

TO INVESTIGATE THE ASSOCIATION BETWEEN VITAMIN D STATUS AND DEPRESSIVE SYMPTOMS AMONG ADULTS THROUGH A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Vitamin D deficiency is a growing public health concern that may affect not only skeletal health but also mental well-being. Emerging evidence suggests a possible association between Vitamin D deficiency and depression. This study aimed to assess awareness and beliefs regarding Vitamin D among adults and to examine its association with depressive symptoms in the adult population. **Methodology:** A cross-sectional survey was conducted among 346 adults using a structured online questionnaire. Information on demographic characteristics, sun exposure habits, Vitamin D awareness, supplementation practices, and depression severity using the Patient Health Questionnaire-9 (PHQ-9) was collected. Data were analyzed using descriptive statistics and Chi-square tests of independence to determine associations between Vitamin D-related variables and depression outcomes. **Results:** Among the 346 respondents, 194 (56.1%) were female and 280 (80.9%) were graduates. Overall, 292 participants (84.4%) were aware of Vitamin D, while 158 (45.7%) believed that Vitamin D deficiency contributes to depression. Only 70 participants (20.2%) reported taking Vitamin D supplements. Significant associations were observed between belief in the Vitamin D–depression relationship and knowledge of Vitamin D’s effect on mental health ($\chi^2 = 14.492$, $p = 0.006$), as well as prior clinical diagnosis of depression ($\chi^2 = 6.744$, $p = 0.034$). PHQ-9 depression severity was significantly associated with sun exposure timing ($\chi^2 = 21.944$, $p = 0.038$). Approximately 41.6% of respondents were categorized within moderate-to-severe depression levels. No significant associations were found between Vitamin D belief and outdoor exposure duration, sunscreen use, gender, educational status, or residential area ($p > 0.05$). **Conclusion:** The study demonstrates a significant association between Vitamin D-related awareness and depression among adults. Mental health knowledge, previous depression diagnosis, and sun exposure timing were the strongest factors associated with Vitamin D beliefs and depressive symptom severity. Despite high awareness of Vitamin D, supplementation practices remained low, highlighting an awareness–action gap. These findings emphasize the need for targeted educational programs, routine Vitamin D screening, and appropriate supplementation strategies to support mental health outcomes.

KEYWORDS: Vitamin D Deficiency, Depression, PHQ-9, Mental Health, Sun Exposure, Awareness, Adults.

INTRODUCTION

Vitamin D (also referred to as calciferol) is a fat-soluble vitamin that is naturally present in a few foods, added to others, and available as a dietary supplement. It is also produced endogenously when ultraviolet (UV) rays from sunlight strike the skin and trigger vitamin D synthesis.

Vitamin D obtained from sun exposure, foods, and supplements is biologically inert and must undergo two hydroxylations in the body for activation. The first hydroxylation, which occurs in the liver, converts vitamin D to 25-hydroxyvitamin D [25(OH)D], also known as calcidiol. The second hydroxylation occurs primarily in the kidney and forms the physiologically active 1,25-dihydroxyvitamin D [1,25(OH)2D], also known as calcitriol.^[1]

Vitamin D promotes calcium absorption in the gut and maintains adequate serum calcium and phosphate concentrations to enable normal bone mineralization and to prevent hypocalcemic tetany (involuntary contraction of muscles, leading to cramps and spasms). It is also needed for bone growth and bone remodeling by osteoblasts and osteoclasts.^[1-3] Without sufficient vitamin D, bones can become thin, brittle, or misshapen. Vitamin D sufficiency prevents rickets in children and osteomalacia in adults. Together with calcium, vitamin D also helps protect older adults from osteoporosis.

Vitamin D has other roles in the body, including reduction of inflammation as well as modulation of such processes as cell growth, neuromuscular and immune function, and glucose metabolism.^[1-3] Many genes encoding proteins that regulate cell proliferation, differentiation, and apoptosis are modulated in part by vitamin D. Many tissues have vitamin D receptors, and some convert 25(OH)D to 1,25(OH)2D.

In foods and dietary supplements, vitamin D has two main forms, D2 (ergocalciferol) and D3 (cholecalciferol), that differ chemically only in their side-chain structures. Both forms are well absorbed in the small intestine. Absorption occurs by simple passive diffusion and by a mechanism that involves intestinal membrane carrier proteins.^[4] The concurrent presence of fat in the gut enhances vitamin D absorption, but some vitamin D is absorbed even without dietary fat. Neither aging nor obesity alters vitamin D absorption from the gut.^[4]

Vitamin D deficiency is associated with an increased risk of depression. Vitamin D receptors are present in brain areas that regulate mood, and it helps in the production of serotonin, a key neurotransmitter involved in emotional balance. Low levels of Vitamin D may increase inflammation and disrupt the stress response system, which can contribute to depressive symptoms. Many studies show a correlation between low serum 25(OH)D levels and higher depression severity. However, Vitamin D deficiency is considered a contributing factor rather

than a direct cause of depression.

Low levels (<20 ng/mL) correlate with higher depression risk, worse symptoms (e.g., BDI scores). Supplementation (2000-8000 IU/day D3) reduces scores (SMD -0.32 to -2.04), best short-term in deficient patients.

REVIEW OF LITERATURE

Wang et al. (2025) conducted a meta-analysis of 20 randomized controlled trials from PubMed, EMBASE, and others, assessing vitamin D supplementation vs. controls on depressive symptoms using scales like BDI, GDS, and HDRS. They found significant reduction in symptoms (SMD = -0.36; 95% CI -0.52 to -0.20; P < 0.00001), with stronger effects in diagnosed depression and baseline levels >50 nmol/L, supporting adjunctive use.

Li et al. (2023) performed a meta-analysis of 18 RCTs on vitamin D supplementation for primary depression in adults, searching PubMed, Embase, and Web of Science. Results showed overall symptom reduction (SMD = -0.15, 95% CI -0.26 to -0.04), significant in patients with serum 25(OH)D >50 nmol/L (SMD = -0.38, 95% CI -0.68 to -0.08).

Musazadeh et al. (2023) conducted a systematic review and meta-analysis of 18 RCTs from Nutrition journal (ScienceDirect), comparing vitamin D supplements vs. placebo in depressed patients using HDRS, BDI, and other scales with RevMan software. They found significant symptom reduction (SMD -0.40, 95% CI -0.70 to -0.10, P<0.01), high acceptability (low dropout), and stronger effects in adults over children/teens

Głabska et al. (2022) systematically reviewed 12 RCTs in Nutrients journal (MDPI), assessing vitamin D supplementation's effect on depression incidence and severity using meta-analysis with subgroup focus on deficiency. They reported reduced incidence in deficient groups (RR 0.72, 95% CI 0.55-0.94) and improved prognosis, though heterogeneity in dosing affected long-term outcomes.

METHODOLOGY

Hypotheses

H1: There is no significant association between Vitamin D status and depressive symptoms among adults.

H2: There is a significant association between Vitamin D status and depressive symptoms among adults.

Objectives

General Objectives: To investigate the association between Vitamin D status and depressive symptoms among adults through a cross-sectional study.

Specific Objectives

❖ To assess the correlation between Vitamin D status and depression severity scores (PHQ-9) among adult

respondents.

- ❖ To determine the level of awareness regarding Vitamin D and its association with mental health among adults.
- ❖ To assess the association between Vitamin D-related lifestyle factors — such as sunlight exposure duration, dietary intake, and supplementation practices — and depressive symptom severity.
- ❖ To examine the relationship between Vitamin D status and demographic variables such as age, gender, occupation, and residential area (urban/rural).
- ❖ To determine whether self-reported Vitamin D deficiency or low sun exposure is associated with moderate to severe depressive symptoms among adults.
- ❖ To explore gender-based differences in the association between Vitamin D status and depressive symptom severity.
- ❖ To assess the level of public awareness and willingness to engage in Vitamin D-related health education or supplementation programs.

STUDY POPULATION

Adults aged 18–60 years attending the selected healthcare facility or residing in the selected community.

Sample

A total of 349 participants were included in the study. The data were collected using a structured Google Form questionnaire distributed online. Participants who met the inclusion criteria and provided informed consent were included in the final analysis.

The sampling technique used was non-probability convenience sampling, as participation was voluntary through online responses.

Research design

A descriptive Analytical cross-sectional case-control study is ideal for examining the association between vitamin D deficiency and depression in adults, allowing efficient prevalence comparison without intervention.

Inclusion Criteria

- Adults aged 18–60 years
- Willing to provide informed consent
- Not currently on Vitamin D supplementation (or recorded separately)

Exclusion Criteria

- Patients with diagnosed psychiatric disorders other than depression
- Chronic kidney disease or liver disease
- Pregnancy
- Current use of antidepressants (optional depending on study design)

Statistical analysis

Data were entered in Excel (v2412) and analyzed using

SPSS v27. Continuous variables were shown as mean $\pm$ SD, while categorical variables were expressed as frequencies and percentages. Chi-square tested categorical data, with $p < 0.05$ considered significant.

Instruments

SOCIO-DEMOGRAPHIC CHARACTERISTICS

Participants provided demographic, lifestyle, and mental health-related information relevant to the study.

0–4 Minimal depression

5–9 Mild depression

10–14 Moderate depression

15–19 Moderately severe depression 20–27 Severe depression

Data Collection

Data was collected through a structured Google Form circulated via social media/email among adults.

RESULTS

Raw Score and Internal Consistency (N=346)

Reliability Statistics	
Cronbach's Alpha	N of Items
.866	8

The Cronbach's Alpha of 0.866 (across 8 items) indicates good internal consistency — the items reliably measure a single underlying construct (depressive symptoms), well above the commonly accepted threshold of 0.70.

SOCIODEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

Variables	(N=) N (%)
Age in years	
> 18 years	346(100)
Gender	
Male	152(44)
Female	194(56)
Educational Qualification	
No formal education	0
Primary school	1(0.2)
Secondary school	25(7)
Graduate	280(81)
Postgraduate	40(11)
Occupation	
Student	241(70)
Office/Indoor work	32(9)
Homemaker	39(11)
Unemployed	25(7)
Retired	9(2)
Residential Area	
Urban	214(62)
Rural	132(38)

The study included 346 respondents, all above 18 years of age, with females (194) outnumbering males (152). Educationally, the sample was highly qualified, with 280 Graduates and 40 Postgraduates, while only 25 had Secondary school education and just 1 had Primary

school education. In terms of occupation, Students (241) made up the largest group, followed by Homemakers (39), Office/Indoor workers (32), Unemployed (25), and Retired (9) respondents. Geographically, the majority resided in Urban areas (214) compared to Rural areas

(132), indicating a predominantly urban sample. Overall, the demographic profile reflects a young, well-educated, urban, and student-heavy population with a slight female majority, which should be considered when interpreting the study's broader applicability.

Section 2: Lifestyle and Sun exposure.				
How many hours do you spend outdoors daily?	<15 min	15–30 min	30–60 min	>1 hour
	71(20)	96(28)	92(26)	87(25)
At what time do you usually get sun exposure?	Morning (6–10 AM)	Midday (10 AM–3 PM)	Evening	Rarely
	148(43)	130(37)	37(11)	31(9)
Do you regularly use sunscreen?	Yes	No		
	167(48)	179(52)		
How physically active are you?	Sedentary	Moderately Active	Highly Active	
	39(11)	254(73)	53(15)	

Section 2 – Lifestyle & Sun Exposure Outdoor time was fairly evenly spread, with the largest groups spending 15–30 min (96) and 30–60 min (92) outdoors daily, while 87 spent over an hour and 71 spent less than 15 minutes. Morning (148) and Midday (130) were the most common

times for sun exposure, while only 37 got sun in the evening and 31 rarely went outdoors. Sunscreen use was nearly split, with 179 not using it regularly versus 167 who do. Most respondents were Moderately Active (254), with far fewer Sedentary (39) or Highly Active (53).

Section 3: Vitamin D Awareness.					
Have you heard about Vitamin D?	Yes	No			
	292(84)	54(16)			
What are the sources of Vitamin D?	Sunlight	Diet (milk, fish, eggs	Supple- ments	Don't know	
	286(83)	26(8)	33(9)	1(0.2)	
Are you aware of the health benefits of Vitamin D?	Bone health	Immune system	Mental health	All of the above	Not aware
	60(17)	18(5)	8(2)	236(68)	24(10)
Do you know Vitamin D deficiency can affect mental health?	Yes	No	Maybe		
	229(66)	78(23)	39(11)		
Have you ever tested your Vitamin D levels?	Yes	No			
	71(21)	275(79)			
If yes, what was the result?	Normal	Low	Very low	Don't remember	
	45(13)	7(2)	41(12)	253(73)	
Do you take Vitamin D supplements?	Yes	No			
	70(20)	276(80)			
How often do you take Vitamin D?	Daily	Weekly	Monthly	Irregular	Not taking
	15(4)	18(5)	35(10)	21(6)	257(74)
Do you feel supplementation improved your mood or energy?	Yes	No	Maybe		
	47(14)	43(12)	256(74)		
Are you currently taking any medications for depression?	Yes	No			
	19(5)	327(95)			

Section 3 – Vitamin D Awareness The vast majority (292) had heard of Vitamin D, with only 54 unaware. Sunlight (286) was overwhelmingly cited as the main source, far ahead of Supplements (33) and Diet (26). Awareness of health benefits was strong, with 236 correctly identifying "All of the above" benefits. Most respondents (229) knew Vitamin D deficiency can affect mental health, though a notable 78 said "No." Very few had actually

tested their levels (71 yes vs. 275 no), and among those who did, results were mixed (45 normal, 41 very low, 7 low). Supplement use was low overall (70 yes vs. 276 no), and among users, intake was mostly irregular (257). Only 47 felt supplementation improved mood/energy, while 256 were unsure ("Maybe"). Very few (19) reported taking medication for depression, against 327 who weren't.

Section 4: Dietary Habits.				
How often do you consume Vitamin D rich foods?	Daily	2–3 times per week	Rarely	Never
	42(12)	216(62)	62(18)	26(8)
Do you consume fortified foods?	Yes	No	Not sure	
	115(33)	60(17)	171(49)	

Section 4 – Dietary Habits Most respondents consumed Vitamin D-rich foods 2–3 times/week (216), while only 42 ate them daily and 26 never did. Awareness of fortified

foods was uncertain for many — 171 were "Not sure," compared to 115 who confirmed consuming them.

Section 5: Depression Assessment (PHQ-9 Scale)				
Over the last 2 weeks, how often have you had little interest or pleasure in doing things?	0	1	2	3
	66(19)	113(33)	121(35)	46(13)
Over the last 2 weeks, how often have you been feeling down, depressed, or hopeless?	128(36)	116(33)	68(19)	44(12)
Over the last 2 weeks, how often have you had trouble falling asleep, staying asleep, or sleeping too much?	142(41)	82(24)	94(27)	28(8)
Feeling tired or having little energy	77(22)	132(38)	106(31)	31(9)
Over the last 2 weeks, how often have you experienced poor appetite or overeating?	139(40)	77(22)	95(27)	35(10)
Over the last 2 weeks, how often have you been feeling bad about yourself — or that you are a failure or have let yourself or your family down?	124(36)	93(27)	66(19)	63(18)
Over the last 2 weeks, how often have you had trouble concentrating on things, such as reading or watching television?	97(28)	117(34)	80(23)	52(15)
Over the last 2 weeks, how often have you been moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual?	136(39)	104(30)	66(19)	40(12)
Over the last 2 weeks, how often have you had thoughts that you would be better off dead or of hurting yourself in some way?	218(63)	41(12)	63(18)	24(7)

0 = Not at all, 1 = Several days, 2 = More than half the days, 3 = Nearly every day

Section 5 – Depression Assessment (PHQ-9) Across most PHQ-9 items, a meaningful share of respondents reported symptoms occurring on "several days" to "more than half the days" — for example, feeling down or hopeless (128 not at all, 116 several days, 68 more than half, 44 nearly every day) and trouble sleeping (142, 82, 94, 28).

Encouragingly, on the self-harm/suicidal ideation item, the majority (218) reported "not at all," though 24 indicated this occurred "nearly every day" — a subgroup that would warrant clinical follow-up in a real research context.

Section 6: Awareness & Feedback.			
Do you believe low Vitamin D contributes to depression?	Yes	No	Not sure
	158(47)	59(17)	129(37)
Would you improve sun exposure or take supplements if advised?	Yes	No	Maybe
	112(32)	33(10)	201(58)
Have you been diagnosed with depression by a healthcare professional?	Yes	No	
	88(25)	258(75)	
Would you like more awareness programs on Vitamin D and mental health?	Yes	No	
	301(87)	45(13)	

Section 6 – Awareness & Feedback A majority (158) believed low Vitamin D contributes to depression, though a large portion (129) remained "Not sure."

Interestingly, when asked if they'd act on medical advice to improve sun exposure or take supplements, most (201) said "Maybe," suggesting openness but hesitancy. Only

88 had been formally diagnosed with depression by a professional, against 258 who hadn't. Overwhelmingly, 301 respondents wanted more awareness programs on

Vitamin D and mental health, compared to just 45 who didn't.

Section: 7 - CORRELATIONS INTERPRETATIONS

7.1 Correlation Among Do you believe low vitamin D levels contribute to depression & How many hours do you spend outdoors daily?		How many hours do you spend outdoors daily?				Total
		15–30 minutes	30–60 minutes	Less than 15 minutes	More than 1 hour	
Do you believe low vitamin D levels contribute to depression?	No	20(6)	12(3)	13(3)	14(4)	59(17)
	Not sure	33(10)	38(11)	29(8)	29(8)	129(37)
	Yes	43(12)	42(12)	29(8)	44(13)	158(46)
Total		96(28)	92(26)	71(21)	87(25)	346(100)

A cross-tabulation of daily outdoor time and the belief that low vitamin D levels are linked to depression was conducted among 346 respondents. • In total, 158 respondents (45.7%) selected "Yes," which is the most prevalent response in the sample as a whole. • Of the responders, just 59 (17.1%) replied "No," while 129 (37.3%) said "Not sure." • Of the 96 people who spent 15 to 30 minutes outside, 43 responded "Yes," 33 replied "Not sure," and 20 said "No"—the most number of "No" responses across all categories. • Of the 92 people who spent 30 to 60 minutes outside, 42 replied "Yes," 38 said "Not sure," and only 12 stated "No." Responses from the

71 people who spent less than 15 minutes outside were about equal: 29 replied "Yes," 29 said "Not sure," and 13 said "No." • Of the 87 individuals who spent more than an hour outside, 44 responded "Yes"—the greatest number of any single cell—while 29 responded "Not sure" and 14 responded "No." • When comparing extremes, people who spent more than an hour outside (44/87 = 50.6%) had the strongest conviction in the link between vitamin D and depression, while people who spent less than fifteen minutes outside (29/71 ≈ 40.8%) had the lowest belief.

7.2. Correlation Among Do you believe low vitamin D levels contribute to depression? & Do you regularly use sunscreen?		Do you regularly use sunscreen?		Total
		No	Yes	
Do you believe low vitamin D levels contribute to depression?	No	31(9)	28(8)	59(17)
	Not sure	63(18)	66(19)	129(37)
	Yes	85(25)	73(21)	158(46)
Total		179(52)	167(48)	346(100)

Of the 346 respondents, 158 (45.7%) agree that depression is caused by insufficient vitamin D levels, and 85 of them don't frequently use sunscreen, while 73 do. Sunscreen users (66) and non-sunscreen users (63) responded almost evenly among those who answered "Not sure" (129 total). Just 59 (17.1%) said "No," divided almost equally between 28 sunscreen users and 31 non-

users. In comparison, 43.7% of sunscreen users (73/167) and 47.5% of non-sunscreen users (85/179) responded "Yes" to the vitamin D-depression association. This indicates a little tendency wherein those who do not wear sunscreen—possibly increasing their exposure to the sun—are slightly more inclined to accept the link between vitamin D and depression.

7.3. Correlation Among Do you feel vitamin D supplementation has improved your mood or energy levels? & How many hours do you spend outdoors daily?		How many hours do you spend outdoors daily?				Total
		15–30 minutes	30–60 minutes	Less than 15 minutes	More than 1 hour	
Do you feel vitamin D supplementation has improved your mood or energy levels?	Maybe	59(16)	68(20)	62(18)	67(19)	256(74)
	No	22(6)	11(3)	5(1)	5(1)	43(12)
	Yes	15(4)	13(4)	4(1)	15(4)	47(14)
Total		96(28)	92(26)	71(21)	87(25)	346(100)

Regardless of the amount of time spent outside, the majority of 346 respondents (256, 74%) indicated "Maybe" when asked if taking vitamin D supplements enhanced their energy or mood. Just 47 (13.6%) respondents clearly replied "Yes," while 43 (12.4%) responded "No." "Maybe" replies were highest among

those who spent 30 to 60 minutes outside (68), but "No" responses were significantly lower for the groups that spent less than 15 minutes (5) and more than an hour (5). It's interesting to note that those who were outside for 15–30 minutes (15) and more than an hour (15) had the greatest "Yes" response, whereas those who were outside

for less than 15 minutes had the lowest verified benefit (4 "Yes").

Overall, outdoor exposure time does not exhibit a strong or consistent pattern with perceived improvement from

supplementation because uncertainty ("Maybe") predominates across all groups, indicating that the majority of respondents may not be precisely monitoring or attributing changes in mood and energy to vitamin D intake.

7.4. Correlation Among Do you feel vitamin D supplementation has improved your mood or energy levels? * Do you regularly use sunscreen?		Do you regularly use sunscreen?		Total
		No	Yes	
Do you feel vitamin D supplementation has improved your mood or energy levels?	Maybe	131(38)	125(36)	256(74)
	No	25(7)	18(5)	43(12)
	Yes	23(7)	24(7)	47(14)
Total		179(52)	167(48)	346(100)

The majority of the 346 respondents (256, 74%) said that taking a vitamin D supplement "Maybe" enhanced their mood or energy, with results from sunscreen users (125) and non-sunscreen users (131) being similarly equal. Just 47 people (13.6%) gave a definite "Yes," divided nearly evenly between 24 sunscreen users and 23 non-users. In a similar vein, 43 (12.4%) responded "No," with somewhat more non-sunscreen users (25) than sunscreen

users (18) reporting no improvement. Comparing proportions, there was very little difference: 13.8% of sunscreen users (24/167) said "Yes" compared to 12.8% of non-users (23/179). Overall, the "Maybe" (uncertain) response consistently predominates across both groups, suggesting that sunscreen use does not significantly affect perceived advantages of vitamin D supplementation.

Section – 8 Correlation of PHQ-9

Matrix of PHQ- 9						
Variables	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Little interest	346	0	3	1.42	.946	.894
Sleeping difficult	346	0	3	1.02	1.004	1.008
Feeling tired	346	0	3	1.26	.906	.820
Poor appetite	346	0	3	1.08	1.038	1.078
Feeling bad yourself	346	0	3	1.20	1.115	1.242
Trouble concentrating	346	0	3	1.25	1.026	1.053
Moving	346	0	3	1.03	1.024	1.048
Thoughts	346	0	3	.69	.998	.997
Over all Severity	346	.00	22.00	8.9538	5.79837	33.621

Among the PHQ-9 symptom items assessed (N = 346, each scored 0–3), "Little interest or pleasure" (mean = 1.42) was the most frequently reported symptom, followed by "Feeling tired" (mean = 1.26) and "Trouble concentrating" (mean = 1.25). "Thoughts of self-harm" had the lowest mean (0.69), though this still indicates a meaningful subgroup experiencing such thoughts. "Feeling bad about yourself" showed the highest variability (SD = 1.115), meaning responses ranged widely across the sample. The computed composite score

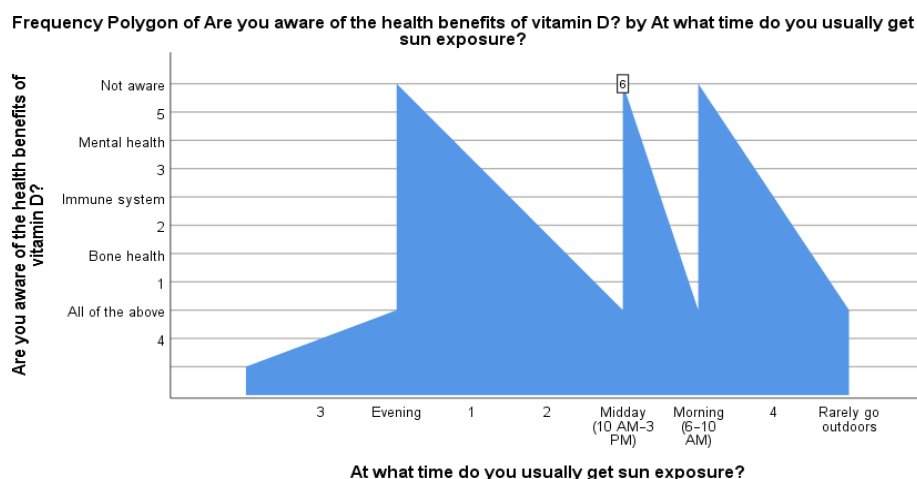
(d) ranged from 0 to 22, with a mean of 8.95 (SD = 5.80), indicating that, on average, respondents fall in the mild depressive symptom range. The high standard deviation relative to the mean shows considerable variation in symptom severity across individuals. Overall, the results suggest mild but variable depressive symptom levels in the sample, reinforcing the relevance of Vitamin D awareness and lifestyle factors examined elsewhere in the study.

Table 8.1: Distribution of Individual Symptoms and Overall Severity (N = 346)

Variables	0 (%)	Minimal (%)	Mild (%)	Moderate (%)
Little interest/pleasure	66 (19.1%)	113 (32.7%)	121 (35.0%)	46 (13.3%)
Sleeping problems	142 (41.0%)	82 (23.7%)	94 (27.2%)	28 (8.1%)
Feeling tired	77 (22.3%)	132 (38.2%)	106 (30.6%)	31 (9.0%)
Poor appetite	139 (40.2%)	77 (22.3%)	95 (27.5%)	35 (10.1%)
Feeling bad about yourself	124 (35.8%)	93 (26.9%)	66 (19.1%)	63 (18.2%)
Trouble concentrating	97 (28.0%)	117 (33.8%)	80 (23.1%)	52 (15.0%)
Moving/speaking changes	136 (39.3%)	104 (30.1%)	66 (19.1%)	40 (11.6%)
Thoughts of self-harm/death	218 (63.0%)	41 (11.8%)	63 (18.2%)	24 (6.9%)
Overall severity	-	202 (58.3%)	128(36.9%)	16 (4.6%)

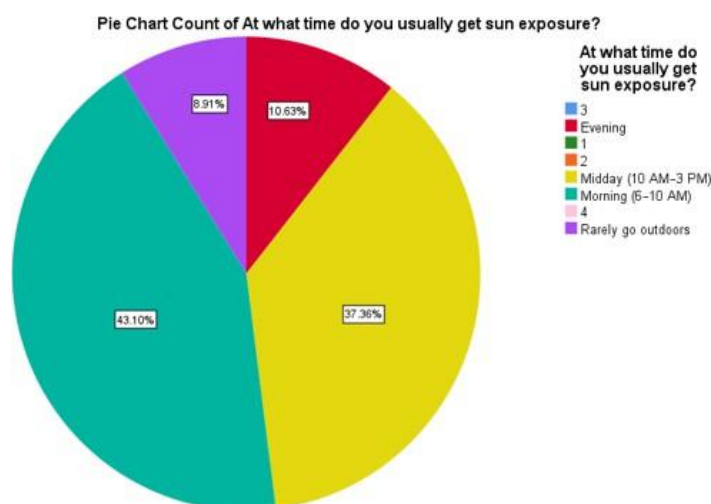
The most frequently reported symptom across all Nine depressive symptom items was little interest or pleasure, with 35.0% reporting mild symptoms and 32.7% reporting minimum symptoms. The two conditions with the highest prevalence of no symptoms were low appetite (40.2%) and sleep issues (41.0%). Psychomotor abnormalities, fatigue, self-doubt, and difficulty focusing were mostly observed at minimum to mild levels.

Clinically noteworthy, 25.1% of respondents reported having some thoughts of self-harm, despite 63.0% reporting no such ideas. Overall, 41.6% exhibited symptoms that needed more care, with 58.4% having minimal-to-mild depression, 21.1% having moderate depression, 15.9% having fairly severe depression, and 4.6% having severe depression.



The graph reveals that respondents who reported getting sun exposure during the evening and morning (6–10 AM) hours showed the highest concentration of responses (a frequency of 6) falling under the "Not aware" category of vitamin D benefits. This suggests that individuals who limit their sun exposure to these specific time windows — typically chosen to avoid peak UV intensity — may also have lower awareness of the health benefits associated with vitamin D. Overall, the trend

indicates a possible association between timing of sun exposure and awareness level of vitamin D benefits, with midday-exposure respondents demonstrating broader awareness compared to those exposed only during morning or evening hours. This finding may have implications for designing targeted health awareness campaigns that not only encourage adequate sun exposure but also educate individuals on the optimal timing for vitamin D synthesis.



Most respondents get sun exposure in the morning (6–10 AM) at 43.10%, making it the most preferred time, followed closely by midday (10 AM–3 PM) at 37.36%. Only 10.63% get sun exposure in the evening, while 8.91% report that they rarely go outdoors. Comparing the two peak periods, morning exposure is slightly more

common than midday, suggesting most people prefer cooler, early hours over the more intense midday sun. Overall, a large majority (over 80%) get sun exposure at some point during morning or midday hours, the times most effective for natural vitamin D synthesis.

Table 9: Final interpretation of study participants.

Association Tested	(χ^2)	df	p-value	Result
Vitamin D Belief vs Outdoor Hours	3.471	6	0.7478	Not significant
Vitamin D Belief vs Sunscreen Use	0.968	2	0.6162	Not significant
Vitamin D Belief vs Gender	3.845	2	0.1462	Not significant
Vitamin D Belief vs Mental Health Knowledge	14.492	4	0.0059	Significant (p<0.05)
Vitamin D Belief vs Sun Exposure Timing	11.055	6	0.0867	Not significant
Vitamin D Belief vs Educational Qualification	10.701	6	0.0981	Not significant
Vitamin D Belief vs Residential Area	0.089	2	0.9563	Not significant
Vitamin D Belief vs Clinical Depression Diagnosis	6.744	2	0.0343	Significant (p<0.05)
Vitamin D Belief vs Supplement Use	1.442	2	0.4862	Not significant
PHQ-9 Severity vs Vitamin D Belief	1.902	8	0.9839	Not significant
PHQ-9 Severity vs Gender	1.139	4	0.888	Not significant
PHQ-9 Severity vs Residential Area	0.478	4	0.9756	Not significant
PHQ-9 Severity vs Outdoor Hours	9.729	12	0.6397	Not significant
PHQ-9 Severity vs Sun Exposure Timing	21.944	12	0.0382	Significant (p<0.05)

DISCUSSION

Among the 346 participants, females (194; 56.1%) slightly outnumbered males (152; 43.9%), and the majority were graduates (280; 80.9%), students (241; 69.7%), and urban residents (214; 61.8%). Overall, 292 participants (84.4%) had heard about Vitamin D, while 158 (45.7%) believed that Vitamin D deficiency contributes to depression. Although belief was somewhat higher among individuals with more than 1 hour of outdoor exposure (50.6%) compared to those with less than 15 minutes (40.8%), the association was not statistically significant ($\chi^2=3.471$, $p=0.748$). Similarly, no significant associations were observed between Vitamin D belief and sunscreen use ($\chi^2=0.968$, $p=0.616$), gender ($\chi^2=3.845$, $p=0.146$), residential area ($\chi^2=0.089$, $p=0.956$), or sun exposure timing ($\chi^2=11.055$, $p=0.087$). However, participants who knew that Vitamin D deficiency could affect mental health were significantly more likely to believe in the Vitamin D–depression relationship ($\chi^2=14.492$, $p=0.006$), and those with a clinical diagnosis of depression also showed significantly stronger belief ($\chi^2=6.744$, $p=0.034$). Furthermore, PHQ-9 depression severity was significantly associated with sun exposure timing ($\chi^2=21.944$, $p=0.038$), suggesting a relationship between sunlight exposure patterns and depressive symptoms. Despite high awareness levels, only 70 participants (20.2%) reported using Vitamin D supplements, while 256 (74.0%) were unsure whether supplementation improved their mood or energy and only 47 (13.6%) reported a definite benefit, indicating a substantial awareness–action gap within the study population.

CONCLUSION

This study among 346 adults found a significant association between Vitamin D-related awareness and depression. Participants with better mental health knowledge were more likely to believe that Vitamin D deficiency contributes to depression ($\chi^2 = 14.492$, $p = 0.006$), and those with a clinical diagnosis of depression also showed stronger belief ($\chi^2 = 6.744$, $p = 0.034$). Furthermore, **PHQ-9 depression severity was significantly associated with sun exposure timing ($\chi^2 =$

21.944, $p = 0.038$). Despite high awareness of Vitamin D (84.4%), supplement use remained low (20.2%), indicating an awareness–action gap. These findings suggest that Vitamin D awareness and sunlight exposure patterns may be important factors related to depression among adults.

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