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THE VITAMIN D PARADIGM: A PLEIOTROPIC HORMONE AND THE CRITICAL KNOWLEDGE-PRACTICE GAP IN POPULATION HEALTH

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Abstract

Vitamin D, a seco-steroid hormone, has undergone a paradigm shift from a mediator of bone metabolism to a systemic pleiotropic regulator. This comprehensive study synthesizes contemporary evidence on its immunomodulatory, cardiovascular, neuroprotective, and anti-proliferative roles, mediated via the ubiquitously expressed vitamin D receptor (VDR). Serum 25-hydroxyvitamin D [25(OH)D] is the established biomarker, with deficiency (<50 nmol/L) linked to increased morbidity across multiple organ systems. To contextualize this knowledge within a specific population, we conducted a cross-sectional survey (n=126) assessing awareness, knowledge, and practices related to vitamin D within a Syrian cohort in Damascus. Results revealed a significant dissociation between high awareness and suboptimal practices: while 97.6% recognized the health risks of deficiency and 73% associated it with depression, 42.9% reported insufficient sunlight exposure, dietary intake was predominantly irregular, and 55.6% had never undergone serum 25(OH)D testing. Notably, 72.2% reported symptoms consistent with deficiency (fatigue, myalgia, bone pain), yet objective clinical assessment remained lacking. This pronounced knowledge-practice gap underscores a critical public health challenge. Our findings advocate for a dual-strategy approach: enhancing clinical protocols through targeted screening and management of high-risk individuals, and implementing precise, culturally adapted public health interventions that translate theoretical awareness into actionable behaviors—such as safe sun exposure guidelines, dietary modifications, and judicious supplementation. Future research must prioritize rigorous, long-term randomized controlled trials to define causal relationships and optimal thresholds for non-skeletal benefits. Ensuring vitamin D sufficiency represents a fundamental, modifiable component of holistic preventive medicine strategies against a broad spectrum of communicable and non-communicable diseases.

Keywords: Vitamin D**;** Pleiotropic Hormone**;** Knowledge-Practice Gap**;** Public Health Strategies**;** Serum 25-Hydroxyvitamin D**;** Population Survey**;** Preventive Medicine.

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I. INTRODUCTION

Vitamin D, a seco-steroid hormone traditionally recognized for its pivotal role in calcium-phosphate homeostasis and skeletal integrity, has undergone a profound scientific re-evaluation over recent decades.[1,2] Once considered primarily an anti-rachitic agent, vitamin D is now understood to be a critical pleiotropic signaling molecule, with its receptor (VDR) ubiquitously expressed in nearly every tissue in the human body.[3,4] This broad receptor distribution underscores its extensive physiological reach, implicating vitamin D in the modulation of a diverse array of biological processes far beyond bone metabolism, including immune regulation, cellular proliferation and differentiation, neuromuscular function, and inflammatory responses.[5,-8] The metabolic activation of vitamin D—from its inert dietary or cutaneous forms to the hormonally active 1,25-dihydroxyvitamin D [1,25$(OH)_2$D]—constitutes a tightly regulated endocrine and paracrine/autocrine system, positioning it as a key global regulator of gene expression.[9,10]

The assessment of vitamin D status, predominantly measured via serum 25-hydroxyvitamin D [25(OH)D] concentration due to its stability and reflection of total body stores, remains a subject of nuanced clinical debate.[11,12] While consensus defines deficiency as levels below 30 nmol/L (12 ng/mL) and insufficiency between 30–50 nmol/L (12–20 ng/mL), optimal thresholds for non-skeletal health outcomes are continually refined.[13,14] This diagnostic complexity parallels the multifaceted sources of vitamin D: endogenous synthesis in the skin triggered by ultraviolet B (UVB) radiation, selective dietary intake from fatty fish, fortified foods, and supplements in the forms of vitamin D_2 (ergocalciferol) and D_3 (cholecalciferol). [15-18] The efficiency of each pathway is influenced by a confluence of genetic, geographic, lifestyle, and environmental factors, contributing to the high global prevalence of hypovitaminosis D across diverse populations. [19,20]

A compelling and expansive body of epidemiological and mechanistic research has progressively linked vitamin D sufficiency to a decreased risk and improved outcomes in a spectrum of chronic diseases. Its immunomodulatory functions, particularly the induction of antimicrobial peptides like cathelicidin and the modulation of T-cell responses, have brought it to the forefront of research on infectious diseases, including respiratory tract infections and COVID-19.[21-25] In cardiometabolic health, vitamin D influences renin-angiotensin system activity, endothelial function, and insulin sensitivity, suggesting a protective role against hypertension, cardiovascular disease, and type 2 diabetes.[27,28] Oncological research highlights its anti-proliferative, pro-differentiating, and anti-angiogenic properties, with consistent observational data suggesting inverse associations with colorectal, breast, and prostate cancer risk. [29-33] Furthermore, evidence points to its potential neuroprotective effects in conditions like Parkinson's disease and cognitive decline, as well as its involvement in mental health, with deficiency correlated with higher risks of depression and anxiety. [34-40] Conversely, vitamin D deficiency represents a significant, modifiable public health burden, associated not only with classic bone disorders—rickets, osteomalacia, and osteoporosis—but also with

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increased susceptibility to autoimmune diseases (e.g., multiple sclerosis, type 1 diabetes), myopathy, and overall mortality.[41-46] The correction of deficiency through sensible sun exposure, dietary modification, and supplementation is a cornerstone of preventive medicine, though it must be balanced against the risks of excessive intake, which can lead to hypercalcemia and its attendant complications.[47-50]

This document presents a comprehensive scholarly revisitation of vitamin D, synthesizing current evidence on its metabolism, sources, multifaceted roles in health and disease, and the clinical implications of its deficiency and excess.[51-53] It further incorporates an original practical study assessing awareness, knowledge, and personal practices related to vitamin D within a specific community cohort.[54-60] By integrating foundational science with contemporary clinical and public health perspectives, this work aims to provide a holistic and updated framework for understanding this critical nutrient-hormone in modern healthcare and disease prevention strategies.[60-66]

II. MATERIALS AND METHODS

This study employed a cross-sectional, survey-based design to assess public awareness, knowledge, and personal practices related to vitamin D within a Syrian cohort, with a particular focus on Damascus. A structured, self-administered questionnaire was developed in Arabic, comprising four sections: (1) demographic data; (2) awareness and knowledge regarding vitamin D sources and health implications; (3) personal practices concerning sun exposure, diet, supplementation, and testing; and (4) perceived needs for public education.

The survey utilized a combination of multiple-choice and Likert-scale questions to capture quantitative data. A total of 126 participants were recruited via purposive and convenience sampling from community settings. Data were collected anonymously and analyzed descriptively using statistical software.

Frequencies and percentages were calculated for all categorical variables to summarize the distribution of responses across the surveyed domains, enabling a comprehensive profile of community-level understanding and behavioral patterns concerning vitamin D.[67]

III. RESULTS

A cross-sectional survey was conducted to evaluate the awareness, knowledge, and personal practices related to vitamin D within the Syrian population, with a focus on the capital, Damascus. The study aimed to delineate public understanding of vitamin D sources, deficiency consequences, and prevailing behavioral patterns. A total of 126 participants completed the questionnaire, providing insights into demographic characteristics, knowledge levels, and health-related behaviors.

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III-1- Demographic Characteristics of Participants

The cohort comprised predominantly young adults, with the largest proportion (42.9%, n=54) aged between 18–25 years, followed closely by those aged 26–35 years (41.3%, n=52). Participants aged 36–45 years, 46–60 years, and over 60 years represented 9.5% (n=12), 4.0% (n=5), and 0.8% (n=1), respectively, while only 1.6% (n=2) were under 18 years **Table 1**. The sample was overwhelmingly female (81%, n=102) compared to male (19%, n=24). Regarding occupational status, employees constituted the largest group (37.3%, n=47), followed by students (31.7%, n=40) and individuals identifying as "other" (31%, n=39).

Table 1: Demographic Profile of Survey Participants (n=126)

Characteristic	Category	Percentage (%)	Frequency (n)
Age	<18 years	1.6	2
	18–25 years	42.9	54
	26–35 years	41.3	52
	36–45 years	9.5	12
	46–60 years	4.0	5
	>60 years	0.8	1
Gender	Female	81.0	102
	Male	19.0	24
Occupation	Student	31.7	40
	Employee	37.3	47
	Other	31.0	39

III-2- Awareness and Knowledge Regarding Vitamin D

Public awareness of vitamin D sources and deficiency consequences was notably high. When asked to identify the primary source of vitamin D, 71.4% (n=90) correctly cited sunlight, while 19.0% (n=24) listed dietary sources such as fish, milk, and eggs (Figure 1).

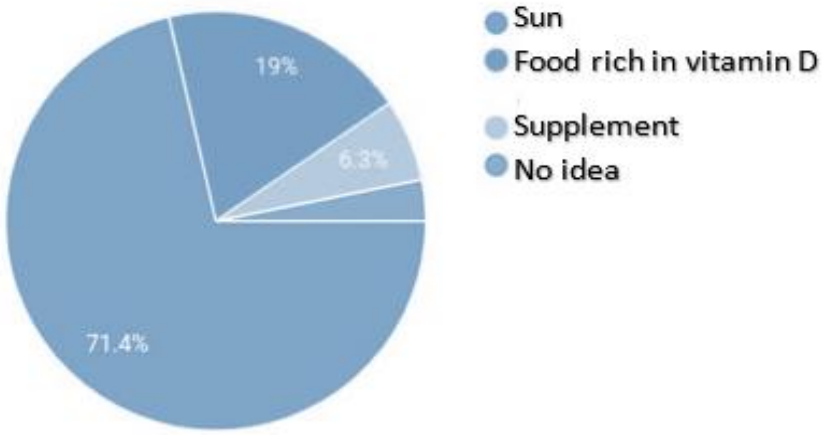

Figure 1: The main source of vitamin D

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An overwhelming majority (97.6%, n=123) acknowledged that vitamin D deficiency could lead to health problems (Figure 2).

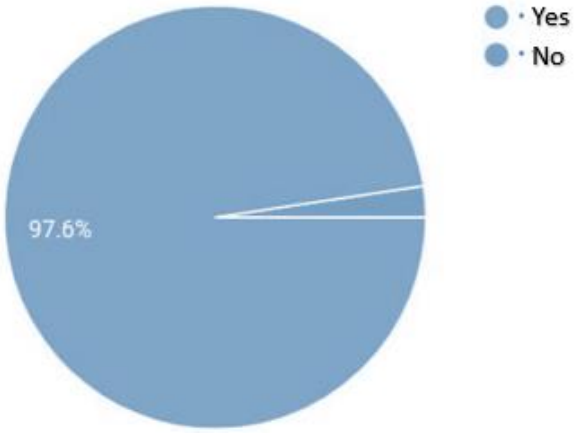

Figure 2: Vitamin d deficiency and health problems

Furthermore, participants demonstrated informed associations between deficiency and specific morbidities: 73.0% (n=92) linked it to depression, 65.1% (n=82) to osteoporosis, and 61.9% (n=78) to weakened immunity (Figure 3). Fewer participants associated deficiency with heart disease (8.7%, n=11) or diabetes (3.2%, n=4).

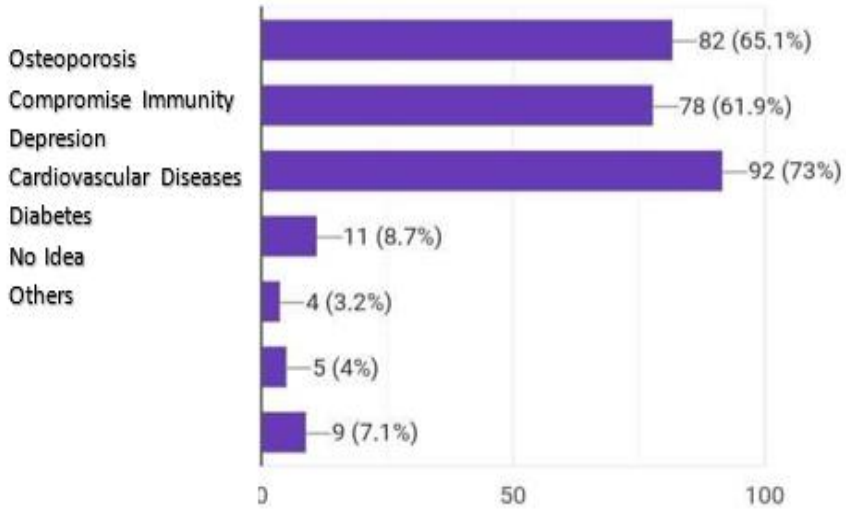

Figure 3: Vitamin d deficiency

Behavioral data regarding sun exposure revealed that 40.5% (n=51) spent 10–30 minutes daily under the sun, 28.6% (n=36) spent less than 10 minutes, and 15.9% (n=20) reported typically avoiding sun exposure (Figure 4).

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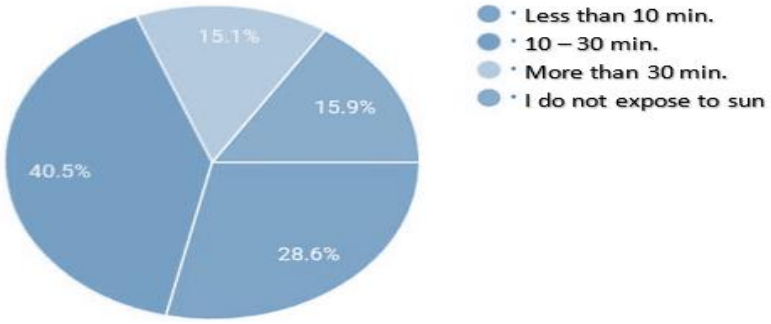

Figure 4: Time spends daily under the sun

A significant proportion (35.7%, n=45) reported feeling more active with increased sun exposure, while 34.1% (n=43) noted mood improvements, suggesting subjective recognition of sunlight's physiological and psychological benefits (Figure 5).

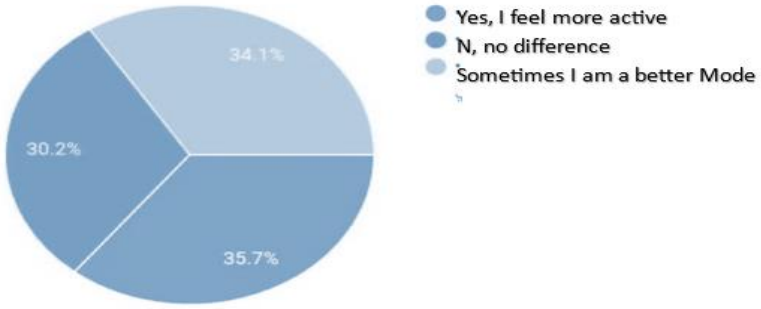

Figure 5: The sun and health

III-3- Personal Practices and Perceived Health Status

Vitamin D supplementation practices varied among participants: 46.8% (n=59) reported occasional use, 20.6% (n=26) regular use, and 32.5% (n=41) no use (Figure 6).

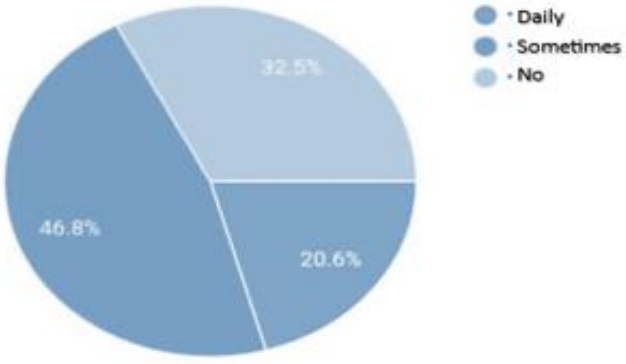

Figure 6: Vitamin d supplements

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Despite this, 42.9% (n=54) reported insufficient sunlight exposure in recent weeks (Figure 7).

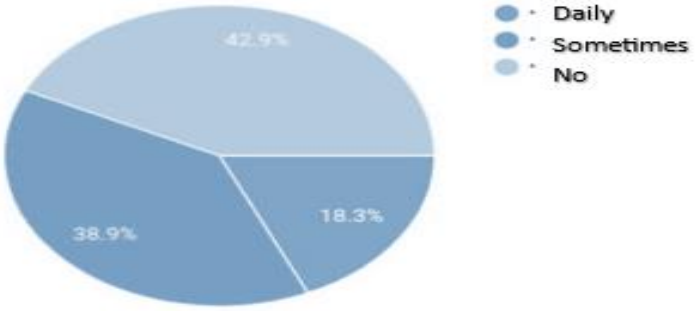

Figure 7: Spend time in the sun

Dietary intake of vitamin D-rich foods was common, with 57.9% (n=73) consuming such foods "sometimes" and 31.0% (n=39) "regularly" (Figure 8).

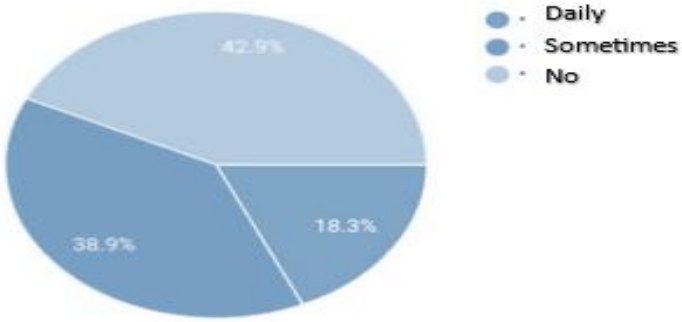

Figure 8: Vitamin D in the diet

Only 44.4% (n=56) of participants had ever undergone a blood test to determine their vitamin D status (Figure 9).

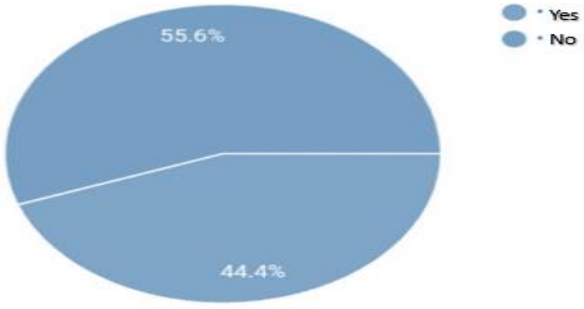

Figure 9: blood test for vitamin d level

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Among those tested, recall of specific results was poor: 54.8% (n=31 of tested) could not remember their levels. Of those who recalled, 22.2% (n=12) reported moderate deficiency (25–49 nmol/L), 15.1% (n=8) reported severe deficiency (<25 nmol/L), and only 7.9% (n=4) reported levels within the normal range (50–125 nmol/L) (Figure 10).

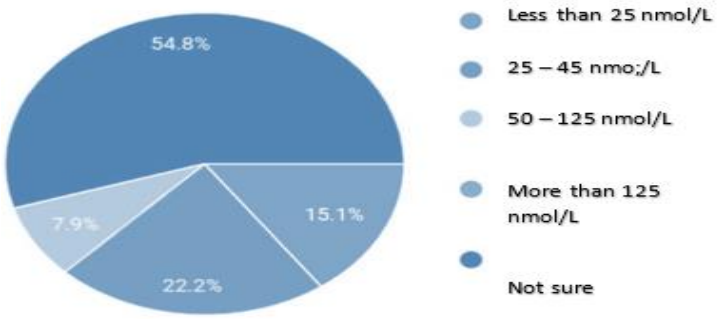

Figure 10: Vitamin d level

Notably, 72.2% (n=91) of all participants reported experiencing symptoms potentially linked to deficiency, such as bone pain, muscle weakness, or poor immunity (Figure 11).

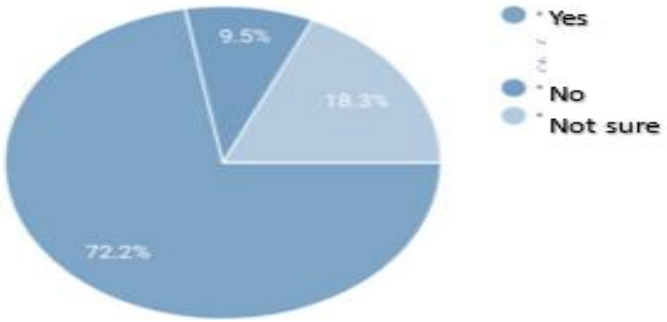

Figure 11: Health symptoms linked to vitamin d deficiency

Perceptions of personal vitamin D status reflected concern, with 40.5% (n=51) believing their levels were inadequate and 38.9% (n=49) being uncertain (Figure 12).

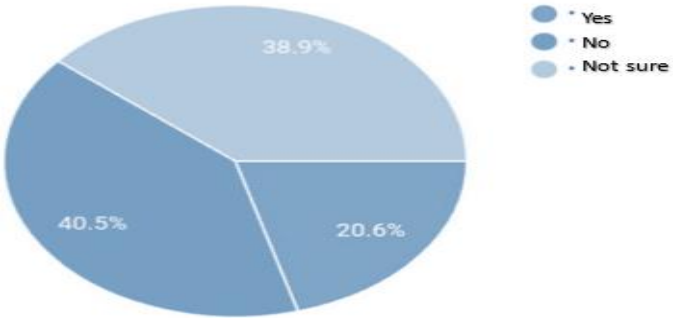

Figure 12: level of vitamin d in the body

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Despite this, regular sunscreen use was reported by 54.8% (n=69) of participants (Figure 13), indicating concurrent sun-protective behavior that may limit cutaneous vitamin D synthesis.

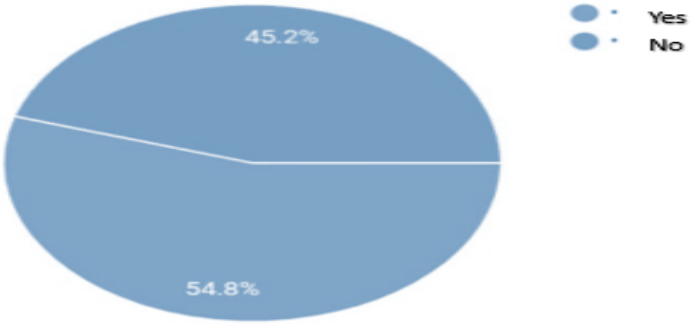

Figure 13: use of sunscreen

Strong consensus emerged on the public health importance of vitamin D. Nearly all participants (99.2%, n=125) agreed that deficiency significantly impacts overall health (Figure 14a), and 96.8% (n=122) endorsed the need for enhanced public awareness campaigns (Figure 14b).

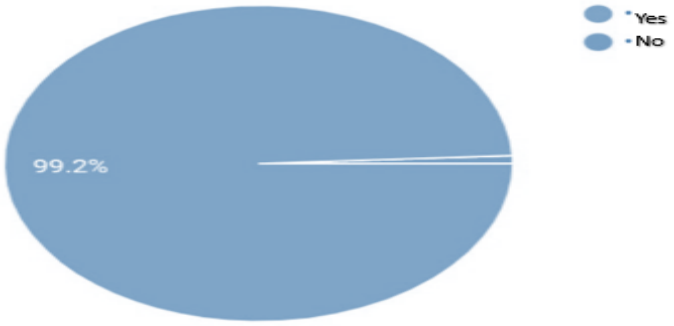

Figure 14a: Vitamin d deficiency and body health

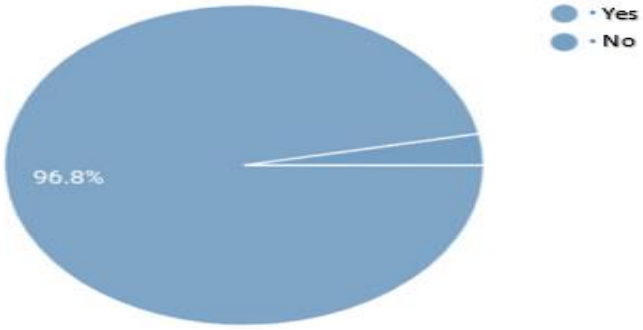

Figure 14b: Public awareness about importance of vitamin D

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Furthermore, 85.7% (n=108) believed in a link between vitamin D deficiency and psychological conditions like depression or anxiety (Figure 15).

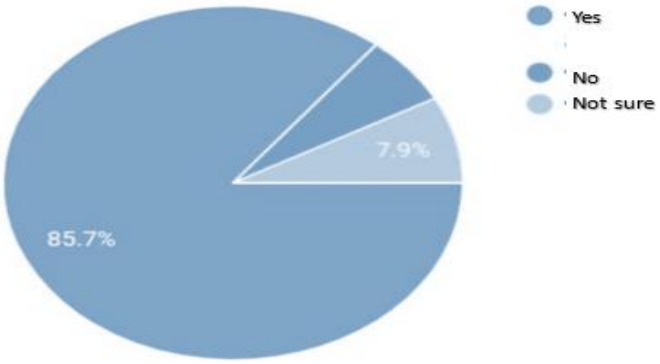

Figure 15: Vitamin D deficiency and depression

An overwhelming 90.5% (n=114) agreed that dietary supplementation is necessary to improve vitamin D levels (Figure 16a), and 97.6% (n=123) expressed a desire for more information on maintaining healthy vitamin D status (Figure 16b).

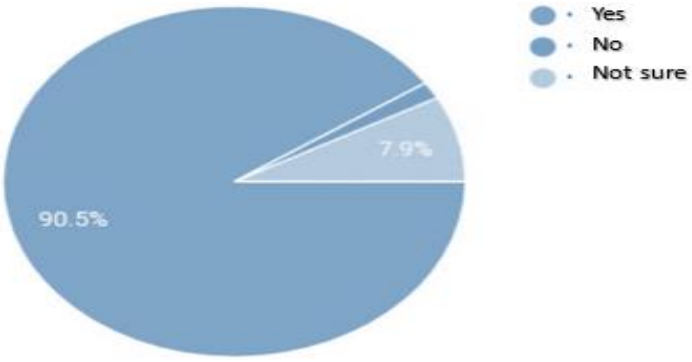

Figure 16a: Supplements improve vitamin d level

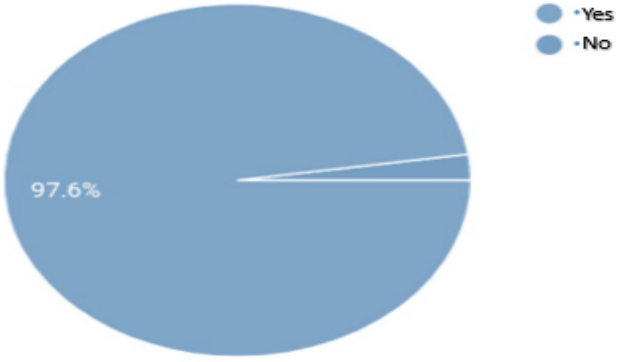

Figure 16b: Know more about vitamin D

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This survey reveals a Syrian population, predominantly young and female, with high theoretical awareness of vitamin D's importance, primary sources, and health implications, particularly regarding bone health, immunity, and mental well-being. However, this knowledge does not fully translate into proactive health practices. A concerning gap exists between awareness and action, evidenced by low rates of serum level testing, poor recall of results, high self-reporting of deficiency symptoms, and significant portions of the population avoiding sun exposure or using sunscreen regularly without compensatory measures. The strong expressed interest in further education highlights a critical opportunity for targeted public health interventions to bridge this knowledge-practice gap and address the evident burden of suspected vitamin D insufficiency.

IV. DISCUSSION

This study provides a comprehensive assessment of vitamin D awareness, knowledge, and practices among a sample of the Syrian population, predominantly in Damascus. The findings reveal a significant paradox: a population with high theoretical awareness of vitamin D's importance coexists with behavioral patterns and self-reported symptoms suggestive of a high prevalence of insufficiency or deficiency. This dissonance between knowledge and practice underscores critical gaps in public health education and clinical management in this Middle Eastern context. [67,68]

IV-1- High Awareness Amidst Perceived Deficiency

The survey data demonstrate a robust foundational knowledge regarding vitamin D. An overwhelming majority (97.6%) recognized that deficiency leads to health problems, and 71.4% correctly identified sunlight as the primary source, aligning with established physiological understanding. Notably, public perception has expanded beyond classical skeletal roles. The strong associations made between vitamin D deficiency and depression (73%) and weakened immunity (61.9%) reflect a growing public cognizance of its extraskeletal functions, supported by emerging evidence on vitamin D's role in neuroendocrine regulation and immune modulation. This high level of awareness likely stems from increased global media coverage, especially regarding vitamin D's potential role in immune health during the COVID-19 pandemic. Consequently, 96.8% of participants endorsed the need for more public awareness campaigns, indicating receptivity to further educational interventions.[69]

IV-2- The Knowledge-Practice Gap: Sun Exposure and Supplementation

Despite this awareness, a substantial knowledge-practice gap is evident. While sunlight is correctly identified as the key source, reported sun exposure habits are suboptimal for consistent vitamin D synthesis. Although 40.5% reported 10-30 minutes of daily exposure—a duration within recommended ranges for some populations 28.6% spent less than 10 minutes, and 15.9% actively avoided sun exposure. These behaviors, coupled with the widespread use of sunscreen (54.8%), create a scenario where

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cutaneous synthesis is likely compromised. Sunscreen with SPF ≥8 can significantly block UVB rays, and while real-world application is often imperfect, regular use indicates a conscious limitation of unprotected exposure. This creates a complex public health tension between advocating for sun exposure to prevent vitamin D deficiency and promoting sun protection to mitigate skin cancer risk.[70]

Dietary intake and supplementation patterns further illustrate this gap. While a majority (57.9%) reported consuming vitamin D-rich foods "sometimes," only 31% did so regularly, highlighting the challenge of relying on a diet naturally low in vitamin D in this region. Supplement use was common but inconsistent: 46.8% took supplements occasionally and only 20.6% regularly. This sporadic use is unlikely to correct a pre-existing deficiency and reflects a potential lack of guidance on appropriate dosing and duration. The strong belief (90.5%) that supplements are necessary to improve levels suggests public acceptance of pharmacological intervention, yet this has not translated into sustained, monitored use.[71]

IV-3- Clinical Assessment and Perceived Health Burden

A critical finding is the disconnect between perceived risk, symptomatic burden, and clinical verification. Alarmingly, only 44.4% of participants had ever undergone a serum 25(OH)D test, the gold-standard biomarker for status assessment. Among those tested, over half (54.8%) could not recall their results, indicating poor communication of health data or a lack of understanding of its significance. Of those who did recall, 37.3% reported levels indicative of moderate or severe deficiency (<50 nmol/L), a prevalence aligning with regional studies suggesting high deficiency rates in the Middle East due to cultural dress, sunscreen use, and environmental factors.[72]

This lack of biochemical testing contrasts sharply with the high burden of self-reported symptoms. A striking 72.2% of participants reported symptoms such as fatigue, bone pain, muscle weakness, and poor immunity—symptoms clinically associated with hypovitaminosis D. Furthermore, 40.5% believed their vitamin D levels were inadequate, and 38.9% were unsure, reflecting a pervasive sense of insufficiency. This subjective health burden, coupled with limited objective testing, points to a significant unmet need in routine healthcare screening and a potential over-reliance on symptomatic diagnosis.[73]

IV-4- Public Health Implications and Future Directions

The study's findings have several implications. First, they highlight that awareness alone is insufficient to drive behavioral change. Public health campaigns must evolve from merely informing about sources and risks to providing practical, culturally-adapted strategies. This includes clear guidance on balancing safe sun exposure (e.g., short periods without sunscreen) with skin cancer prevention, and promoting affordable, accessible food fortification programs, which are limited in Syria compared to Western nations.[74] Second, the data call for the integration of vitamin D status assessment into routine primary care, especially for high-risk groups (e.g., young women, those with minimal sun exposure).

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The low testing rate and poor result recall suggest a need for better patient-clinician communication and patient education regarding the interpretation and importance of 25(OH)D levels. Third, the strong public interest in learning more (97.6%) presents a clear opportunity. Educational interventions should be targeted, perhaps leveraging digital platforms, to address specific gaps: the importance of consistent supplementation over occasional use, the interpretation of blood tests, and the management of the sun exposure-sun protection dilemma.

IV-5- Limitations

This study has limitations. Its cross-sectional design precludes causal inferences. The sample, while providing valuable insights, is not nationally representative, with an overrepresentation of young, educated females from an urban center (Damascus), which may limit generalizability to rural populations or other demographic groups. Data on sun exposure and diet are self-reported and subject to recall bias. Most importantly, the study lacks objective, contemporaneous biochemical measurement of serum 25(OH)D to correlate with the reported knowledge, practices, and symptoms. This investigation reveals a Syrian population caught in a vitamin D paradox: enlightened about its crucial role in skeletal and extraskeletal health yet engaged in lifestyle and healthcare practices that predispose them to deficiency. The chasm between high awareness and inadequate practice, compounded by limited clinical verification despite a high symptomatic burden, signals an urgent need for a multifaceted public health strategy. Moving forward, efforts must bridge this gap by translating knowledge into actionable, personalized guidelines, enhancing clinical screening protocols, and implementing sustainable food-based solutions to mitigate the silent burden of vitamin D insufficiency in Syria.

V. CONCLUSION

Vitamin D, traditionally recognized for its pivotal role in calcium homeostasis and skeletal integrity, has emerged as a critical pleiotropic hormone with extensive systemic implications. This review synthesizes contemporary evidence elucidating the multifunctional contributions of vitamin D beyond bone metabolism, encompassing immunomodulation, cardiovascular regulation, neuroprotection, and oncological risk modulation. The principal circulating metabolite, 25-hydroxyvitamin D [25(OH)D], serves as the definitive biomarker of nutritional status, with concentrations below 50 nmol/L (20 ng/mL) widely indicative of deficiency and associated with increased morbidity. The pathophysiological sequelae of hypovitaminosis Dare profound and diverse. In skeletal tissue, insufficiency precipitates defective mineralization, manifesting as rickets and osteomalacia, and contributes to osteoporosis through impaired calcium absorption. Extraskeletal manifestations are equally significant, including myopathy characterized by proximal weakness, heightened susceptibility to respiratory infections—notably underscored during the COVID-19 pandemic through impaired innate immune response—and dysregulation of inflammatory pathways implicated in autoimmune conditions such as multiple sclerosis and type 1 diabetes. Epidemiological and

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mechanistic studies further suggest a cardioprotective role, with adequate 25(OH)D levels correlating inversely with hypertension, atherosclerosis, and cardiovascular mortality, potentially mediated via renin-angiotensin system modulation. Emerging evidence also points to neuroprotective effects, with vitamin D receptors abundant in critical brain regions, though causality in neurodegenerative disorders requires further elucidation. In oncology, while observational data link higher 25(OH)D levels to reduced risks of colorectal and other cancers, randomized controlled trials like VITAL demonstrate more nuanced outcomes, highlighting the complexity of isolating vitamin D's direct chemopreventive effects. Notwithstanding its benefits, a calibrated approach is imperative, as pharmacologic over-supplementation can induce hypercalcemia, nephrotoxicity, and vascular calcification. The interplay between vitamin D and various pharmacotherapies, including corticosteroids, statins, and thiazides, necessitates careful clinical management. Public health strategies must therefore prioritize the prevention of deficiency, particularly in high-risk demographics—including individuals with limited sun exposure, darker skin pigmentation, obesity, or advanced age—through sensible solar exposure, dietary fortification, and judicious supplementation. Future research should aim to refine optimal 25(OH)D thresholds for non-skeletal benefits, standardize assay methodologies, and clarify the efficacy of high-dose supplementation in disease-specific prophylaxis through robust, long-term interventional studies. Ultimately, maintaining vitamin D sufficiency represents a fundamental, modifiable factor in the holistic prevention of a broad spectrum of chronic communicable and non-communicable diseases.

References

1) Institute of Medicine, Food and Nutrition Board. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: National Academy Press, 2010.

2) Jones G. Vitamin D. In: Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR, eds. Modern Nutrition in Health and Disease, 11th ed. Philadelphia: Lippincott Williams & Wilkins, 2014.

3) Silva MC, Furlanetto TW. Intestinal absorption of vitamin D: a systematic review. Nutr Rev. 2018 Jan 1;76(1):60-76. doi: 10.1093/nutrit/nux034. PMID: 29025082.

4) Welsh J. Vitamin D and cancer: integration of cellular biology, molecular mechanisms and animal models. Scand J Clin Lab Invest Suppl 2012; 243: 103–11.

5) Roseland JM, Phillips KM, Patterson KY, Pehrsson PR, Taylor CL. Vitamin D in foods: An evolution of knowledge. Pages 41-78 in Feldman D, Pike JW, Bouillon R, Giovannucci E, Goltzman D, Hewison M, eds. Vitamin D, Volume 2: Health, Disease and Therapeutics, Fourth Edition. Elsevier, 2018.

6) Taylor CL, Patterson KY, Roseland JM, Wise SA, Merkel JM, Pehrsson PR, Yetley EA. Including food 25-hydroxyvitamin D in intake estimates may reduce the discrepancy between dietary and serum measures of vitamin D status. J Nutr 2014; 144:654-9.

7) Bouillon R. Comparative analysis of nutritional guidelines for vitamin D. Nat Rev Endocrinol 2017; 13:466-79.

8) Holick MF. Vitamin D deficiency. N Engl J Med 2007; 357:266-81.

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 68 Issue 12 | 2025
DOI: 10.5281/zenodo.17894451

9) U.S. Department of Health and Human Services. The Surgeon General's Call to Action to Prevent Skin Cancerexternal link disclaimer. Washington, DC: U.S. Dept of Health and Human Services, Office of the Surgeon General; 2014.

10) Hirsch AL. Industrial Aspects of Vitamin Dexternal link disclaimer. In: Feldman D, Pike JW, Adams JS, eds. Vitamin D. 3rd ed. Academic Press; 2011:73-93.

11) Tripkovic L, Lambert H, Hart K, Smith CP, Bucca G, Penson S, et al. Comparison of vitamin D2 and vitamin D3 supplementation in raising serum 25-hydroxyvitamin D status: A systematic review and meta-analysis. Am J Clin Nutr 2012; 95:1357-64.

12) van Driel M, van Leeuwen JPTM. Vitamin D and bone: a story of endocrine and auto/paracrine action in osteoblasts. Nutrients. Switzerland. 2023; 15:480.

13) N.Thallaj.Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/ Journal of Xi'an Shiyou University, Natural Sciences Edition.2022.65, 06. 289-301. DOI:10.17605/OSF.IO/W8RS5

14) N.Thallaj. Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/ Journal of Xi'an Shiyou University, Natural Sciences Edition.2022.65, 06. 313-328. DOI:10.17605/OSF.IO/K8RFE

15) Z. MALEK, A. ABBOOD, N. THALLAJ. Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/ Journal of Xi'an Shiyou University, Natural Sciences Edition.2022.65, 06. 302-312. DOI:10.17605/OSF.IO/K56XY

16) N.Thallaj. 2022. 65, 7, 169-184. Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/Journal of Xi'an Shiyou University, Natural Sciences Edition. DOI:10.17605/OSF.IO/7F23D

17) N.Thallaj. 2022. 65, 7, 110-142. Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/Journal of Xi'an Shiyou University, Natural Sciences Edition.DOI:10.17605/OSF.IO/KZRDJ

18) Machkour A, Thallaj NK, Benhamou L, Lachkar M, Mandon D.Chemistry. 2006 Aug 25;12(25):6660-8. P. https://doi.org/10.1002/chem.200600276.

19) Thallaj, N., Machkour, A., Mandon, D., Welter, R., New. J. Chem., 2005, 29, 1555 – 1558. https://doi.org/10.1039/B512108F

20) Thallaj NK, Rotthaus O, Benhamou L, Humbert N, Elhabiri M, Lachkar M, Welter R, Albrecht-Gary AM, Mandon D. Chemistry–A European Journal 14 (22), 6742-6753. 2008. https://doi.org/10.1002/chem.200701967

21) Wane A, Thallaj NK, Mandon D. Chemistry. 2009 Oct 12;15(40):10593-602. P10594-10595-10595. https://doi.org/10.1002/chem.200901350

22) Thallaj NK, Orain PY, Thibon A, Sandroni M, Welter R, Mandon D. Inorg Chem. 2014 Aug 4;53(15):7824-36. P7826-7828. https://doi.org/10.1021/ic500096h

23) N. K. Thallaj, J. Przybilla, R. Welter and D. Mandon, J. Am. Chem. Soc. 2008, 130, 2414-2415. https://doi.org/10.1021/ja710560g

24) N. K. Thallaj, D. Mandon and K. A. White, Eur. J. of Inorg. Chem., 2007, 44–47. https://doi.org/10.1002/ejic.200600789.

25) Thallaj, N.; International journal of applied chemistry and biological sciences 2021, 2 (4), 65-77. https://identifier.visnav.in/1.0001/ijacbs-21f-07003/

26) Thallaj, N. Review of a Few Selected Examples of Intermolecular Dioxygenases Involving Molecular Oxygen and Non-Heme Iron Proteins. Int. J. Adv. ParmaceuticalSci. Res. (IJAPSR) (2023)., 3, 1-18. DOI: 10.54105/ijapsr.C4011.023223

27) N.Thallaj. Indian journal of advanced chemistry, 2021. 1, 2, 20-26. DOI: 10.54105/ijac. B2009.101221

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 68 Issue 12 | 2025
DOI: 10.5281/zenodo.17894451

28) N.Thallaj. Indian journal of advanced chemistry, 2022. 2, 2, 1-11. DOI: 10.54105/ijac. D2015.102222

29) N.Thallaj. Indian journal of advanced chemistry, 2, 1, 2022. 5-9. DOI: 10.54105/ijac.C2012.041322

30) N.Thallaj. Indian journal of advanced chemistry, 2, 1, 2022. 10-14. DOI: 10.54105/ijac.C2013.041322

31) N.Thallaj. 2022. 65, 7, 110-142. Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/Journal of Xi'an Shiyou University, Natural Sciences Edition. DOI:10.17605/OSF.IO/KZRDJ

32) N Thallaj, (2023). 44, (6),21-29. Tishreen University Journal-Medical Sciences Series.

33) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2022. 2, 3,1-28. DOI: 10.54105/ijapsr.C4018.042322

34) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2023. 3, 2,1-18. DOI: 10.54105/ijapsr.C4016.062422

35) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2022. 2, 6,1-12. DOI: 10.54105/ijapsr.C4015.102622

36) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2023. 3, 3,1-10. DOI: 10.54105/ijapsr.C4012.043323

37) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2024. 4, 1,32-52. DOI: 10.54105/ijapsr. A4036.124123

38) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2024. 4, 5,29-49. DOI: 10.54105/ijapsr. E4049.04050824

39) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2024.4, 4,7-21. DOI: 10.54105/ijapsr. D4042.04040624

40) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2024.4, 6,7-27. DOI: 10.54105/ijapsr. F4054.04061024

41) N.Thallaj. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR) 2024.4, 6,33-48. DOI: 10.54105/ijapsr. F4055.04061024

42) Besherb S, Alallan L, Hassan Agha MA, AIshamas I, Thallaj N. Influence of soil salinity on the chemical composition of essential oil of Rosmarinus Officinalis in Syria, Research J. Pharm. and Tech. 2024; 17(5). DOI: 10.52711/0974-360X.2024.00358

43) Thallaj, N. (2024). Advancements in Pharmaceutical Science: Synthesis and Application of Molecular Cages Integrating N-Heterocyclic Carbenes for Enhanced Stability and Functionality. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR), 5(1), 6-19. DOI:https://doi.org/10.54105/ijapsr.A4063.05011224

44) Ayat Abbood, Hassan Hadi Ali, Samir Azzat Malik, Dima AlDiab, Nasser Thallaj. Investigation of the Charge Variant Profile of Non-cleavable Conjugated Antibodies. Research Journal of Pharmacy and Technology. 2025;18(1):185-0. doi: 10.52711/0974-360X.2025.00028

45) Thallaj, N. Analyzing Charge Variant Profiles of Monoclonal Antibodies Conjugated to Cytotoxic Agents. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR), Volume-4 Issue-3, april 2025, pages 20-26. DOI:10.54105/ijapsr.C4071.05030425

46) Thallaj, N. Biomimetic Synthesis and Phytochemical Analysis of Lodopyridone: Insights into 4-Pyridone Derivatives and Thiopeptide Antibiotic. Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR), Volume-4 Issue-3, april 2025, pages 9-19.
DOI: 10.54105/ijapsr. B4069.05030425

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 68 Issue 12 | 2025
DOI: 10.5281/zenodo.17894451

47) Mousa Al Khleif, Nour Alhuda Alzoubi, Ghassan Shannan, Zeina S Malek, Nasser Thallaj*. Exploring Circadian Rhythms:A Comprehensive Study on Sleep Patterns and Disorders in Syrian Society. Am J Biomed Sci & Res. 2025 26(2) AJBSR.MS.ID.003416, DOI:10.34297/AJBSR.2025.26.003416.

48) Ranim Abdul Rahman, Louai Alallan, Ahmed Khalid Aldhalmi, Nasser Thallaj. Separation, Determination, and Potential Application of Active Compounds in Porosopis cineraria: A Comprehensive Analysis. Research Journal of Pharmacy and Technology. 2025;18(4):1604-0. doi: 10.52711/0974-360X.2025.00230

49) Dalia Aboufakher, Rita Zeinaldin, Racha Khatib, Rawa Khreit, Mohamed Sami Joha, Nasser Thallaj. Prevalence and AntibioticResistance Patterns of Multidrug-Resistant Gram-Negative Bacilli in Hospitalized Patients in Sweida, Syria. Am J Biomed Sci & Res. 2025 26(3) AJBSR.MS.ID.003436, DOI: 10.34297/AJBSR.2025.26.003436.

50) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Advances in Supported Synthesis of Oligosaccharides Using Thioglycoside Donors. Am J Biomed Sci & Res. 2025 27(1) AJBSR.MS.ID.003528, DOI: 10.34297/AJBSR.2025.27.003528.

51) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Bioinspired Iron (III) Complexes: Catalysts for Sustainable Oxygen Atom Transfer Reactions. Am J Biomed Sci & Res. 2025 27(1) AJBSR.MS.ID.003516, DOI: 10.34297/AJBSR.2025.27.003516.

52) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Endosulfatases: Promising Therapeutic Targets in Cancer and Inflammatory Diseases. Am J Biomed Sci & Res. 2025 27(1) AJBSR.MS.ID.003523, DOI: 10.34297/AJBSR.2025.27.003523.

53) Ghassan Shannan, Zeina S Malek and Nasser Thallaj. Advancements in Monomolecular Multimodal Platforms for Cancer Theranostics. Am J Biomed Sci & Res. 2025 27(3) AJBSR.MS.ID.003569, DOI: 10.34297/AJBSR.2025.27.003569.

54) Z. MALEK,2022. 65, 7, 143-152. Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/Journal of Xi'an Shiyou University, Natural Sciences Edition. DOI:10.17605/OSF.IO/2UNHK

55) Besherb S, Alallan L, Hassan Agha MA, AIshamas I, Thallaj N. Influence of soil salinity on the chemical composition of essential oil of Rosmarinus Officinalis in Syria, Research J. Pharm. and Tech. 2024; 17(5). DOI: 10.52711/0974-360X.2024.00358

56) Ayat Abbood, Hassan Hadi Ali, Samir Azzat Malik, Dima AlDiab, Nasser Thallaj. Investigation of the Charge Variant Profile of Non-cleavable Conjugated Antibodies. Research Journal of Pharmacy and Technology. 2025;18(1):185-0. doi: 10.52711/0974-360X.2025.00028

57) SHANNAN, Ghassan; MALEK, Zeina S.; THALLAJ, Nasser. Advancements in Protein Synthesis: Triazole Multi-Ligation and Cycloadditions for Pharmaceutical Applications.

58) SHANNAN, Ghassan; MALEK, Zeina S.; THALLAJ, Nasser. Advancements in Protein Synthesis: Triazole Multi-Ligation and Cycloadditions for Pharmaceutical Applications.

59) SHANNAN, Ghassan; MALEK, Zeina S.; THALLAJ, Nasser. A Review of Antibiotic-Induced Drug Allergies: Mechanisms, Prevalence, And Future Perspectives. European Journal of Biomedical and Pharmaceutical Sciences (EJBPS), 2025, 12.4: 387-399.

60) THALLAJ, Nasser. Analyzing Charge Variant Profiles of Monoclonal Antibodies Conjugated to Cytotoxic Agents. International Journal of Advanced Pharmaceutical Sciences and Research (IJAPSR), 2025, 4.3: 20-26.

61) THALLAJ, Nasser, et al. Studying the efficacy of the plant extract of Tetracera scandens as an antidiabetic treatment. Latakia University Journal-Medical Sciences Series, 2023, 45.1: 33-44.

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 68 Issue 12 | 2025
DOI: 10.5281/zenodo.17894451

62) WANE, Amadou; THALLAJ, Nasser K.; MANDON, Dominique. Biomimetic Interaction between FeII and O2: Effect of the Second Coordination Sphere on O2 Binding to FeII Complexes: Evidence of Coordination at the Metal Centre by a Dissociative Mechanism in the Formation of μ-Oxo Diferric Complexes. Chemistry–A European Journal, 2009, 15.40: 10593-10602.

63) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Advancements in Protein Synthesis: Triazole Multi-Ligation and Cycloadditions for Pharmaceutical Applications. Am J Biomed Sci & Res. 2025 - 26(5). AJBSR.MS.ID.003481. DOI:10.34297/AJBSR.2025.26.003481

64) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Endosulfatases: Promising Therapeutic Targets in Cancer and Inflammatory Diseases. Am J Biomed Sci & Res. 2025 - 27(1). AJBSR.MS.ID.003523. DOI:10.34297/AJBSR.2025.27.003523

65) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Advances in Supported Synthesis of Oligosaccharides Using Thioglycoside Donors. Am J Biomed Sci & Res. 2025 - 27(1). AJBSR.MS.ID.003528. DOI:10.34297/AJBSR.2025.27.003528

66) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Bioinspired Iron (III) Complexes: Catalysts for Sustainable Oxygen Atom Transfer Reactions. Am J Biomed Sci & Res. 2025 - 27(1). AJBSR.MS.ID.003516. DOI:10.34297/AJBSR.2025.27.003516

67) Dalia Aboufakher, Rita Zeinaldin, Racha Khatib, Rawa Khreit, Mohamed Sami Joha, et al. Prevalence and Antibiotic Resistance Patterns of Multidrug-Resistant Gram-Negative Bacilli in Hospitalized Patients in Sweida, Syria. Am J Biomed Sci & Res. 2025 26(3) AJBSR.MS.ID.003436, DOI: 10.34297/AJBSR.2025.26.003436.

68) Samer alkhoury, Rasha Kateeb, Rawa Akasha and Nasser Thallaj*. Analysis of Crocin Content in Saffron (Crocus sativus L) Cultivated in Syria Using Liquid Chromatography-Mass Spectrometry. Am J Biomed Sci & Res. 2025 26(3) AJBSR.MS.ID.003443, DOI: 10.34297/AJBSR.2025.26.003443.

69) Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Advancements in Monomolecular Multimodal Platforms for Cancer Theranostics. Am J Biomed Sci & Res. 2025 27(3) AJBSR.MS.ID.003569, DOI: 10.34297/AJBSR.2025.27.003569.

70) Mousa Al Khleif, Nour Alhuda Alzoubi, Ghassan Shannan, Zeina S Malek and Nasser Thallaj*. Exploring Circadian Rhythms: A Comprehensive Study on Sleep Patterns and Disorders in Syrian Society. Am J Biomed Sci & Res. 2025 26(2) AJBSR.MS.ID.003416, DOI:10.34297/AJBSR.2025.26.003416.

71) Ahmed Alawadd, Ahmed Aldyry, Rasha Khatib, Rawa Akasha, Mohamed Sami Joha, et al. Serological prevalence of Brucella at the livestock-human interface in northeast of Deir al-Zor in Syria. Am J Biomed Sci & Res. 2025 28(2) AJBSR.MS.ID.003660, DOI: 10.34297/AJBSR.2025.28.003660.

72) Mouhmad Anwar Ahmeed, Maya Moeen Issa, Ibrahim Al Tamr, Ghassan Shannan and Nasser Thallaj*. Prevalence and Antibiotic Resistance Patterns of Urinary Tract Infections in Syrian Patients: A Comprehensive Analysis. Am J Biomed Sci & Res. 2025 28(1) AJBSR.MS.ID.003646, DOI: 10.34297/AJBSR.2025.28.003646.

73) Ahmed Alawadd, Ahmed Aldyry, Rasha Khatib, Rawa Akasha, Mohamed Sami Joha, et al. Serological prevalence of Brucella at the livestock-human interface in northeast of Deir al-Zor in Syria. Am J Biomed Sci & Res. 2025 28(2) AJBSR.MS.ID.003660, DOI: 10.34297/AJBSR.2025.28.003660.

74) Zeina S Malek, Ghassan Channan, Nasser Thallaj, Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/ Journal of Xi'an Shiyou University, Natural Sciences Edition.2025.68, 10. 1-35. DOI: 10.5281/zenodo.17321958.