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PATH ANALYSIS OF PERCEPTION OF HEAT PRESSURE, PULSE RATE, BODY TEMPERATURE AGAINST HEAT STRAIN EVENTS IN WORKERS IN BREM PRODUCTION INDUSTRY

ANALISIS JALUR PERSEPSI TEKANAN PANAS, DENYUT NADI, SUHU TUBUH TERHADAP KEJADIAN REGANGAN PANAS PADA PEKERJA DI INDUSTRI PRODUKSI BREM

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ABSTRACT

Background: Brem industry workers can be at risk to get into heat strain in their workplace. The cases are caused by heat pressure, pulse rate, and body temperature. **Purpose:** To analyze the heat pressure, pulse rate, and body temperature that can influence the heat strain simultaneously to the workers of the Brem industry in the Kaliabu region, Madiun city, Indonesia. **Method:** The research is characteristic analytic observation quantitative with the cross-sectional approach in which a sample is 157 respondents with a total amount are 266 workers. The analysis test path use SPSS AMOS 23 accessories to analyze the data. **Result:** The results of the research are that heat stress does not influence the pulse rate (estimate 0, 02). Heat stress influences body temperature (estimate 0, 12). Heat stress does not influence the heat strain directly (estimate 0, 011). Pulse rate does not influence the heat strain (estimate 0, 08) and body temperature influences the heat strain (estimate 0, 04). **Conclusion:** Heat stress does not influence the heat strain directly but it influences the variety of body temperature so it needs to pay attention to the work duration time well (7 hours working and 1 hour for taking rest). Also, it needed an arrangement of the room and adding the system of ventilation to get down the heat from the environment so heat strain can be restrained by checking the environment temperature and body temperature workers routine.

ABSTRAK

Latar belakang: Pekerja industri Brem berisiko mengalami heat strain di tempat kerjanya. Kasus-kasus tersebut disebabkan oleh tekanan panas, denyut nadi dan suhu tubuh. **Tujuan:** Menganalisis tekanan panas, denyut nadi, dan suhu tubuh yang dapat berpengaruh terhadap regangan panas secara simultan pada pekerja industri Brem di wilayah Kaliabu, kota Madiun, Indonesia. **Metode:** Jenis penelitian ini adalah observasional analitik karakteristik kuantitatif dengan pendekatan cross-sectional dengan sampel 157 responden dengan jumlah 266 pekerja. Analisis jalur uji menggunakan aksesoris SPSS AMOS 23 untuk menganalisis data. **Hasil:** Hasil penelitian menunjukkan bahwa tekanan panas tidak berpengaruh terhadap denyut nadi (estimasi 0, 0). Tekanan panas berpengaruh terhadap suhu tubuh (estimasi 0, 12). Tegangan panas tidak berpengaruh langsung terhadap regangan panas (perkiraan 0,011). Denyut nadi tidak berpengaruh terhadap regangan panas (perkiraan 0,08) dan suhu tubuh berpengaruh terhadap regangan panas (perkiraan 0, 04). **Kesimpulan:** Tekanan panas tidak berpengaruh langsung terhadap tekanan panas tetapi berpengaruh terhadap variasi suhu tubuh sehingga perlu memperhatikan waktu durasi kerja dengan baik (7 jam kerja dan 1 jam istirahat). Selain itu, diperlukan penataan ruangan dan penambahan sistem ventilasi untuk menurunkan panas dari lingkungan sehingga regangan panas dapat ditahan dengan memeriksa suhu lingkungan dan suhu tubuh pekerja secara rutin.

INTRODUCTION

Heat strain is a word that is used to describe the effect by body temperature caused of heat stress explanation. The main human body temperature is kept up at 37 degrees Celsius. The higher human body temperature can interfere with body chemistry reaction as well as structure and protein function. A serious health threat to the workers in the heat environment can cause thermal strain disorders (Rampino et al., 2012). Heat strain is indicated by a rising of body temperature more than 38 degrees Celsius. The reaction that occurred is vasodilatation, heartbeat is on the rise, and skin temperature too (Bo et al., 2020). At first, the main body temperature is hereditary but then it gets increases (Kosmidis et al., 2013). Heat clarify that occurred continuously is can increase the risk of health interference that due to the hot climate of the environment workplace (Pruvot et al., 2019). Too much heat strain is also able to lose weight (Habibi et al., 2016). Body temperature is one way to control the heat strain (Katica, 2014). The body temperature gets down more slowly than the heartbeat when it clarify with heat stress. The measuring of the body temperature is on the tympanic membrane (Yeoh et al., 2017) and it uses an infrared digital thermometer to measure it (Kim et al., 2019). The measuring is done at the beginning of work when working is continues and after work (Rasdi et al., 2017). The oral temperature is lower at 0.6 % than the main body temperature (EUCTR2020-001951-42-PL, 2020). Controlling body weight can be done with a bathroom scale (Linder et al., 2021). The test body weight is can do at beginning of work and after clarifying with heat stress (National Institute For Occupational Safety and Health, 2016).

The research informal sector is not yet extensively performed, especially in the Brem industry. Heat stress in the Brem industry should be controlled, so it is necessary to do the research. The aim of the research is to analysis the heat stress influence, pulse rate, and body temperature on workers after being clarified by heat strain (research at Brem industry in Kaliabu region, Madiun). The research is quality analytic observation quantitative with cross-section approach which research sample is 157 respondents from the total amount of 266 workers (Sugiyono and Susanto, 2015). Analyzed test path using SPSS AMOS 23 equipment for observing the data (Santoso, 2014). Inclusion criteria is an indoor worker who to is interviewed and have good communication to the 157 workers at Brem industry in Kaliabu region, Madiun. The time of observation is from 2020 September until 2020 October. Data analysis use path analysis with AMOS 23 software (Marsh et al., 2014).

MATERIAL AND METHOD

The research is quality analytic observation quantitative with cross-section approach which research sample is 157 respondents from the total amount of 266 workers (Sugiyono and Susanto, 2015). Analyzed test path using SPSS AMOS 23 equipment for observing the data (Santoso, 2014). Inclusion criteria is an indoor worker who to be interviewed and has good communication with 157 workers at Brem industry in Kaliabu region, Madiun. The ttime of observation is from 2020 September until 2020 October. Data analysis use path analysis with AMOS 23 software (Marsh et al., 2014).

RESULT

Based on Table 1, the measuring result of work environment conditions comprises temperature measuring, (Bendia et al., 2018) relative humidity (Du et al., 2020), and airspeed (Deniz et al., 2018). The measuring is done at five points as long as 45 minutes in every point of measuring. There are five measuring points. (1) steaming area, (2) condensation area, (3) mixing area, (4) casting area, (5) drying in the sun area.

Temperature and humidity measuring relatively use Heat Stress Monitor TM – 188. But airspeed measuring use a Digital Vane Anemometer instrument. It is taking place on Thursday, November 12, 2020. Started at 7 am West Indonesian Time and finished at 3 pm WIT. It is started with calibration instrument for 10 minutes long. When research was going on the weather condition was clear.

Showed in Table 2, heat stress measuring result at Brem industry in Kaliabu territory, Madiun, Indonesia, it is known that the highest heat stress is 30.8 degrees Celsius and the lowest is 28.9 degree Celsius. The average ISBB is 30.1 degree Celsius. It means that it is exceeded with NAB (steaming area, condensation area, mixing area, casting area, drying in the sun area). The employees start working at 7 am and finish working at 3 pm. It has 8 hours long (7 hours for working time and an hour for taking a rest). Based on Table 3, heat stress at Brem industry environment in Kaliabu territory, Madiun, Indonesia which total respondent are 157 persons. Many of them get heat stress (74.5 %).

Showed in Table 4, research output at Brem industry in Kaliabu territory, Madiun, Indonesia, the data body temperature from 157 respondents who measuring is put through tympanic membrane. They are claimed that 123 persons (78.3 %) have body temperature more than 37.6 °C while 34 persons (21.7 %) have less than 37.6 °C of its. So it can to be concluded that respondents in the majority have body temperature more than 37, 6 °C. There are 123 respondents (78.3 %).

Table 1. Measurement of temperature, humidity and angina speed at each measuring point

No	Measurement Location	Nilai	Sk (°C)	Sb (°C)	Sg (°C)	ISBB (°C)	RH (%)	V_{angin} (m/dt)
1	Steaming area	Min	35.2	27.5	36.0	30.0	53	0.4
		Max	35.7	28.0	36.9	30.6	59	1.5
		Avg	35.4	27.7	36.4	30.3	56	0.9
2	Condensation area	Min	35.6	27.4	36.3	30.0	56	0.3
		Max	36.1	28.2	36.9	30.8	62	1.3
		Avg	35.3	27.8	36.6	30.4	59	0.8
3	Mixing area	Min	34.3	25.6	35.6	28.6	54	0.5
		Max	35.2	26.2	36.3	29.2	56	0.8
		Avg	34.7	25.9	35.9	28.9	55	0.6
4	Casting area	Min	34.4	27.6	35.2	30.0	52	0.1
		Max	34.9	27.9	36.2	30.3	58	1.2
		Avg	34.6	27.7	35.7	30.1	55	0.6
5	Drying in the sun area	Min	36.2	28.0	37.0	30.7	57	0.6
		Max	36.8	28.4	37.5	30.9	61	1.5
		Avg	36.5	28.2	37.2	30.8	59	1.0

Table 2. Results of heat pressure research based on Permenakertrans number 13 in 2011

No	Measurement location	ISBB average (°C)	NAB (°C)	Workload	Description
1	Drain area	30.3	>NAB	Weight	Indoor
2.	Rating area	30.4	>NAB	Weight	Indoor
3.	Stirring area	28.9	<NAB	Light	Indoor
4.	Shaping area	30.1	>NAB	Medium	Indoor
5.	Drying area	30.8	>NAB	Weight	Outdoor

Table 3. Distribution of respondents based on precepts of heat pressure exposure

	Amount	Percentage (%)
Yes	117	74.5%
No	40	25.5%
Total	157	100.0%

Table 4. Distribution of respondents based on body temperature

	Amount	Percentage (%)
< 37.6°C	34	21.7%
≥ 37.6°C	123	78.3%
Total	157	100.0%

As shown in Table 5, the result of research at Brem industry in Kaliabu territory, Madiun, Indonesia, Respondent are 157 totally. 25 persons or 15.9 % are employees who have heartbeat 75 – 100 per minute. They get work in the light category. Employees who have a heartbeat 101 – 125 per minutes are 33 persons (2.0) with moderate job category. While 99 persons (63.1 %) their heartbeat are 126 – 150 per minute and getting a job in the heavy category.

Table 5. Distribution of respondents by pulse

Pulse	Workload Category	Amount	Percentage (%)
75 - 100	Light	25	15.9
101 - 125	Moderate	99	63.1
126 - 150	Heavy	33	21.0
151 - 176	Very Heavy	0	0
>176	Very Very heavy	0	0
Total		157	100.0%

So it can be concluded that the majority of the respondents have a heartbeat between 101 – 125 per minute and they get a job in the moderate category there are 99 respondents (63.1 %) and the average of employees heartbeat are 110 per minute. The research

result of the heat strain occurrence at Brem industry in Kaliabu territory, Madiun, Indonesia, can be seen on the next Table 6.

Table 6. Distribution of respondents with heat strain events

Heat strain level	Amount	Percentage (%)
No under heat strain	15	9.6%
Low category heat strain	134	85.4%
Medium category heat strain	8	5.1%
High category heat strain	0	0%
Very high category heat strain	0	0%
Total	157	100.0%

Showed in Table 6, The research result at Brem industry environment in Kaliabu, Madiun, 134 Respondents with low category heat strain are in majority (85.4%) from the amount of 157 persons. And 15 persons are respondents who do not suffer from heat strain (9.6%). Also, the respondent who has medium category heat strain is 8 persons (5.1%). The results of data analysis using AMOS 23 software obtained the following results in Figure 1.

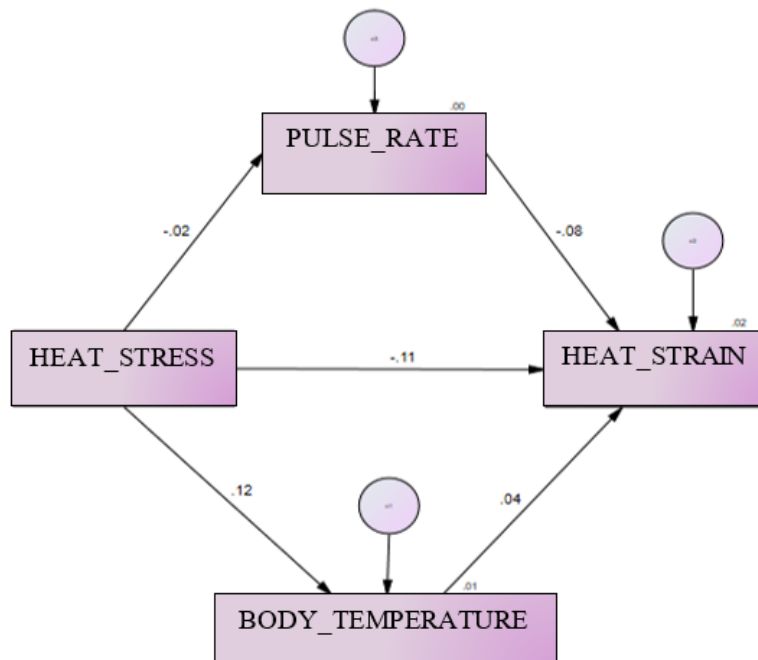|					
Chi-square	= 1.529	GFI	= .995	CFI	= .319
Probability	= .216	AGFI	= .951	RMSEA	= .058
CminDF	= 1.529	TLI	= -3,084	DF	= 1

Figure 1. Model path analysis

Analysis result on path analysis test, output regression weight describe the influence from the variable that to be observed. Data validity can be seen from the result of calculation statistic SPSS AMOS 23 on figure 1, show the value probability level model indicate furthermore 0.05. It shows the model can be considered fit of the data and results from GFI and AGFI have shown the number above 0.9 , indicating the model can be said fit (Santoso, 2018).

Based on Figure 1, chi-square, the output of measurement is 1.529, probability = 0.216, CminDF = 1.529, GFI = 0.995, AGFI = 0.951, TLI = -3.084, CFI = 0.319, RMSEA = 0.058 and DF = 1. Based on Figure 1, the Standardized regression of weight heat pressure values against the pulse of -0.02, heat pressure against body temperature 0.12, heat pressure against heat strain -0.011, pulse against heat strain -0.08, and body temperature against heat strain 0.04. Table 7 is regression weights and Table 8 is standardized regression weights.

Table 7. Regression weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
BODY_TEMPERATURE	<---	HEAT_STRESS	.112	.075	14.902	.013	
PULSE_RATE	<---	HEAT_STRESS	-.032	.111	-.290	.772	
HEAT_STRAIN	<---	HEAT_STRESS	-.099	.070	-1.423	.155	
HEAT_STRAIN	<---	PULSE_RATE	-.050	.050	-1.004	.315	
HEAT_STRAIN	<---	BODY_TEMPERATURE	.038	.074	5.101	.049	

Table 8. Standardized regression weights: (Group number 1 - Default model)

			Estimate
BODY_TEMPERATURE	<---	HEAT_STRESS	.118
PULSE_RATE	<---	HEAT_STRESS	-.023
HEAT_STRAIN	<---	HEAT_STRESS	-.114
HEAT_STRAIN	<---	PULSE_RATE	-.080
HEAT_STRAIN	<---	BODY_TEMPERATURE	.041

DISCUSSION

• Analysis of the effect of heat pressure on body temperature

Statistical test results using SPSS AMOS 23 showed that the result of calculation of Critical Ratio (C.R.) value is 14.902 > 1.96 and indicated by significance level of 0.013 below > α (0.05) which means there is a significant influence and an estimated standardized regression weight of 0.118 between heat pressures on the body temperature of workers in the Brem industry in Kaliabu Village, Madiun Regency in 2020. This means that workers with heat pressure are at 0.118 times greater risk of experiencing high temperatures than workers with heat pressure under NAB. The results of other studies are in line with research that found the presence of heat pressure that occurs in workers of PT Indocement Tunggal Prakarsa, Tbk. The results of sari research also showed a significant relationship with body temperature (Sari, 2017).

• Analysis of the effect of heat pressure on pulse

The results of statistical analysis of SPSS AMOS 23 showed that heat pressure has no effect on pulse rate with significance level of 0.772 above α (0.05) which means there is no significant influence and standardized regression weight negative value (-). All relationships, if any and real, are positive. This is because theory-based is unlikely to negatively affect (Santoso, 2018). This can be said to have no significant effect on the pulse of the increased heat pressure. The absence of an increase in the pulse of 25 respondents was influenced by workers' drinking habits and working period so that workers did not experience a physiological response that seemed because the workers had enough bodily fluids and had been very well-readied.

• Analysis of the effect of pulse on heat strain events

The results of statistical analysis of SPSS AMOS 23 showed that pulse rate has no effect on pulse with significance level of 0.315 above α (0.05) which means no significant influence and standardized regression weight negative value (-). All relationships, if any and real, are positive. This is because theory-based is unlikely to negatively affect (Santoso, 2018). This can be said that there is no significant influence on the incidence of heat strains. High workload, heart difficulty to meet all the demands needed. The result will be an increase in heart rate and body temperature as well as a decrease in muscle ability. Workload control that must be done to reduce the incidence of heat strains in workers in the Brem Industry, namely improvement of work position or automation of tools can reduce metabolic heat produced by the body (Berry et al., 2011).

• Analysis of the effect of body temperature on heat strain events

Statistical test results using SPSS AMOS 23 showed that the result of calculation of Critical Ratio (C.R.) value is 5,101 > 1.96 and indicated by the significance level of 0.049 below α (0.05) which means there is a significant influence indicated by the level of significance below the value of α (0.05) and the standardized regression weight estimate value of 0.041 between body temperature to heat strain workers in the Brem industry in Kaliabu Village, Madiun district in 2020. This means that workers with abnormal body temperatures (above 36.5°C) have a 0.041 times greater risk of heat straining than workers with normal body temperatures. The high workload makes the metabolism of the worker's body increase, as well as the body's heat is increased because of the metabolism process (Hunt, 2011). Since the body always maintains its body temperature to stay within normal limits, the amount of heat generated with which it is emitted must remain balanced. To balance the temperature, some of the body's heat must come out through sweat. But the process of heat exiting through sweat is still influenced by the temperature of the surrounding environment. Because the body's heat temperature flows towards a colder environment, the presence of a hotter environment than the body can interfere with the process of transferring heat from the inside out of the body, this can trigger the occurrence of heat strains (Suma'mur, 2009).

• Analysis of the effect of heat pressure on heat strain events

The results of statistical analysis of SPSS AMOS 23 showed that heat pressure has no direct effect on heat strain with a significance level of 0.115 above α (0.05) which means there is no significant influence and standardized regression weight negative value (-). All Relationships, if any and real, are positive. This is because theory-based is unlikely to negatively affect (Santoso, 2018). But under the influence of multivariate models, heat pressure affects indirectly directly on heat strains, through variables between body temperatures. In the measurement of heat environment that exceeds body temperature, it occurs in some Brem Industries in Kaliabu Village. Measurement results of 5 location points showed quite high results. Where the average ISBB factory work environment tofu reaches 30.1°C. The temperature already exceeds NAB Permenaker for the category of medium and heavy workloads. Many workers complain of heat pressure. When the heat pressure is close to the limit of tolerance the body's risk of rising body temperature will also cause health disorders such as dizziness, fatigue and increased (heat strain). This is in line with research conducted by (Istiqomah and Nawawinetu, 2013) which states that heat pressure does not effect the occurrence of heat strains. This is likely due to the distribution of the working climate which shows the results of almost all respondents working in the working climate > NAB (84.6%) (Sunaryo and Sahri, 2019).

CONCLUSION

The results of statistical analysis of SPSS AMOS 23 based on the precepts of industrial workers Brem Kaliabu showed that heat pressure does not directly affect heat strains, but affects through variables between body temperature. As for the heat pressure of industrial workers Brem Kaliabu Madiun district does not effect on the pulse of workers. Therefore, it can be concluded that to reduce the incidence of heat strains of the Brem industry in Kaliabu Subdistrict, Madiun district must ensure that workers' body temperature remains normal with improved layout, air ventilation, and proper work shifts to maintain environmental temperature and workers' body temperature (Sunaryo and Sahri, 2019).

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