



## Study of Reliability of PC-PVT 2.0 on Sex and Sleep Duration Restrictions Factors

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### Abstract

**Background.** There are two million workers in Indonesia who died from work accidents caused by fatigue. Fatigue is a contributing factor to accidents, injuries, and deaths. The differences between men and women hinder the relationship between fatigue and gender. On average, women work less hours than men.

**Aim.** Lack of sleep, increased alertness, and longer duration of work can increase a person's fatigue. Someone who experiences sleepiness and fatigue has a strong relationship with decreased alertness. One of the measuring tools used for the evaluation of human awareness is the Psychomotor Vigilance Task (PVT). So the aim of this study is to determine the reliability level of PC-PVT 2.0 on gender and limited sleep duration factors

**Methods.** This study uses Personal Computer (PC) - PVT 2.0 as a tool with three parameters: mean reaction time (RT), minor lapses, and number of false starts as indicators of alertness. The PC-PVT 2.0 tool has not been tested for its reliability in measuring the level of alertness when it is under the influence of sex differences and limited sleep duration. This study involved sixteen participants (eight men and eight women with a mean age of  $21.375 \pm 1.087$ ) to test PC-PVT 2.0 for 10 minutes with two tests for each treatment. During the PC-PVT 2.0 test, each participant's heart rate data was recorded using the Mi Band 2. Each participant received two treatments, sleep for 4 hours and 8 hours with two repetitions (test-retest). PC-PVT 2.0 testing on the effect of gender and limited sleep duration used two methods: Multivariate Analysis of Variance (MANOVA) and Analysis of Variance (ANOVA). In determining the reliability value, the Intraclass Correlation Coefficient (ICC) method is used with a two-way mixed effect model, definitions of absolute agreement & consistency, and multiple measurement types.

**Result.** ANOVA and MANOVA test results showed that the three parameters of PC-PVT 2.0 affected the differences in sleep treatment conditions, namely lack of sleep (4 hours) and sufficient sleep (8 hours). However, the PC-PVT 2.0 parameter, which had an effect on gender differences, was only valid for the mean RT and minor lapses parameters. The reliability test results showed that the mean RT parameter had an ICC value of  $> 0.8$  for all test categories (male, female, lack of sleep and sufficient sleep) with a good reliability rating category. The minor lapses parameter has an ICC value of  $> 0.7$  for all test categories with sufficient reliability rating categories.

**Conclusion.** This shows that the PC-PVT 2.0 device with the alertness indicator of the mean RT and minor lapse parameters has a high level of reliability when it is under the influence of sex differences and limited sleep duration.

**Implementation.** PC-PVT 2.0 is reliable on Sex and Sleep Duration Restrictions Factors

**Keywords:** gender, PC-PVT 2.0, intraclass correlation coefficient (ICC), multivariate analysis of variance (MANOVA), analysis of variance (ANOVA)

## **INTRODUCTION**

According to Markkanen (2004) there are two million workers in Indonesia died due to work accidents caused by fatigue factors. As a result of work accidents that occur in addition to casualties, the cost of the Indonesian economy is 3.94% of global gross domestic product (GDP) (ILO, 2018). Fatigue is a factor that contributes to accidents, injuries and deaths because people who are tired give a bad performance and unsafe actions on their job (Williamson et al., 2011). Williamson et al. (2011) stated that a person's inability to work optimally all the time is caused by being compressed by three factors, time of day (circadian rhythm), time's awake (duration of alertness) and task-related factors (duration and work load).

According to Di Milia et al. (2011) the relationship between gender and fatigue is hindered by differences between men and women in the type of work performed, the level of supervision and the level of training to carry out the task of a job. On average, the total working hours of women is lower than that of men because women avoid jobs that require a lot of times at night or overtime as well as work that takes up time on weekends (Presser, Gornick, & Parashar, 2008). In addition, Di Milia et al. (2011) stated that it is easier for women to recognize and acknowledge feelings of fatigue than men.

Based on research reviewed by Williamson et al. (2011), fatigue is a biological urge for each individual to rest. Fatigue can be identified in a person when drowsiness begins (Di Milia et al., 2011). Dorrian, Baulk, and Dawson (2011) stated that lack of sleep, increased alertness and a longer duration of work can increase fatigue. When a person sleeps less than 5 hours in the last 24 hours before working, it can increase fatigue and lead to errors in the workplace (Dorrian et al., 2011). In order to reduce the level of fatigue for each individual to minimize accidents, especially at work, every worker needs an ideal sleep time. According to Hirshkowitz et al. (2015) healthy individuals have a normal sleep duration, namely for adolescents (18-25 years) 8-10 hours, adults (26-64 years) are 7-9 hours, for older people (over 65 years) it is 7-8 hour.

According to Dinges (2004) decreased alertness has a close relationship with sleepiness and fatigue. One of the ways to evaluate one's vigilance is the Psychomotor Vigilance Task (PVT) measurement tool. This vigilance evaluation can be used to determine whether a person is allowed to work and can work in safe conditions to avoid the possibility of work accidents that

may occur. According to Balkin et al. (2004) PVP is the most sensitive tool in the assessment of job performance due to sleepiness, the most reliable and is a simple tool to use. This study uses a type of PVP that has been developed using a Personal Computer (PC).

Reifman et al. (2018) has developed PC-PVT 2.0 which is the latest generation of PC-PVT 1.0 with the advantages of software that is more accurate and precise in the RT measurement process. PC-PVT 2.0 has several parameters as an indicator of alertness, but in this study three parameters were used, namely minor lapses, mean reaction time (RT) and number of false starts. The three parameters have been declared sensitive to the testing process for someone who experiences sleep deprivation (Basner & Dinges, 2011).

Research conducted by Reifman et al. (2018) only conducted PC-PVT 2.0 testing in measuring the level of awareness of the effects of sleep deprivation that affect a person's performance, regardless of gender. Research conducted by Blatter et al. (2006) have proven that the PVT-192 device can show differences in RT results and the number of false starts between men and women. In addition, the research of Beijamini, Silva, Peixoto, and Louzada et al. (2008) have conducted tests on the Palm PVT measuring instrument and found that men have a faster reaction time than women. The purpose of this study was to test the reliability of the PC-PVT 2.0 tool in measuring the level of alertness of a person with the assessment indicators used were the mean RT, number of false start and minor lapses parameters on the effect of gender differences (male and female) and limited sleep duration. (4 hours and 8 hours). Based on the discussion that has been done, the formulation of the research problem can be formed, namely what is the reliability of PC-PVT 2.0 in measuring the level of alertness when under the influence of gender and limited sleep duration?

In testing the effect of gender and limited sleep duration on the three parameters of PC-PVT 2.0, two statistical methods were used, namely Multivariate Analysis of Variance (MANOVA) and Analysis of Variance (ANOVA). To determine the level of reliability of the PC-PVT 2.0 measuring instrument based on the three predetermined parameters, the Intraclass Correlation Coefficient (ICC) method was used. ICC is a method that capable of measuring reliability and showing the level of correlation and agreement in a measurement (Koo & Li, 2016).

## METHODS

### Participant

This study used two independent variables, namely gender and restricted sleep duration. The experimental design used was mixed design because for the gender variable used the between subject experimental design and for the limited sleep duration variable used the within subject experimental design. The research experiment design can be seen in Table 1.

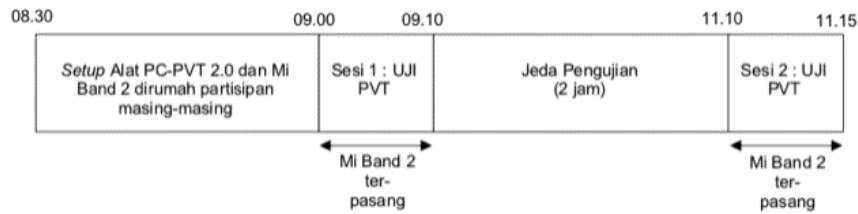
**Table 1.** Research experiment design

		Gender	
		Man	Woman
Sleep Duration	4 hour	P1,P2,.....,P8	P1,P2,.....,P8
	8 hour	P1,P2,.....,P8	P1,P2,.....,P8

The calculation of the number of participants is carried out by considering the number of minimum ICC values and the number of observations made on participants. Based on the calculation results, a minimum of 15 people is required. Therefore, it can be seen in Table 1 that it has been determined that the number of participants in this study was 16 people consisting of 8 men and 8 women. Each participant will receive two treatments, namely lack of sleep (4 hours) and sufficient sleep (8 hours) with two repetitions (test-retest). Participants involved have an age range of 19-23 years because according to Blatter et al. (2006) the results of RT measurements obtained are more ideal.

### The Procedure

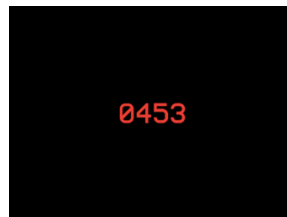
Participants were asked to sleep at 22.00 WIB for the 8 hours treatment and 02.00 WIB for the 4 hours treatment, the day before the study was carried out. Participants are asked to prepare the tools needed during the research in their respective homes, namely PC-PVT 2.0, Mi Band 2, laptops, gaming mice and cellphones. Participants will do PC-PVT 2.0 testing with a duration of 10 minutes for two sessions. There is a time lag between the first testing session and the second testing session for 2 hours. During this testing break, the participants' activities are monitored to avoid the presence of confounding variables. During the PC-PVT 2.0 testing, participants were asked to wear the Mi Band 2 watch as a tool for recording heart rate data. The research timeline can be seen in Figure 1.



**Figure 1** Research timeline

**Tools**

In testing a person's alertness level, this study uses the PC-PVT 2.0 tool. This awareness level testing tool is formed on a PC basis based on the PVT-192 (gold standard) testing tool. PC-PVT is developed as well as possible so that reaction time (RT) measurements can be carried out on all kinds of computer devices and provide precise and accurate test results such as a gold standard alertness level testing tool (Reifman et al., 2018).



**Figure 2** PC-PVT 2.0 illustration  
(Reference: PC-PVT *User's Guide*)

During the study, participants' sleep hours will be recorded using the Mi Band 2 with the Mi Fit application. This is for determine the sleep duration the participants get each night. In addition, the results of the sleep duration recordings obtained were used to measure the quality of the participants' sleep each night. The data on the sleep quality of the participants were used as the study covariate variable. According to Salkind (2010) the existence of covariate variables often interferes with research results because they can interact with the independent variable and destroy the influence of the independent variable on the dependent variable. In this study, the sleep quality variable has a close relationship with the sleep duration variable. To find out whether the existence of sleep quality variables can affect the results of the study or not, the Multivariate Analysis of Covariance (MANCOVA) and Analysis of Covariance (ANCOVA) statistical methods are used.



**Figure 3** Mi Band 2 Watch

During the PC-PVT 2.0 test, participants' heart rate data will be recorded using the Mi Band 2 device with the Mi Heart Rate application. The heart rate data obtained in this study are used as supporting data because, according to Chua et al. (2012), heart rate data correlates with a person's performance while doing PVT testing and under sleep deprivation conditions. The Pearson correlation test was used to determine whether there was a correlation between the heart rate data and the three predetermined parameters of PC-PVT 2.0.

## **ABOUT THE DATA**

### ***Psychomotor Vigilance Task (PVT)***

The PC-PVT 2.0 test results data for 10 minutes will be processed based on three predetermined parameters, namely minor lapses, mean RT, and number of false starts. Minor lapses are the number of responses a person gives to a stimulus but has a reaction time of more than 500 milliseconds. Mean RT is the average reaction time a person gives in response to a stimulus. The number of false starts is the number of responses a person gives without a stimulus in a reaction time of less than 100 milliseconds. In this study, the value of % minor lapses and the number of false starts was used to compare the measurement results between participants. The PC-PVT 2.0 data used in the statistical test is the average result of the first and second session testing. Then, the PC-PVT 2.0 data that has been obtained will be divided into three parts, namely the test results for the initial 2 minutes, initial 5 minutes, and 10 minutes. All of these data are used as supporting data to prove the sensitivity level of the PC-PVT 2.0 test with a duration of 10 minutes compared to the test duration of 5 minutes and 2 minutes.

### ***Heart Rate (HR)***

The HR data used in this study were the results of the average HR for 10 minutes obtained from the two testing sessions in beats per minute (bpm).

### ***Sleep Quality***

The results of sleep duration recordings that have been carried out using the Sleep Monitor application can be processed to produce sleep quality data. To determine the sleep quality of each participant can be done by calculating sleep efficiency using Eq. 1 and Eq. 2 (Reed & Sacco, 2016).

$$SE = \frac{TST}{DSE} \times 100 \tag{Eq. 1}$$

$$DSE = SOL + TST + WASO + TASAFA \tag{Eq. 2}$$

with explanation :

SE = *Sleep Efficiency* presented in percentage (%)

TST = *Total Sleep Time*

DSE = *Duration of the Sleep Episode*

SOL = *Sleep Onset Latency*

WASO = *Time Awake After Initial Sleep Onset but before final awakening*

TASAFA = *Time Attempting to Sleep After the Final Awakening*

TST, DSE, SOL, WASO, and TASAFA scores were presented in minutes.

## RESULT

### MANOVA and ANOVA Methods

The MANOVA test was used to determine whether the three parameters as indicators of alertness from the PC-PVT 2.0 measuring instrument affected gender and sleep duration simultaneously. However, the conclusions obtained from the MANOVA test results need to be reaffirmed by ANOVA testing. This is necessary because the simultaneous test results cannot see the effect of the independent variable on each dependent variable of the study specifically.

The results of the MANOVA

test can be seen in Table 2. The results of the ANOVA test can be seen in Table 3.

**Table 2.** Recapitulation of MANOVA test result

Factor	Test		Retest	
	F (4,11)	Sig.	F (4,11)	Sig.
Sleep Duration	16,525	0,000	32,014	0,000
Gender	12,338	0,000	11,936	0,001
Sleep Duration * Gender	2,591	0,095	3,242	0,055

### The Result of *Intraclass Correlation Coefficient (ICC)*

Reliability is one of the research techniques used to assess accuracy on a measurement scale (Bannigan & Watson, 2009). In this study, testing the reliability of the measuring instrument used the ICC method. The ICC method used in this study uses a two-way mixed effects model, definitions of absolute agreement & consistency and multiple measurement types. The ICC value used in processing is the average measure value. The results of the ICC value interpretation obtained from the calculation results can be seen in Table 4. The interpretation results can be used as an assessment of the reliability of a measuring instrument. The results of the ICC test that have been carried out can be seen in Table 5.

**Table 3.** Recapitulation of ANOVA test result based on gender and sleep duration factors

Factors	Mean RT		% Lapses		% FS		HR	
	F (1,14)	Sig.	F (1,14)	Sig.	F(1,14)	Sig.	F (1,14)	Sig.
Test Data								
Sleep Duration	72,558	0,000	40,973	0,000	7,306	0,017	0,025	0,876
Gender	27,294	0,000	11,692	0,004	1,272	0,278	0,652	0,652
Sleep Duration * Gender	1,841	0,196	0,009	0,924	0,064	0,804	10,798	0,005
Retest Data								
Sleep Duration	51,494	0,000	111,624	0,000	7,082	0,019	0,110	0,110
Gender	30,830	0,000	35,347	0,000	0,224	0,224	0,526	0,526
Sleep Duration * Gender	1,006	0,333	4,271	0,058	0,002	0,966	0,364	0,364

**Table 4.** The interpretation of ICC Score

Score	Interpretation
<0,5	Poor
0,5-0,75	Moderate
0,75-0,9	Good
>0,9	Excellent

(Reference: Koo & Li,2016)

**Table 5.** Recapitulation of ICC test result

Parameter	Category	ICC Score	Lower Bound	Upper Bound	Interpretation
Absolute Agreement					
Mean RT	Man	0,896	0,707	0,964	Moderate - Excellent
	Woman	0,933	0,812	0,976	Good - Excellent
	Lack of Sleep	0,869	0,623	0,954	Moderate - Excellent
	Sufficient Sleep	0,944	0,842	0,980	Good - Excellent
% Lapses	Man	0,896	0,698	0,964	Moderate - Excellent

**Table 5.** Recapitulation of ICC test result

Parameter	Category	ICC Score	Lower Bound	Upper Bound	Interpretation
% Lapses	Woman	0,873	0,623	0,956	Moderate - Excellent
	Lack of Sleep	0,716	0,223	0,899	Poor - Good
	Sufficient Sleep	0,960	0,890	0,986	Good - Excellent
% FS	Man	0,648	-0,021	0,879	Poor - Excellent
	Woman	0,721	-0,211	0,923	Poor - Excellent
<i>Consistency</i>					

Mean RT	Man	0,893	0,695	0,963	Moderate – Excellent
	Woman	0,934	0,810	0,977	Good – Excellent
	Lack of Sleep	0,863	0,607	0,952	Moderate – Excellent
	Sufficient Sleep	0,948	0,852	0,982	Poor - Excellent
% Lapses	Man	0,890	0,685	0,961	Moderate – Excellent
	Woman	0,891	0,689	0,962	Moderate – Excellent
	Lack of Sleep	0,724	0,211	0,904	Poor - Excellent
	Sufficient Sleep	0,961	0,888	0,986	Poor - Excellent
% FS	Lack of Sleep	0,742	0,261	0,910	Poor - Excellent
	Sufficient Sleep	0,878	0,652	0,958	Moderate – Excellent

**MANCOVA and ANCOVA Methods**

The MANCOVA test was conducted to determine the effect of the independent variable on the dependent variable simultaneously after controlling for the effect of the covariate variable. ANCOVA testing is carried out to strengthen the conclusions that have been obtained from the results of the MANCOVA test because it can be seen that the effect of the covariate variable on each dependent variable is more specific. The MANCOVA test results can be seen in Table 6. The ANCOVA test results can be seen in Table 7.

**Table 6.** Recapitulation of MANCOVA test result

Factor	Sleep Duration			
	4 hour		8 hour	
	F(4,10)	Sig.	F(4,10)	Sig.
Sleep Quality	0,973	0,464	0,871	0,514
Gender	4,836	0,020	7,350	0,005

**Table 7.** Recapitulation of ANCOVA test result

Factor	Mean RT		% Lapses		% FS		HR	
	F (1,13)	Sig.	F (1,13)	Sig.	F (1,13)	Sig.	F (1,13)	Sig.
4 hour Sleep								
Sleep Quality	0,009	0,924	0,635	0,440	0,019	0,893	2,201	0,162
Gender	15,206	0,002	6,416	0,025	0,838	0,377	0,864	0,369
8 hour sleep								
Sleep Quality	0,463	0,508	0,141	0,713	0,410	0,533	0,497	0,493
Gender	12,559	0,004	5,410	0,037	1,168	0,299	0,577	0,461

**Table 8.** Recapitulation of ANOVA test result based on sleep duration and time on task

10 Menit - 5 Menit Awal						
	Mean RT		% Lapses		% FS	
Factor	F (1,15)	Sig.	F (1,15)	Sig.	F (1,15)	Sig.
Sleep Duration	62,780	0,000	74,095	0,000	6,370	0,023
Time on Task	81,281	0,000	28,375	0,000	50,303	0,000
Sleep Duration * Time on Task	1,361	0,262	9,524	0,008	2,710	0,120
10 Menit - 2 Menit Awal						
	Mean RT		% Lapses		% FS	
Factor	F (1,15)	Sig.	F (1,15)	Sig.	F (1,15)	Sig.
Sleep Duration	64,734	0,000	63,274	0,000	13,004	0,003
Time on Task	122,965	0,000	57,337	0,000	229,896	0,000
Sleep Duration * Time on Task	1,848	0,194	22,780	0,000	1,764	0,204

**ANOVA Methods for Sensitivity of PC-PVT 2.0 of 10 Minute Duration Test**

This ANOVA test was conducted to determine whether the PC-PVT 2.0 test with a duration of 10 minutes had a high level of sensitivity in detecting a decrease in a person's alertness which was affected by lack of sleep. This test is done by comparing the results of the PC-PVT 2.0 test for 10 minutes with the test results for the initial 5 minutes and the initial 2 minutes. ANOVA test results can be seen in Table 8.

**Pearson Correlation Methods**

Pearson's correlation test was conducted to determine whether HR data had a correlation with the PC-PVT 2.0 test results based on each of the predetermined parameters, namely mean RT, minor lapses and number of false starts. The correlation value from the calculation results consists of two types, namely positive and negative correlation. Positive correlation is when the first variable has a large value, the second variable also has a greater value (unidirectional). Negative correlation is when the first variable has a large value but the second variable has a smaller value (in the opposite direction). The determination of the interpretation of the correlation value can be seen in Table 9.

**Table 9.** Interpretation of correlation score

Correlation Score	Interpretation
< 0,20	None of relationship
0,20 – 0,40	Relationship exists but are low
> 0,40 – 0,70	Moderate Relationship
> 0,70 – 0,90	Good Relationship
> 0,90 – 1,00	Excellent Relationship

(Reference: Sarwono, 2006)

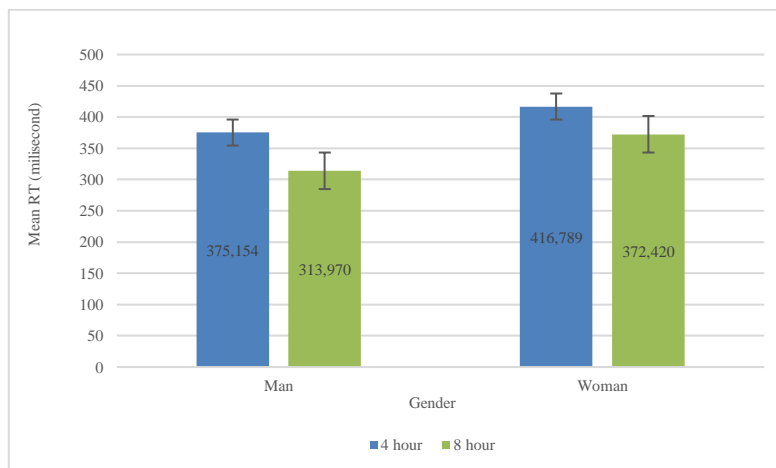
The result of Pearson correlation test can be seen in Table 10.

**Table 10.** Recapitulation of correlation test result

Parameter PC-PVT 2.0	Correlation Score	Interpretation	Kind of Relationship
Mean RT	0,168	None of Relationship	Positive
% Minor Lapses	0,113		
% FS	0,130		

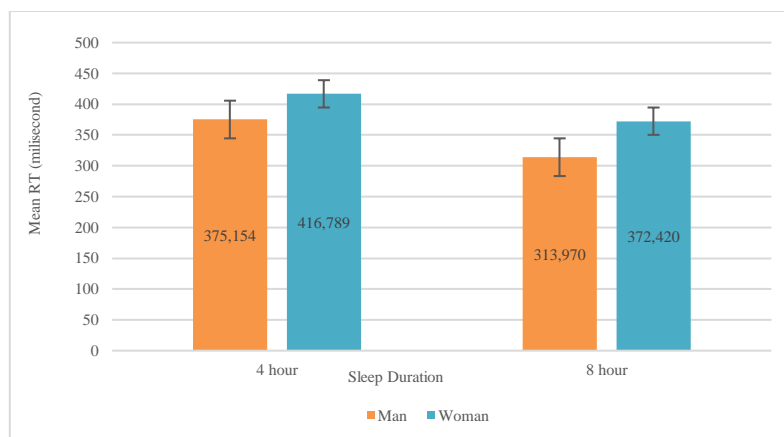
**RESULT**

Based on the results of the MANOVA and ANOVA tests that have been carried out, it is known that the three parameters of PC-PVT 2.0 affect the limited sleep duration factor. However, the parameters that affect the sex factor only apply to the mean RT and minor lapses parameters. Apart from being based on inference statistical tests, conclusions are also based on descriptive statistical data processing. One of the results of data processing using descriptive statistics that will be presented is the mean RT parameter. The results of the average of overall mean RT based on sleep duration factors can be seen in Figure 4.



**Figure 4** Average of mean RT in global based on sleep duration

Figure 4 shows that the test, carried out in a sleep deprived condition, resulted in a slower mean RT rate when compared to a well-slept condition for both men and women participants. Next, the results of the mean RT average based on gender are presented, which can be seen in Figure 5.



**Figure 5** Average of mean RT in global based on gender

Figure 5 shows that men have an average reaction time faster than women in conditions of less and enough sleep. The results of descriptive statistical data processing have proven that the previous MANOVA and ANOVA test results were valid.

Testing the reliability of the PC-PVT 2.0 measuring instrument based on three predetermined parameters, was carried out based on the results of the MANOVA and ANOVA tests. The reliability test for gender category was only performed for the minor lapses and the mean RT parameters. To test the reliability of the sleep duration category, it was carried out for the three predetermined parameters. Based on the test results, it is known that the mean RT and minor lapses parameters have high reliability for the gender and sleep duration testing categories. Overall, the ICC value obtained from the mean RT parameter was  $> 0.8$  for all test categories while the minor lapses parameter was  $> 0.7$  for all test categories. However, the number of false start parameter has poor reliability because it is considered from the lower bond value result. Most of the lower bond values generated have negative values or are in the category of poor reliability ratings.

The results of the MANCOVA and ANCOVA tests carried out have proven that the existence of sleep quality variables as a covariate does not affect the results of the study. From the comparisons that have been made between the results of the MANCOVA and ANCOVA tests with MANOVA and ANOVA, it can be seen that there is no difference in conclusions obtained from the results of the manipulations carried out by the independent variables on the dependent variable of the study.

Based on the results of statistical inference (ANOVA) and descriptive testing, it can be seen that the test duration of 10 minutes proved to be sensitive when used in a sleep deprived condition compared to the duration of the test for 2 minutes and 5 minutes. This is in accordance with the statement of Loh, Lamond, Dorrian, Roach, and Dawson (2004) which states that the less time testing is given to a person, the less sensitive the device is to detect the effect of sleep deprivation on one's performance. Then Loh et al. (2004) also stated that PVT testing of less than 10 minutes could not detect any additional lapses sensitively. This happens because a person cannot show their best performance with a short duration of testing so that the results of the research carried out can be biased or less valid.

The results of the correlation test produced in this study contradict research conducted by Chua et al. (2012) stated that HR data has a correlation with the results of PVT testing. This incident was caused by three factors, have limited tools available in measuring HR, the data used in correlation testing was not the result of data transformation and research conducted by Chua et al. (2012) only tested one of the parameters of PVT, namely lapses, so there was not enough evidence that HR data had a correlation value with the results of the PVT test for the mean RT and number of false start parameters.

## **CONCLUSION**

Based on the results of data processing and analysis, the following conclusions can be drawn:

1. The three PC-PVT 2.0 parameters that have been determined have an effect on the limited sleep duration factor because based on the results of the Multivariate Analysis of Variance (MANOVA) and Analysis of Variance (ANOVA) test results, there is a significant average difference between the results of the tests of lack of sleep and sufficient sleep conditions. However, the PC-PVT 2.0 parameter which affects the gender factor only applies to the mean RT and minor lapses parameters because based on the ANOVA test results, the number of false start parameter cannot distinguish the average value between the test results conducted by men and women.
2. PC-PVT 2.0 has high reliability to measure the level of alertness when under the influence of sex and sleep duration is limited based on the alertness indicators mean RT and minor lapses.
3. The mean RT parameter has a high reliability because the overall ICC value obtained is > 0.8. The ICC value obtained was based on absolute agreement for the men category 0.896

[95% Confidence Interval (CI) = 0.707-0.964], for the woman category 0.933 [95% CI = 0.812-0.976], for the category of lack of sleep 0.869 [95% CI = 0.623-0.954 ] and for sufficient sleep category 0.944 [95% CI = 0.842-0.98] while the ICC value based on the consistency for men category 0.893 [95% CI = 0.695-0.963], for the women category 0.934 [95% CI = 0.81-0.977 ], for sleep deprivation category 0.863 [95% CI = 0.607-0.952] and for sufficient sleep category 0.948 [95% CI = 0.852-0.982].

4. The minor lapses parameter has high reliability because the overall ICC value obtained is > 0.7. The ICC value obtained was based on an absolute agreement for the men category 0.896 [95% CI = 0.698-0.964], for the woman category 0.873 [95% CI = 0.623-0.956], for the sleep deprivation category 0.716 [95% CI = 0.223-0.899] and for the sufficient sleep category 0.960 [95% CI = 0.89-0.986] while the ICC value based on the consistency for men category 0.89 [95% CI = 0.685-0.961], for the woman category 0.891 [95% CI = 0.689-0.962], for the lack of sleep category 0.724 [95% CI = 0.211-0.904] and for the sufficient sleep category 0.961 [95% CI = 0.888-0.986].
5. The number of false start parameter has a poor level of reliability based on the overall assessment (ICC and lower bound values) for the category of lack of sleep and sufficient sleep.

## RECOMMENDATION

Some constructive suggestions for the overall research are as follows:

1. Research related to measuring heart rate data should use the Fitbit, Garmin and others, which have a better sensitivity level for measuring human heart rates.
2. Testing the level of reliability of PC-PVT 2.0 parameters and its effect on gender for the age range > 50 years (parents). This is in accordance with the research of Blatter et al. (2006) which states that there is a difference in reaction time between adolescent participants and parents, so it is possible that the level of reliability of PC-PVT 2.0 and the effect of gender on parents has differences in results with adolescents.

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