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Effectivity of Sunbathing Therapy for Reducing Blood Glucose Levels on Respondents Over 40 Years Old

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Abstract. Sunbathing activity could convert pro-vitamin D into vitamin D to maintain pancreas for controlling blood glucose. This study aimed to determine the effect of sunbathing therapy in the morning to reduce blood glucose levels in men and women aged over 40 years. This study recruited 30 respondents who were over 40 years old using simple random sampling in Kutisari Village, Surabaya city, East Java Province, Indonesia. Respondents were divided into two groups: control group without sunbathing therapy and treatment group with sunbathing therapy in the morning for 10 minutes throughout seven days. Capillary blood glucose levels were taken using Point of Care Testing on 1st day before therapy began and on 7th day after therapy finished. The analysis unveiled that on treatment group was able to decrease blood glucose levels from 241.93 ± 132.84 to 173.13 ± 86.91 mg dL⁻¹ with a significance p -value = 0.001. Meanwhile, on control group was able to increase from 209.47 ± 118.89 to 249.27 ± 152.10 mg dL⁻¹ with p -value = 0.098. Therefore, sunbathing therapy in the morning for 10 minutes significantly reduces blood glucose levels effectively on respondents aged over 40 years.

INTRODUCTION

One of the best vitamin D sources is sunlight due to change 7-dehydrocholesterol into vitamin D3 (cholecalciferol) in the body naturally [1]. Sunlight contains UV-A radiation with wavelength 320 - 400 nm, UV-B with wavelength 290 - 320 nm, and UV-C with wavelength 200 - 290 nm [2]. Research about the therapy of Vitamin D deficiency mostly used UV-B rays and oral vitamin D supplement. But, the most recommended treatment was sunlight exposure in the morning [3]. The intensity of UV-B rays of sunlight is lowest at 07:00 a.m. and then increases the next hour until 11:00 a.m. After 11:00 noon, the power of sunlight exposure is relatively stable and high until 14:00 and then decreases again, and the intensity of exposure at 16:00 is equivalent to 07:00 a.m. [4].

Based on Matsuoka *et al.*, research showed that UV-B rays exposure twice in a week for three months on 50 men and 20 women had an increased serum concentration of 25 (OH) D in the body [5]. Furthermore, the results of a collaborative study between Malaysia and Indonesia conducted in Kuala Lumpur and Jakarta showed participants who had an average serum concentration of 25 (OH) D of 48 nmol L⁻¹. This result showed that vitamin D deficiency in Indonesia was over 60% among women [6]. Based on Wacker and Holliack's study was known that individuals with an age range of 1-70 years should receive Vitamin D supplementation of about 600 IU a day, and the elderly (> 70 years old) should receive 800 IU a day. Furthermore, vitamin D supplementation of about 100 IU a day could increase 25 (OH) D by 0.6-1 $\mu\text{g mL}^{-1}$ [7].

Vitamin D deficiency is a risk factor for non-skeletal organ dysfunction conditions, such as type 2 diabetes mellitus [8], due to vitamin D receptor presence on beta cells pancreas is a suspicion regarding the relation between Vitamin D deficiency with diabetes mellitus [3]. This research was designed to construe the effectiveness of sunbathing therapy

in the morning for decreasing blood glucose levels in people aged over 40 years old. Hopefully, sunbathing therapy could become an alternative therapy for diabetes mellitus patients with a low price but a high benefit for health.

EXPERIMENTAL DETAILS

Materials for blood glucose levels testing included easy touch GCU model ET-301, blood glucose strip test (Easy Touch brand), Sella auto click, blood lancet Avico 28G, alcohol swab Aximed 2-ply, sterile cotton, and sterile glove size L (Maxter brand). This study used the Point of Care Testing (POCT) methods with capillary blood as object sampling. The fingertip was wiped using an alcohol swab and sterile cotton. Afterward, the fingertip was pinned by using a blood lancet that was put into auto click, arranged the size, and pressed the button, then bleeding happened. Capillary blood dripped onto blood glucose strip test, which placed into POCT Easy Touch GCU until blood glucose levels showed on the monitor display. Furthermore, blood flows stopped by using sterile cotton [9].

The study conducted using a cross-sectional design with simple random sampling to obtain 30 respondents aged over 40 years old. There were two main groups: treatment group, 15 respondents, sunbathing therapy in the morning for 10 minutes throughout seven days, and the control group, which involved 15 respondents without treatment. Blood glucose levels checked on 1st day before treatment and 7th day after treatment ends. Sunbathing therapy was conducted at 09.00 until 09.10 a.m. with the face and hand area exposed to sunlight, also wearing sunglasses for safety reasons. Diabetes Mellitus risk factor data were collected and analyzed descriptively.

RESULTS AND DISCUSSION

Distribution of respondents' characteristics based on age, gender, Body Mass Index (BMI), and DM status screening is presented in Table 1. The age range of respondents is 40-49 years old. People aged 40-49 years old are included in the adult category that is referred to as productive ages. Therefore, an adult must do a healthy lifestyle. Health problems would increasingly promote metabolic disorders potency as people are getting older. This finding indicated that sex includes diabetes mellitus risk factors, particularly on women who have a greater health risk than men. BMI and nutritional status are also mainly related to health problems. Based on Al-Mansour, people who are aged over 40 years old have a higher risk of getting diabetes mellitus syndrome (44.6%) than people who have aged less than 40 years old (15.6%) [10]. It proved by Diabetes Mellitus screening status on respondents achieved 57%. Pre-Diabetes Mellitus screening status reached 33%, while the normal screening status reached 10%. As increasing people age, they could experience changes in carbohydrate metabolism, and insulin release in the body due to the lack of endocrine system activity in pancreas and insulin resistance happened [11].

Women are more at risk of suffering from Diabetes Mellitus [12] due to women have a greater chance of increasing BMI and central obesity, indeed [13]. Menstruation and menopause cycles on women cause body fat distribution easy to accumulate due to hormonal processes [11]. Estrogen hormone and its receptors have a role play in weight regulation and insulin sensitivity [14]. This study used 60% of women respondents, 57% indicated as diabetes mellitus based on the screening test. Women are more at risk of suffering Diabetes Mellitus because women have a greater chance of increasing BMI and central obesity [11,15,16].

Overweight respondents in the study reached 33%. Non-esterified fatty acids (NEFAs), which are secreted from adipose tissue in obese patients, it suspected of any relationship between BMI and dysfunction of β cells pancreas. Insulin sensitivity might be affected by BMI because people with high BMI increase their insulin resistance [17]. The result of blood glucose levels on respondents with sunbathing therapy along 10 minutes in the morning throughout seven days showed in Table 2.

Based on the statistical analysis using paired t-test showed that respondents with sunbathing therapy in the morning for seven days had a significant difference between before and after the sunbathing therapy with p -value 0.001 ($p < 0.05$), there was decreasing of blood glucose levels from 241.93 ± 132.84 to 173.13 ± 86.91 mg/dL. However, on respondents without sunbathing therapy had an increase of blood glucose from 209.47 ± 118.89 to 249.27 ± 152.10 mg/dL while no significant differences statistically due to the p -value over 0.05. Therefore, sunbathing could be an alternative therapy to reduce excessive blood glucose in the body.

Sunbathing activity regularly for 10 minutes in the morning could affect vitamin D synthesis and reduce blood glucose levels. Vitamin D can increase pancreatic β cells, vitamin D receptors, and hydroxylase enzymes that can activate insulin transcription genes. Appropriate with Thieden *et al.*, study, sunbed radiation by using sunlamps were emitting mainly UV-A only 0.5 or 1.4% UV-B will increase serum 25-hydroxyvitamin D (25(OH)D) level [18]. UV-B rays therapy could be increase serum 25(OH)D level from 45.9 to 75.3 nmol/L for 18 days. Vitamin D directly

effects on activation of the Vitamin D receptor and indirectly on various mechanisms related to the pathophysiology of diabetes mellitus type 2, including impaired pancreatic- β cell function and insulin resistance by the regulation activity of calcium homeostasis [19].

TABLE 1. Characteristics of respondents

Characteristics	Total	
	*n	%
Age		
40-49	12.0	40.0
50-59	8.0	26.7
60-69	8.0	26.7
70-79	2.0	6.6
Gender		
Man	12.0	40.0
Woman	18.0	60.0
Job description		
Workers	18.0	60.0
Non workers	12.0	40.0
BMI		
Underweight (< 18.5 kg/m ²)	1.0	3.3
Normal (18.5-22.9 kg/m ²)	8.0	26.7
Overweight (23-24.9 kg/m ²)	10.0	33.3
Obesity I (25-29 kg/m ²)	8.0	26.7
Obesity II (> 30 kg/m ²)	3.0	10.0
DM status screening		
Normal	3.0	10.0
Pre-DM	10.0	33.3
DM	17.0	57.0

*n = number of cases

TABLE 2. Blood glucose levels before and after with or without sunbathing therapy treatment along seven days

Variables	Blood Glucose Levels		p-value*
	Before (mg dL ⁻¹)	After (mg dL ⁻¹)	
Without Sunbathing Therapy	209.47 ± 118.89	249.27 ± 152.10	0.098
With Sunbathing Therapy	241.93 ± 132.84	173.13 ± 86.91	0.001 ^a

*p –value for paired t-test; ^a Statistically significant p-value < 0.05

UV-B light therapy could change pro-vitamin D under the skin into vitamin D with CYP27A1 enzyme as a catalysator [20]. Afterward, Vitamin D stimulates beta pancreas cells to maintain calcium concentration in the pancreas cell, which further promotes insulin secretion [21]. Vitamin D would reduce insulin resistance risk alongside peripheral tissue by controlling inflammation cytokine and inhibiting PPAR- γ expression [22]. Moreover, vitamin D affects insulin sensitivity by stimulating peroxisome proliferator-activated receptor γ (PPAR- γ) and the expression gene of the insulin receptor [23].

Based on the risk factor analysis, 80% of respondents in both groups still do activities as usual and eat regularly three times a day. Respondents without sunbathing, mostly like to eat sweet food (53.3%) and drinks daily (60%), 80% of respondents also remain as a worker. The high number of Diabetes Mellitus patients' sufferers in Indonesia is due to Indonesians' dietary habits who consume too many carbohydrates that produce glucose and an imbalance of consumption with energy needs [11]. Therefore, blood glucose increases, even doing activities as usual. However, respondents with sunbathing therapy had a decrease of blood glucose levels even they had risk factor included worker (50%), heredity (40%), consumed sweet drink (66,7%), exercises (20%), and smoking (13.3%). There was no significant relationship between work and diabetes mellitus type 2 incidence [24]. The present research differs from Wahyuni's research, which showed a statistically significant relationship between work and diabetes mellitus (p = 0.009) and that people who do not work tend to have the risk of diabetes mellitus up to 1.34 times (OR = 1.34) [25].

Meanwhile, Akrom and Marzuqoh explained that people who did not work tend to do less physical activity. Therefore, glucose could not be converted into energy [26]. Physical activity regularly could improve insulin sensitivity and cardiovascular healthy [27]. The respondents in this study still had low exercises <30%. Physical activity affects decreasing blood glucose levels due to active muscles could increase the sensitivity of insulin receptors. Therefore, glucose intake for cells could increase 7-20 times [28]. Exercises regularly could lower the risk of diabetes mellitus.

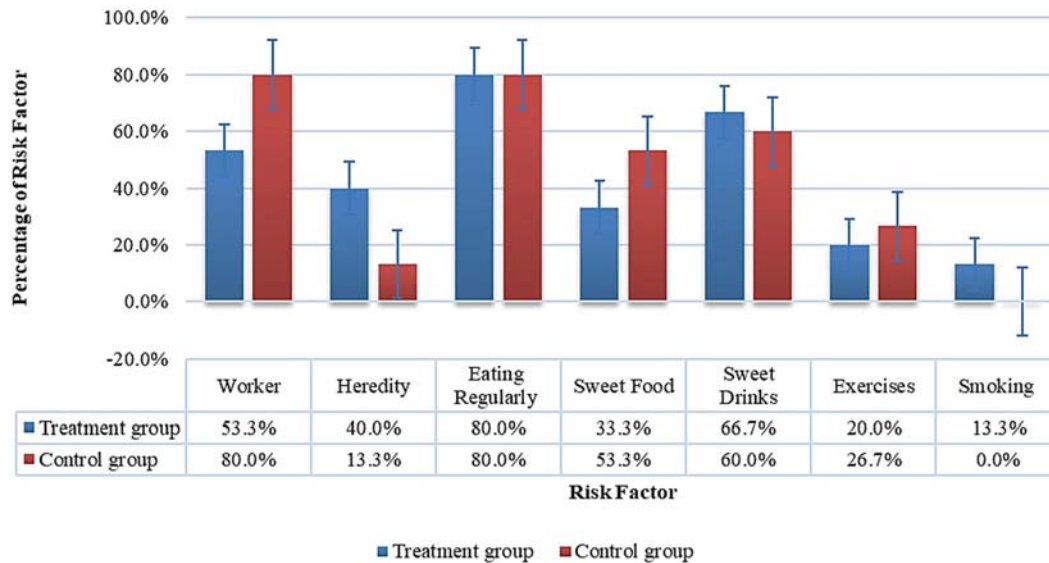


FIGURE 1. Diabetes mellitus risk factor on respondents of each group

As many as 40% of the respondents in the treatment group had a family history of Diabetes Mellitus from their parents. This percentage is higher than the control group, which only reached 13.3%. Based on Riyanto's study, people who have parents with diabetes mellitus tend to expose diabetes mellitus up to 19.8 times than people who have healthy parents [16]. Genetic factors in diabetes mellitus cases originate from the concordance of diabetes mellitus, which could increase in monozygous twins, a high prevalence of diabetes mellitus in children from parents suffering from diabetes mellitus, and certainly ethnic groups [11]. The percentage of diabetes mellitus risk occurs when one of the parents has it by about 15%. If both parents suffer from diabetes mellitus, then diabetes mellitus risk reaches about 75% [15].

Respondents who eat regularly three times a day reached 80% and they also prefer to consume sweet foods and sweet drinks on both categories still high. There was a significant relationship between diet and diabetes mellitus [29]. Consuming food with a large portion and have snack frequently indeed could increase blood glucose levels if done continuously. It would cause complication of Diabetes Mellitus in long term [30]. Based on the previous research by Murti *et al.*, it was informed that people who have consumed sugar more than four spoons/day would tend to have a risk factor of Diabetes Mellitus until 3.9 times [31]. Glucose diet needs to be considered, due to consuming excess sugar could increase blood glucose levels and promote diabetes mellitus type 2 [32].

Respondents in the treatment group who were active smokers reached 13.3%. The results of this study were not in line with the previous investigation by Banihosseini *et al.*, which explained that chemicals derived from tobacco when smoking could affect vitamin D metabolism. Smoking would affect the thickness of plasma walls of blood vessels and promote cardiovascular complications [33]. According to Slatger *et al.*, smoking is associated with an increase of metabolic syndrome prevalence and an increase in BMI due to lower HDL cholesterol and higher triglycerides [11]. Hilawe *et al.* explained that adiponectin concentrations appear partially mediate the effect of smoking on diabetes [15,34].

SUMMARY

This research revealed that sunbathing therapy in the morning for 10 minutes at 09.00-09.10 a.m. within seven days could reduce blood glucose levels effectively on respondents aged over 40 years. Therefore, sunbathing therapy with short time period exposure becomes low cost and effective treatment to reduce circulating blood glucose level in elder population.

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