the age, gender, genetics, chemicals use, and exposure characteristic factors did not significantly

affect to the incident of irritant contact dermatitis. Meanwhile, the H₂SO₄ content, personal protective equipment, and knowledge factors affected significantly to the incident of irritant contact dermatitis. The testing result on factors which could affect to the occurrence of irritant contact dermatitis in the plantation area company of Sumber Tenggulun Tanggul Jember would be presented below :

Table 4. Result of Partial Testing on Factors which Influence the Irritant Contact Dermatitis Case in Plantation Area Company of Sumber Tenggulun Tanggul Jember

Variable	B	S.E.	Wald	Df	Sig.	Exp (B)
Age	0,983	1,031	0,909	1	0,340	2,672
Gender	0,681	2,197	0,096	1	0,757	1,976
Genetics	-1,908	1,885	1,024	1	0,311	0,148
Chemicals	0,221	1,665	0,018	1	0,894	1,248
Exposure Characteristic	-0,941	1,631	0,333	1	0,564	0,390
H ₂ SO ₄	3,163	1,582	3,997	1	0,046	23,644
Personal Protective Equipment	4,206	2,038	4,260	1	0,039	67,089
Knowledge	4,215	2,071	4,141	1	0,042	67,670
Constant	-18,594	8,020	5,375	1		

Based on the table 4, the regression coefficient value (B) was 0,983 and natural algorithm (Exp(B)) was 2,672 which this data referred the age increase factor would also increase the probability of irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (2,672). The regression coefficient value (B) was 0,681 and natural algorithm (Exp(B)) was 1,976 which referred that female gender would increase the probability of irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (1,976). The regression coefficient value (B) was -1,908 and natural algorithm (Exp(B)) was 0,148 referred that no record of disease would decrease the probability of irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (0,148 or less than 1). The regression coefficient value (B) was 0,221 and natural logarithm (Exp(B)) was 1,248 which referred that the fewer chemicals use would increase the probability of irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (1,248). The regression coefficient value (B) was -0,941 and natural logarithm (Exp(B)) was 0,390 which referred that improvement of personal protective equipment wear would decrease the probability of irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (0,390 or less than 1). The regression coefficient value (B) was 3,163 and natural algorithm (Exp(B)) was 23,644 which referred that increase of H₂SO₄ content use would increase the probability of no irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (23,644). The regression coefficient value (B) was 4,206 and natural logarithm (Exp(B)) was 67,089 which referred that improvement of personal protective equipment use would increase the probability of no irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (67,089). The regression coefficient value (B) was 4.215 and natural logarithm (Exp(B)) was 67,670 which referred that increase of knowledge acquisition would increase the probability of no irritant contact dermatitis case in the plantation area company of Sumber Tenggulun Tanggul Jember (67,670).

4.2 Discussion

The use of personal protective equipment at the Sumber Tenggulun Tanggul Jember Plantation Company (PDP) according to the research respondents most of them stated that it was incomplete (54.3%) and of the majority there were 40.0% experienced irritant contact dermatitis and some did not. experienced an incidence of irritant contact dermatitis (14.3%).

The concentration of H₂SO₄ material in the Regional Plantation Company (PDP) Sumber Tenggulun Tanggul Jember according to most of the research respondents was not concentrated, namely 62.9%. Of these, 42.9% did not experience irritant contact dermatitis and some others experienced irritant contact dermatitis (20.0%).

The incidence of irritant contact dermatitis in the Plantation Area Company (PDP) Sumber Tenggulun Tanggul Jember was almost equal, namely respondents who experienced irritant contact dermatitis were 48.6% while those who did not experience irritant contact dermatitis were 51.4%.

Based on gender, it shows that the majority of respondents who either experienced or did not experience irritant contact dermatitis were male, namely those who experienced irritant contact dermatitis were 37.1% and those who did not experience irritant contact dermatitis were 28.6%.

The relationship between H₂SO₄ levels and the incidence of irritant contact dermatitis in rubber plantation workers at Sumber Tenggulun Plantation Company (PDP) Sumber Tenggulun Tanggul Jember obtained a χ^2 -count value of 6.655 with a significance of 0.010. The significance value is less than (0.050), which means that there is a significant relationship between gender and the incidence of irritant contact dermatitis in rubber plantation workers at Sumber Tenggulun Tanggul Jember Plantation Company (PDP).

5. Conclusion and Suggestion

The use of personal protective equipment on rubber plantation workers in the plantation area company of Sumber Tenggulun Tanggul Jember was still in an incomplete category. The H₂SO₄ content on rubber plantation workers in the plantation area company of Sumber Tenggulun Tanggul Jember according to the majority of respondents was not concentrated. Moreover, the case of irritant contact dermatitis in the plantation area company of Sumber Tenggulun Tanggul Jember was indicated that the number of workers who were not exposed to irritant contact dermatitis was still dominant. The age, gender, genetics, chemicals use, and exposure characteristic factors could not affect significantly to irritant contact dermatitis case. While, the H₂SO₄ content, personal protective equipment, and knowledge factors could affect significantly to irritant contact dermatitis case.

The plantation should recommend the use of personal protective equipment as an earlier protection step from the dangers of accident and occupational disease, especially which is caused by the use of hazardous chemicals.

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