The Effect of Sunlight (Ultraviolet) Exposure & Vitamin D Intake Deficiency towards the Increase of Systolic Blood Pressure

Dessy Hermawan, Wahyu Dani Purwanto, Achmad Farich

Abstract—Hypertension is one of common diseases found on worker, especially night shift worker, such as doctors and nurses. This disease possibly happens on under roof worker like in the office or indoors. This fact was derived from the finding of Qureshi et al in 2009 stating that 20% nurses in US suffering hypertension. Recently, there are some investigations about the correlation between lack of vitamin D content in the blood and hypertension. These lead the researchers' interest in studying the correlation among sunlight exposure and vitamin D intake deficiencies towards hypertension. This study was an experiment in which the subjects were *Rattus norvegicus*. They were investigated to reveal the impact of sunlight omission, vitamin D reduction and hypertension. The subjects were placed in a dark cage and fed with free vitamin D food. On the following days, the subjects were moved in the bright room and supplied with vitamin D 0.25µg/kg body weight. **T**he absence of sunlight by situating the subjects in the dark area and supplying non vitamin D food affected the rise of systolic blood pressure significantly ($p = 0.01$). The decline of vitamin D content in the blood happened after the gradual omission of vitamin D along seven days ($p = 0.035$). The relocation of the cage to the rich sunlight room together with feeding the subjects 0.25µg/kg body weight vitamin D influenced the increase of vitamin D content in the blood since the first day of reposition. However, the significant decline of systolic pressure and noteworthy vitamin D increase ($p = 0.001$) happened after four day vitamin D supply. **T**he sunlight (ultraviolet) exposure and vitamin D intake is influencing towards the increase of vitamin D content and decline of systolic blood pressure on *Rattus norvegicus*.

Index Terms— ultraviolet, vitamin D and hypertension

1 Introduction

ypertension is a health problem that affects 30% of the adult Hpopulation in the United States" [1]", and the number of cases tends to increase. Hypertension is found in many workers, especially night shift workers, such as doctors and nurses. The disease is also found in workers who always were in indoor room/closed building. "[2]" stated that 20% of nurses in the U.S. suffering hypertension.

This condition is suspected relating to low levels of vitamin D in the blood of the workers, because they are less exposed to sunlight (ultraviolet). The data show nearly one third of Americans suffering vitamin D lack in the blood "[3]". The habit that tend to avoid sun, such as the use of an umbrella, use sunscreen lotion, use a long shirt and always indulge in the building might play a role in increasing vitamin D deficiency in the blood. This happens because the body with less sunlight exposure is difficult to have optimal vitamin D biosynthesis in the skin "[4]".

Recently, many studies have reported an association between vitamin D levels in the blood with blood pressure "[5-8]". This is possible to occur due to the secretion of rennin in the renin-angiotensin-aldosterone system seems to be connected with low levels of vitamin D in the blood. "[8]" reported that animals possessed with vitamin D could decrease the production of rennin by directly reducing rennin production in the kidney, however, it's mechanism has not been explained certainly. They suspect that vitamin D directly suppresses gene that encoding rennin, rennin that is not produced in sufficient quantities. If renin is produced less, then there would not be enough material to activate the renin-angiotensin - aldosterone, the final impact is blood pressure increase.

This condition is interesting and still raises many questions. If the correct levels of vitamin D are associated with increased blood pressure, then it should be in tropical regions such as Indonesia will lower the incidence of hypertension, but in reality the incidence of hypertension was reported quite high. In 2007 it was reported prevalence of 17-22% and increased to 32.2% in 2009 "[9]". This has attracted researchers to investigate further the effects of sunlight lack to decreased levels of vitamin D and increased blood pressure.

2 Materials and Methods

This study is an experimental research using experimental animals (Rattus norvegicus) to examine the effect of the removal of sun exposure, blood vitamin D level decrease and the incidence of hypertension. The subjects were situated in a dark cage and fed with free-vitamin D in a few days and then moved into a lighted cage, then fed by vitamin D. The subjects in this study were white male rats (Rattus norvegicus) aged 8 weeks which were obtained from laboratorium penelitian & pengujian terpadu Gadjah Mada University (UGM LPPT) Yogyakarta. Maintenance and

- *Dessy Hermawan is currently lecturer in nursing program in Medical Faculty in Malahayati University, Indonesia, PH-628154021525. E-mail: hermawan_dessy@yahoo.co.id*
- *Wahyu Dhani Purwanto is currently lecturer in Medical Faculty in Malahayati University, Indonesia, PH-6281957012500. E-mail: wahyudhani@yahoo.com*
- *Achmad Farich is currently lecturer in Public Health Faculty in Malahayati University, Indonesia, PH-62856707070. E-mail:farichrich@yahoo.co.id*

treatment as well as systolic blood pressure measurements performed in the animal laboratory PAU UGM. They were divided into 5 groups and treated according to the research scheme below:

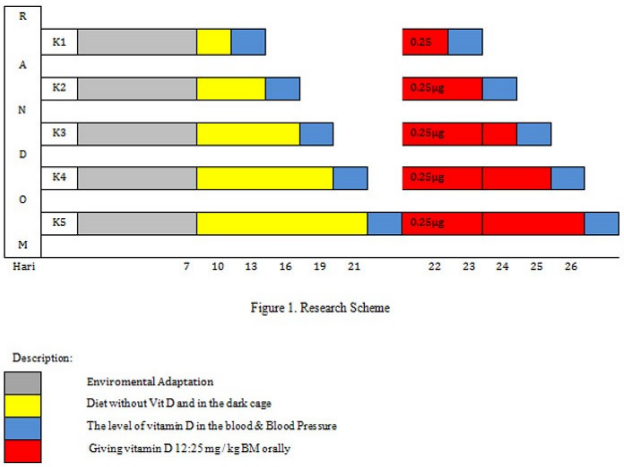

Figure 1. Research Scheme

Description:

Enviromental Adaptation
Diet without Vit D and in the dark cage
The level of vitamin D in the blood & Blood Pressure
Giving vitamin D 12:25 mg / kg BM orally

3. Result

Once the subject was placed in a dark cage and fed without vitamin D, the average levels of 1,25 (OH) 2 D3 blood seen in figure 2 below:

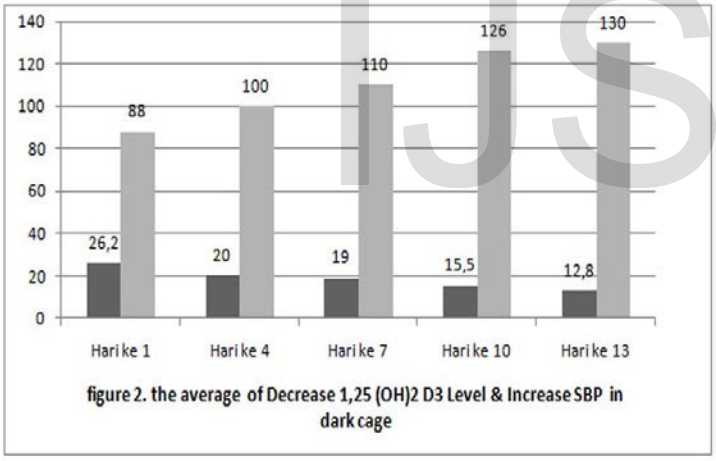

figure 2. the average of Decrease 1,25 (OH)2 D3 Level & Increase SBP in dark cage

In figure 2, it showed that from day to day there was a decrease in the levels of 1,25 (OH) 2 D3 blood. On the first day of the removal of vitamin D intake of 1,25 (OH) 2 D3 from 26.2 µgr becoming 12.8 µgr on the 13th day of the removal of vitamin D intake. On the other hand, it seemed to have an increase in systolic blood pressure of experimental animals. On the first day of the removal of vitamin D intake, systolic blood pressure was 88 mm Hg and increased to 130 mmHg after the 13th day of removal. Decreased levels of vitamin D in the blood and an increase in SBP occurs significantly since the fourth day in a dark cage, but it would look very significant after seven days in a dark cage (p: 0.001)

If the data of decreased 1,25 (OH) 2 D3 was correlated with the increase of blood pressure, it will be presented on Figure 3

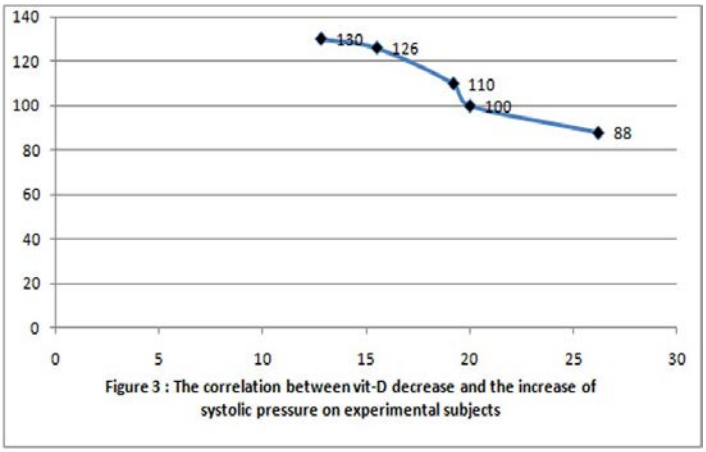

Figure 3 : The correlation between vit-D decrease and the increase of systolic pressure on experimental subjects

In figure 3 it presents that the lower level of 1,25 (OH) 2 D3 the higher systolic blood pressure of experimental animals. By using the correlation test, it is showed that there was significant correlation between the levels of 1,25 (OH) 2 D3 with an increase in blood pressure with p: 0.007. The significance level is also very close correlation with the value of r: 0.97.

On the other hand, after the animals were placed back in light cage and given oral vitamin D intake of 0.25 µg / kg bw / day for several days, it indicates the increase of 1,25 (OH) 2 D3 blood and a decrease in SBP level. The average increase of 1,25 (OH) 2 D3 blood and decrease of SBP shown in Figure 4:

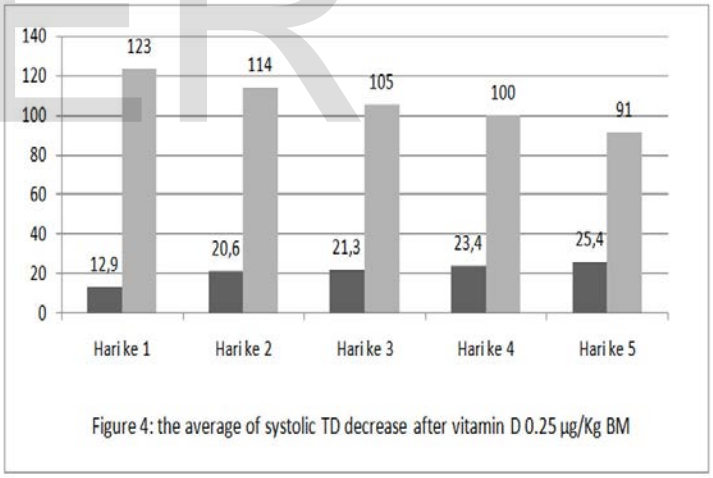

Figure 4: the average of systolic TD decrease after vitamin D 0.25 µg/Kg BM

From figure 4 it shows that there was a regain on 1,25 (OH) 2 D3 blood level after the animals were moved back in the lighted cage and fed standard and given additional vitamin D intake of 0.25 mg/kgBW/day. On the first day of administration of 1,25 (OH) 2 D3 the blood amounting to 12.9 µgr. It rose into 25.4 µgr after five days of administration of vitamin D. Instead systolic blood pressure of experimental animals decreased. It is shown that the systolic blood pressure declined after the animals were placed back in the bright cage and fed with vitamin D of 0.25 mg/kg bw/day. Systolic blood pressure on the first day was still high at 123 mmHg, decreased to 91 mm Hg after five days of vitamin D administration. The increase of vitamin D gained followed by the decrease of TDS already apparent from the first day of bright cage, but it would seem very meaningful after four days at bright

home (p: 0.001).
If the data of the increase of blood 1,25 (OH) 2 D3 was correlated with the reduction in systolic blood pressure then it will look like in Figure 5:

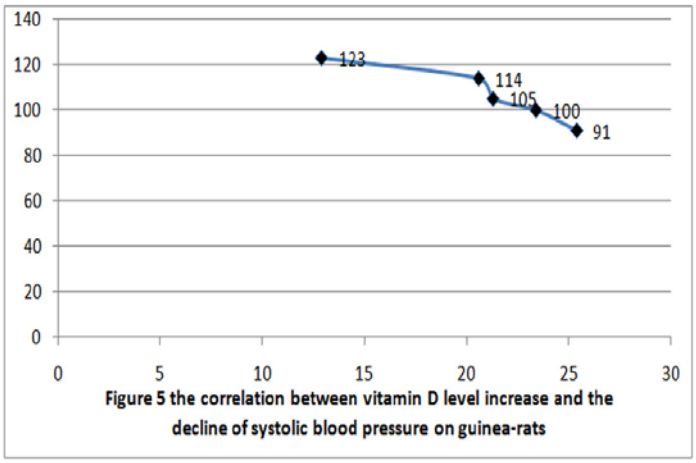

Figure 5 the correlation between vitamin D level increase and the decline of systolic blood pressure on guinea-rats

In Figure 5, it indicates that the higher the levels of blood 1,25 (OH) 2 D3 the lower systolic blood pressure is. By using the correlation test shown, the correlation between elevated levels of blood 1,25 (OH) 2 D3 and blood pressure reduction correlates tightly with r values of 0.95 and significant relation with p: 0.014.

4. Discussion

From Figure 2 and 3, it is clear there is a strong correlation between decrease of blood 1,25 (OH) 2 D3 and systolic blood pressure increase in experimental animals during the dark domesticating times with r value of 0.97. The lower the levels of blood 1.25 (OH) 2 D3 the higher the increase in systolic blood pressure in experimental animals is. The result is consistent with [7] research in 1997, which states that there is a positive correlation between residence distance to the equator with blood pressure. This condition is hypothesized to be the cause of low levels of blood 1,25 (OH) 2 D3 on those living far from the equator. Low level of blood 1,25 (OH) 2 D3 occurs because the body lacks sunlight exposure, consequently the body is not able to do biosynthesis to turn pro vitamin D into vitamin D "[10]".
Vitamin D is needed to prevent the occurrence of renin gene transcription, so that renin is not formed. If rennin is produced, it will immediately activate the rennin-angiotensin-aldosterone system that resulting an increase in blood pressure at the end. Detailed mechanism shown in Figure 6 "[11-12]".

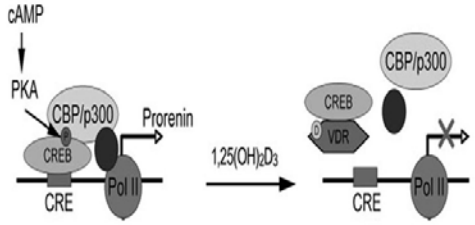

Figure 6. Mechanism of vitamin D as a negative regulator of the renin gene (Yuan et al, 2007)

In this study, removal of the intake of vitamin D seen followed by placing experimental animals in dark cages and feeding free vitamin D is able to reduce levels of blood vitamin D and increase systolic blood pressure significantly. If the results of the research in the dark cage is analogized to normal human behavior which moving away from sunlight exposure or a group of workers who worked in night shifts or indoors, it would seem that their potential to experience a lack of vitamin D in their blood. Moreover, it has already been proven that low levels of vitamin D in the blood will cause an increase in systolic blood pressure.
From Figure 4 and 5, there is a strong correlation (r: 0.95) between elevated levels of blood 1,25 (OH) 2 D3 with a drop in blood pressure during the study subjects in the light cage. The higher the rising of blood 1,25 (OH) 2 D3 the lower the systolic blood pressure dropped. The results are consistent with research conducted by "[3,13]" it implies vitamin D tend to decline a person's risk of cardiovascular disease including hypertension. Vitamin D can suppress renin gene "[11-12]", so it does not experience increased renin production.
In this study shows that the oral giving of vitamin D back and put the animal back in the lighted cage can increase vitamin D levels in the blood, so the SBP back down. This condition strengthens the research that states vitamin D is a negative regulator of the rennin production '[8]" and intake of vitamin D can be used to lower the blood pressure of experimental animals "[5]".
If the result of research in the bright cage was analogized with human life, they require sunlight exposure (ultraviolet) and adequate vitamin D intake is to maintain vitamin D levels in the blood within normal limits. Normal levels of vitamin D will keep the SBP does not increase, therefore, hypertension could be avoided.

5. Conclusion

Exposure of sunlight (ultraviolet) and oral intake of vitamin D is important to maintain blood vitamin D levels in the normal range in order to prevent the increase of systolic blood pressure.

Ethical considerations

This study was approved by the ethics committee by issuing an ethics committee letter of approval Ref: KE/FK/282/EC on May 7, 2012. In addition, researchers also have applied the principles of Replacement, Reduction and Refinement in the use of experimental animals.

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