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Original Article

THE EFFECT OF SUN LIGHT EXPOSURE ON PREDIABETIC PATIENTS IN SOUTH INDIAN POPULATION

VENKATESH G.[*], ARSHA JAYPRAKASH,[*] SWATHI K. S.[#]

[1]Department of Pharmacology, PSG College of Pharmacy, Coimbatore, Tamilnadu, India, [2]Department of Endocrinology, PSG Institute of Medical Science and Research, Coimbatore, Tamilnadu, India.
Email: gvenkatpharma@gmail.com

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ABSTRACT

Objective: Type 2 diabetes evolves through a phase of normoglycemia and impaired glucose tolerance due to vitamin D deficiency. It was believed that sun light exposure is the natural way to improve the blood 25 (OH) D levels which delay or prevent disease progression. The study was to assess the effect of sunlight exposure in South Indian prediabetic population.

Methods: Data of the subjects were retrospectively collected in three continuous intervals. Total 160 subjects were identified as prediabetes based on inclusion and exclusion criteria. Age between 30 to 65 years subjects was randomly recruited for the study. Subjects were assigned into two groups based on sunlight exposure. All anthropometric and metabolic parameters were measured and interpreted.

Results: Between the group and within the group variation was assessed. In Comparative analysis sun light exposure group showed significant improvement in BMI (P=0.0309), glucose (P<0.0001), HbA1c (P<0.0001) and systolic BP (P=0.0042) were showed significant effect but not in diastolic BP (p>0.2893). In lipid profile, cholesterol (P=0.0002) and triglyceride (P=0.0019) showed significant improvement, but no significant effect was observed in HDL (P= 0.131), LDL (P=0.4735) level in sun light exposure group.

Conclusion: Daily exposure of sunlight can improve the disease condition. Along with sunlight exposure, intensive life style changes and appropriate vitamin D supplementation may need to prevent or delay the disease progression.

Keywords: Sunlight light exposure, Vitamin D, Prediabetes, Metabolic changes.

INTRODUCTION

Prediabetes occurs when glucose levels more than the normal level but not considered as diabetes, mainly because of insulin resistance and insulin sensitivity. People with prediabetes have an increased risk of developing Type 2 diabetes and heart diseases [1,14,17]. It has been estimated that 380 million individuals would be affected with diabetes worldwide by the year 2025. In India, it is expected to affect 70 million by the year 2025 [2]. It can be delayed or prevented through lifestyle modification, dietary change, weight loss, exercise and metformin intervention. In a three arm study, the lifestyle intervention group had 58 % of reduction in the incidence of diabetes [3].

Vitamin D insufficiency has been suspected to be a high risk factor for type 1 diabetes. Higher incidence and prevalence of type 1 diabetes were identified in countries at higher latitude [4]. There was a seasonal variation develop type 1 diabetes, most commonly diagnosed in the winter, which suggests an effect of lower sunshine in associated with lower vitamin D status [5,6,7,18]. Increased insulin resistance, systemic inflammation and HbA1c level were found in patients with type 2 diabetes and Vitamin-D deficiency [8]. Major risk factor for prediabetes is obesity, which is commonly associated with hypovitaminosis due to the capacity of adipose tissue to store 25-hydroxy vitamin-D [9]. A decreased amount of serum 25 (OH) D can stimulate lipogenesis predisposing a patient to further weight gain and thus increasing the risk of diabetes [10]. Administration of vitamin-D has been shown to decrease insulin resistance in diabetic patients [11]. Vitamin D activates the pancreatic β cell function through the vitamin D receptor and 1-alpha-hydroxylase, which is expressed in beta cells and also it enhances insulin sensitivity by stimulating insulin receptors and by activating peroxisome proliferators activated receptor (PPAR). Vitamin D may also affect insulin secretion and sensitivity indirectly through regulating extracellular calcium concentration in the beta cells and peripheral insulin-target tissues. [12]. Sunlight exposure is the natural way to increase serum 25(OH) D concentrations [13]. Hence the present study was aimed to suggest whether the sun light exposure of vitamin D utilization can reduce or prevent the predisposing of patients from prediabetic to diabetic and other cardiovascular diseases.

MATERIALS AND METHODS

Study site and duration

This retrospective observational study includes all cases diagnosed as prediabetes in a period of three years from January 2010 to December 2013. Data of the patients were retrospectively collected from the Medical Record Department and Department of Endocrinology, PSG hospital, Coimbatore which is a tertiary care teaching hospital. The study was approved by Human ethics committee PSG IMS&R (IHEC 13/381). The data were compiled in proforma which included details of the patients, symptom analysis, clinical findings, investigations and management. Patient data were collected in three continuous visits after diagnosed as prediabetes

Subjects

In total, 160 subjects were identified as prediabetes from the clinical reports based on inclusion and exclusion criteria. The subjects were included age between 30 to 65 years and glucose level >100mg/dl to <125mg/dl were randomly recruited. Subjects were excluded if chronic alcoholism, hepatic failure, cardiovascular diseases and renal disorder. Patients receiving only written advice from the physician for lifestyle change considered for the study. Patients were classified into two groups based on their sun light exposure. The first was prediabetic group (n=80) and the second group was prediabetic patients exposed to sunlight (n=80) frequently in their routine life. All anthropometric parameters were obtained while the medical record was assessed.

Statistical analysis

Documented data were analyzed by using Analysis of Variance (ANOVA) and Student't' test by using prism software (user guide 6.1). Statistical significance was taken at the 95% level ($P < 0.05$). Results were expressed as Mean ± Standard Deviation.

RESULTS

Changes of metabolic parameter in prediabetic patients without sun light exposure

The study result showed most of them belongs to the age group between 25 and 35 years (42.3%). Female patients (53.75%) were more than the male patients (46.25%) in prediabetic condition. Based on the guideline, we found Subjects predisposed to T2DM (77.5%), hypertension (81%) and dyslipidemia (40%). Between the groups variation was observed in three continuous visits. Significant increase of Body weight ($p<0.05$), BMI range ($p<0.001$), Glucose level ($p<0.001$), HbA1c ($p<0.001$) was observed. In blood pressure level, systolic BP increased significantly ($p<0.05$) but in diastolic BP there was no significant change was observed ($p>0.05$). In lipid profile evaluation, significant increase of triglyceride ($p<0.001$) and cholesterol ($p<0.05$) was observed but rest of the parameters HDL ($p>0.05$) and LDL ($p>0.05$) was showing changes in each visit but statistically not significant. (Table -1)

Table 1: Changes of Metabolic parameters in Prediabetic group

	Prediabetic Group			
	Visit1	Visit 2	Visit 3	P Value
N	180			
Age	56.94±14.15			
Sex (M/F)	43(37)			
Weight (Kg)	67.33±7.02	68.93±7.24	70.88±7.96	0.05
BMI (Kg/m^2)	25.8±1.4	26.5±1.4	27.3±1.6	0.0003
Blood glucose (Mmol/L)	6.3±0.3	7.2±1.1	7.7±13	0.0001
HBA1c (%)	5.6±0.3	6.2±0.7	6.5±0.7	0.0001
Blood pressure (mmHg)				
Systolic pressure	116.1±15.2	122.7±13.7	127.4±18.9	0.0328
Diastolic pressure	78.7±10	80±7.6	80.8±7.5	0.5711(NS)
Lipid profile				
Total CHO (Mmol/L)	4.55±.31	4.65±.27	4.66±.31	0.2211(NS)
LDL (Mmol/L)	2.94±.34	3.0±.32	3.0±.31	0.2533(NS)
HDL(Mmol/L)	1.25±.17	1.23±.15	1.18±0.14	0.1977(NS)
TG (Mmol/L)	1.34±.12	1.43±.11	1.51±.11	0.0001

Note: Data presented as mean ± standard error; NS – not significant; significance at $p < 0.05$. To convert the values for glucose to millimoles per liter, multiply by 0.05551. To convert the values for triglycerides to millimoles per liter, multiply by 0.01129. To convert the values for cholesterol to millimoles per liter, multiply by 0.02586.

Table 2: Changes of Metabolic parameters in Prediabetic patients exposed to Sunlight

	Sun light Exposed Group			
	Visit 1	Visit 2	Visit 3	P Value
N	80			
Age	47.08±13.21			
sex(M/F)	49(31)			
Weight (Kg)	63.86±7.67	63.7±7.9	63.13±7.6	
BMI (Kg/m^2)	25.1±1.4	25.6±1.2	25±1.4	0.3819 (NS)
Blood glucose (Mmol/L)	6.29±0.4	6.27±.43	6.24±.46	0.8757(NS)
HBA1c (%)	5.57±.27	5.5±.26	5.5±.28	0.8184(NS)
Blood pressure				
Systolic pressure (mmHg)	127±21.67	122.11±18.8	118.86±14.44	0.1313(NS)
Diastolic pressure (mmHg)	78.97±10.5	78.69±7.85	78.69±7.8	0.9882(NS)
Lipid profile				
Total CHO (Mmol/L)	4.42±0.32	4.46±0.31	4.49±0.32	0.614(NS)
LDL (Mmol/L)	2.87±0.37	2.86±0.34	2.86±0.34	0.9738(NS)
HDL(Mmol/L)	1.30±0.17	1.3±0.15	1.31±0.15	0.9873(NS)
TG (Mmol/L)	1.24±0.12	1.25±0.11	1.2±0.10	0.9049(NS)

Note: Data presented as mean ± standard error; NS – not significant; significance at $p < 0.05$. To convert the values for glucose to millimoles per liter, multiply by 0.05551. To convert the values for triglycerides to millimoles per liter, multiply by 0.01129. To convert the values for cholesterol to millimoles per liter, multiply by 0.02586.

Changes of metabolic parameter in prediabetic patients with sun light exposure group

Most of the subjects belong to the age group between 35 and 45 years (54.3%). Male (61.25%) patients were more than the female (38.75%) patients in sun exposed group. Subjects predisposed to T2DM (52.5%), hypertension (51%) and dyslipidemia (35%) was observed. Only Body weight showed significant improvement ($p<0.05$) but no significant improvement were observed in BMI range ($p>0.05$), glucose level ($p>0.05$), HbA1c ($p>0.05$). In blood pressure level, both systolic and diastolic BP showed no significant changes ($p>0.05$) the steady state level was observed. In lipid profile evaluation, gradual improvement was observed in all the metabolic parameters but statistically no significant changes were observed triglyceride ($p>0.05$), cholesterol ($p>0.05$), HDL ($p>0.05$) LDL ($p>0.05$). (Table -2)

Comparative analysis on prediabetic and sun light exposed group

Comparative analysis was made between prediabetic and sun light exposure group. Significant improvement in BMI (2.95%, $P = 0.0309$), glucose (10.54%, $P<0.0001$), HbA1c (11.10%, $P<0.0001$) and systolic BP (4.81%, $P=0.0042$) was observed in sun light exposed group but not in diastolic BP. In lipid profile, cholesterol (4.41%, $P=0.0002$) and triglyceride (4.27%, $P=0.0019$) produced significant improvement in sun light exposed group but no significant change was found in HDL (1.42%, $P= 0.131$), LDL (0.68%, $P=0.4735$) level (Table-4). Subjects significantly predisposed to

hypertension ($p<0.05$) and T2DM ($p<0.01$) was observed in prediabetic group than sun light exposed group but significant changes was not observed in dyslipidemic condition in both the groups. (Table-3)

Table 3: Changes in risk factors at the end of third visit

	Prediabetic group		Sun light Exposed group		P Value
	Male (43)	Female (37)	Male (49)	Female (31)	
Hypertension					
Primary	22 (51.1%)	9 (24.3%)	14 (28.5%)	7 (22.5%)	P<0.05
Secondary	14 (32.5%)	20 (54%)	8 (16.3%)	13(41.9)	
Type2 Diabetes Mellitus	34(79%)	28(75.6%)	24(48.9%)	17(54.8%)	P<0.01
Dyslipidemia	14(32.5%)	18(48.6)	15(30.6%)	13(41.9%)	P>0.5(NS)

Note: Data presented as percentages (%). NS – not significant; significance at $p < 0.05$. End of the third visit Patients Predisposed to metabolic disorder. Conditions are obtained based on the diabetes, hypertension and dyslipidemic guidelines.

Table 4: Comparative analysis between the prediabetic and sun light exposed group

	Comparison score (%)	P value
BMI	2.95	0.0309
Blood glucose	10.54	P<0.0001
HbA1c	11.10	P<0.0001
Systolic BP	4.81	0.0042
Diastolic BP	1.09	0.2893 (NS)
Cholesterol	4.41	0.0002
HDL	1.42	0.131 (NS)
LDL	0.68	0.4735 (NS)
TG	4.27	0.0019

Note: Data presented as percentages (%). NS – not significant; significance at $p < 0.05$.

DISCUSSION

In our study rate of improvement was less in the female than male subjects in sun exposure group. This may be explained by limited skin exposure due to skin-covering clothes and by limited sunlight exposure. In fact, a poor vitamin D status can be seen in pigmented persons even in regions with abundant sunshine [15]. Blood glucose level was remained unvarying in sun exposure group in contrast to the prediabetic group. Periodic sun light exposure supposes to be improved the blood glucose at a halt. Chel et al study has shown ultraviolet irradiation is as effective as vitamin D supplementation in geriatric patients [28]. Hence this study also chains with Vitamin-D is related with insulin resistance and HbA1c in patients of T2DM [19]. In contrast, Reis *et al* and Wareham *et al* reported no association of 25(OH) D with metabolic syndrome. [25, 26]. Ford *et al*, in a study of 7904 individuals reported 25(OH) D to be inversely associated with metabolic syndrome [27]. These controversial reports may be explained by the differences in race, BMI, blood sugars, sunlight exposure and obesity.

Body mass index ratio was maintained and no further increase of body weight was observed in sun light exposure group. It demonstrated that vitamin D may increases the lipolysis and reduce the expression of Matrix metalloproteinase (MMPs) enzymes like MMP-2, MMP-8, MMP-9 and lower plasma tissue inhibitor of metalloproteinase 1 (TIMP-1) which is involved in the pathogenesis of obesity [19,20] leads to cause type 2 diabetes. In addition to that, diabetic prevention program (DPP) study have shown that weight loss was an effective method for reducing the incidence of diabetes [21]. Sun light Significantly decreased the HbA1c level in patient with prediabetes it could be due to sun light exposure reduces association of glucose with hemoglobin which decreased blood glucose level gradually [22]. Consistent weekly exposure of sun light may be beneficial effect to maintain healthy vitamin D levels in the blood [16].

Steady state level of systolic and diastolic BP indicates, sun light increases the production of vitamin D (25(OH) D) in body cells which are actively participating in control of renin release which decreases blood pressure by regulating aldosterone secretions [23]. Exposure of UV-A for six weeks, 3 times weekly increased vitamin D level in the blood has been shown to reduce blood pressure when compare to UV-B exposure which does not produce vitamin D [24]. In our study sunlight exposure was not associated with majority of the metabolic parameters measured, with only triglycerides showing a positive association among patients with prediabetes which is supporting Al-Daghri et al study, additional finding of this study was negligible improvement of total cholesterol which could be due to south Indian populations exposed more to UV radiation and the blood 25 (OH) D levels are relatively higher compared with other populations [29]. Consequently there was a possibility an intensive life style modification in sun exposure or vitamin D supplementation might improve the total cholesterol and other metabolic parameters. Predisposed to T2DM and cardiovascular disease was less in subjects exposed to sun light which may possibly due to vitamin D improving insulin resistance and sensitivity and blood pressure regulations [17].

CONCLUSION

In this study, we found that exposure to sunlight itself was not very effective, intensive life style changes and appropriate vitamin D supplementation may need to prevent or delay the disease progression. Although this study indicates association of sunlight and dyslipidemia are contradictory and unclear. Further prospective studies are required for confirming these findings.

CONFLICT OF INTERESTS

The authors have no funding sources or conflict of interests to report.

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ABBREVIATIONS

UV-A&B - Ultraviolet radiation A & B

T2DM- Type 2 diabetes Mellitus

25 (OH) D- 25-hydroxy vitamin D

PPAR -Peroxisome proliferators activated receptor

BP- Blood pressure

DPP- Diabetic prevention program

MMPs - Matrix metalloproteinase

TIMP-1-Tissue inhibitor of metalloproteinase 1

HbA1c- Hemoglobin A1c

HDL- High density lipoprotein

LDL- Low density lipoprotein

BMI- Body mass index

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