

La relación entre las experiencias adversas en la infancia y la vitamina D: evidencia de una cohorte de adultos mayores.

The relationship between Adverse Childhood Experiences and Vitamin D evidence from: older adult cohort.

A relação entre experiências adversas na infância e a vitamina D: evidências de uma coorte de adultos mais velhos.

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Resumen

Introducción: En adultos mayores, las experiencias adversas pueden influir en enfermedades crónicas y en el estado nutricional. La vitamina D es esencial para la salud ósea y metabólica, y su deficiencia se relaciona con múltiples problemas en esta población. **Objetivo:** Evaluar la relación entre las experiencias adversas en la infancia y los niveles séricos de vitamina D en adultos mayores de Tabasco. **Materiales y Métodos.** Se incluyeron 88 adultos mayores de 60 años. Las experiencias adversas se evaluaron mediante una escala con puntuación de 0 a 10, agrupada en cuatro categorías. Los niveles de vitamina D se determinaron en muestras de suero mediante técnica inmunoenzimática. Se recolectaron variables sociodemográficas y clínicas, y se aplicaron pruebas estadísticas. **Resultados:** La edad promedio fue de 66 años y predominó el sexo femenino. Una proporción importante presentó al menos una experiencia adversa. No se encontró asociación estadísticamente significativa entre estas experiencias y los niveles de vitamina D; sin embargo, se observó una tendencia a niveles más bajos conforme aumentaba la adversidad. Se identificaron asociaciones significativas con la edad, la ocupación y la actividad física. **Discusión:** Aunque no hubo asociación significativa, los resultados sugieren que una mayor exposición a experiencias adversas podría relacionarse con menor vitamina D. Factores como envejecimiento, empleo y actividad física pueden influir en esta relación. **Conclusiones:** Las experiencias adversas en la infancia no mostraron relación significativa con la vitamina D, pero se observó una tendencia, por lo que se requieren estudios futuros para profundizar en estos hallazgos.

Palabras claves: vitamina D; adversidad; adulto mayor.

Abstract

Introduction: In older adults, adverse experiences can influence chronic diseases and nutritional status. Vitamin D is essential for bone and metabolic health, and its deficiency is associated with multiple problems in this population. **Objective:** To evaluate the relationship between adverse childhood experiences and serum vitamin D levels in older adults from Tabasco. **Materials and Methods:** Eighty-eight adults over 60 years of age were included. Adverse experiences were assessed using a scale with scores from 0 to 10, grouped into four categories. Vitamin D levels were determined in serum samples using an enzyme immunoassay. Sociodemographic and clinical variables were collected, and statistical tests were applied. **Results:** The average age was 66 years, and females predominated. A significant proportion had at least one adverse experience. No statistically significant association was found between these experiences and vitamin D levels; however, a trend toward lower levels was observed as the adversity increased. Significant associations were identified with age, occupation, and physical activity. **Discussion:** Although no significant association was found, the results suggest that greater exposure to adverse experiences

may be related to lower vitamin D levels. Factors such as aging, employment, and physical activity may influence this relationship. **Conclusions:** Adverse childhood experiences did not show a significant relationship with vitamin D, but a trend was observed, so further studies are needed to explore these findings further.

Keywords: vitamin D; adversity; older adult.

Resumo

Introdução: Em idosos, experiências adversas podem influenciar doenças crônicas e o estado nutricional. A vitamina D é essencial para a saúde óssea e metabólica, e sua deficiência está associada a múltiplos problemas nessa população. **Objetivo:** Avaliar a relação entre experiências adversas na infância e os níveis séricos de vitamina D em idosos de Tabasco. **Materiais e Métodos:** Oitenta e oito adultos com mais de 60 anos de idade foram incluídos no estudo. As experiências adversas foram avaliadas utilizando uma escala com pontuação de 0 a 10, agrupadas em quatro categorias. Os níveis de vitamina D foram determinados em amostras de soro por meio de um ensaio imunoenzimático. Variáveis sociodemográficas e clínicas foram coletadas e testes estatísticos foram aplicados. **Resultados:** A idade média foi de 66 anos, com predominância do sexo feminino. Uma proporção significativa relatou pelo menos uma experiência adversa. Não foi encontrada associação estatisticamente significativa entre essas experiências e os níveis de vitamina D; entretanto, observou-se uma tendência a níveis mais baixos com o aumento da adversidade. Associações significativas foram identificadas com idade, ocupação e atividade física. **Discussão:** Embora nenhuma associação significativa tenha sido encontrada, os resultados sugerem que uma maior exposição a experiências adversas pode estar relacionada a níveis mais baixos de vitamina D. Fatores como envelhecimento, emprego e atividade física podem influenciar essa relação. **Conclusões:** Experiências adversas na infância não apresentaram relação significativa com a vitamina D, mas observou-se uma tendência, sendo necessários mais estudos para explorar esses achados com maior profundidade.

Palavras-chave: Vitamina D; adversidade; idoso.

Introduction

The prevalence of Adverse Childhood Experiences (ACEs) is reported globally in European countries (such as France and England) that over 23.5% of the population lifespan development at least have one ACEs (Madigan et al. 2023). In Asia, particularly in China, the prevalence of ACEs is high, reaching 46% to 47% of Chinese adults (Wang et al. 2026, He et al. 2024). Moreover, in America is estimated that nearly 60% of adults have experienced one or more types of ACEs (Jones et al., 2020). Data of the National Project on Adverse Experiences in Mexico (acesmexico.org) showed that in Tabasco the prevalence of having at least one is 73.7%, and more than four is 40.0%. Therefore, high prevalence of ACEs highlights the necessity of further studies.

The ACEs refer to various negative events or environmental factors experienced during childhood that have a profound and long-term impact on a child's physical, psychological, and social behavior, affecting life development and increasing the risk of stressors associated with a decline in physical, psychological, and social health throughout life (Joshi et al., 2021, Petruccelli et al., 2019, Lin et al., 2021). Furthermore, because there is evidence that showed that ACEs entails a chronic inflammation state in the individuals that result in health problems (Lin et al., 2021, Tian et al., 2019). In particular, it has been reported that a major number of ACEs is strongly associated with multiple comorbidities. For example, in older adults with ACEs present clinical manifestations of musculoskeletal pain, cardiometabolic disorders, mental health issues and other traits that increase mortality rates adults (Jin & Lin, 2025, Lin et al., 2021, Petruccelli et al., 2019). Therefore, is vital to understand the biological effects of ACEs in a long-term, particularly in older adults that are predispose to present multiple comorbidities that decrease their quality life and lifespan.

An important factor that could help us understand the biological effects of ACEs is the assessment of nutritional biomarkers, which provide an overview of a person's health status. In this context, vitamin D is well known for its critical role in the metabolism of multiple tissues. One of the most important is the musculoskeletal system, where vitamin D deficiency is associated with bone fragility, weakness in walking, and an increased risk of fractures health effects that are very common in older (Giustina et al., 2023, Norman et al., 2021). Moreover, some studies on biological changes in the hypothalamic-pituitary-adrenal (HPA) axis have indicated that vitamin D dysregulation can trigger biological changes such as those affecting the HPA axis the primary stress response system since the continuous release of cortisol leads to chronic inflammation and metabolic changes that can reduce the synthesis, activation, or availability of vitamin D in older adults increasing susceptibility to depression and anxiety (Zmijewski, 2019). This vitamin D deficiency may be due to several factors, including reduced sun exposure, a decreased ability of the skin to produce vitamin D, and reduced absorption in the gastrointestinal tract. Additionally, age, sex, and

demographic characteristics such as marital status, family environment, and depression are associated with this deficiency, as older adults may lack access to specialized care (Albuloshi et al., 2022).

Studying the relationship between ACE and vitamin D levels could provide a broader perspective and address not only mental health needs but also related conditions that may arise, as a significant number of ACE have been found to be closely linked to multiple comorbidities. Consequently, our objective is to evaluate the relationship between adverse childhood experiences and vitamin D in a group of older adults.

Materials and Methods

Participant's characteristics

The participants were obtained through a structured interview and direct measurements performed by previously trained personnel. The sociodemographic variables collected included age (between 60 and 83 years), sex (71.59% women and 28.40% men), marital status (61.36% single and 38.63% in a relationship), occupation (21.59% employed and 78.40% unemployed), and living arrangements (21.59% living alone or 78.40% living with family members); in addition, relevant clinical variables were recorded, such as comorbidities (<1: 65.90% and >2: 38.63%), medication use, (yes, 67.04% and no, 32.95%), physical activity (yes, 22.72% and no, 77.27%), alcohol consumption (yes, 9.09% and no, 90.90%), and smoking (yes, 3.40% and no, 96.59%).

A total of 88 older adults agreed to participate in the study. They were recruited through home visits, social media advertisements, day centers, and gerontological centers. Eligibility criteria included: adults over 60 years of age residing in the state of Tabasco, agreeing to participate in the study and signing the informed consent form, and not having traveled outside the state within the past three months. Exclusion criteria were: subjects who reported stays of more than one month in another state during the last two years; withdrawal of consent to participate in the study; refusal to provide a sample; insufficient sample size; incomplete information from clinical interviews that prevented diagnosis; failure to fast; hemolyzed blood samples; lipidemic blood samples; and difficulty in obtaining the sample.

The participants were obtained through a structured interview and direct measurements performed by previously trained personnel. Socio-demographic variables collected included age, sex, marital status, occupation, and family living arrangements (living alone or with relatives), in addition, relevant clinical variables such as comorbidities, medication use, physical activity, alcohol consumption, and smoking were recorded.

Adverse Childhood Experiences (ACEs)

Exposure of ACEs was assessed by Adverse Childhood Experiences scale, which addresses 10 individual ACEs under three categories: i) abuse: emotional, physical and sexual abuse, ii) neglect: emotional and physical neglect and iii) household dysfunction: parental separation/divorce, violence against mother, household substance abuse, household mental illness and incarceration of household member. The total score is calculated by summing the reported adverse experiences, with a range of 0 to 10 points, where higher scores indicate greater exposure to traumatic events during childhood. The Cronbach's alpha coefficient for this scale in its Spanish version is 0.89. (Rojas et al., 2025)

Vitamin D measurements

The specimens were serum type. The samples were stored at -20°C until use. Circulating levels of 25-hydroxyvitamin D were determined using an Accubind commercial ELISA kit (Monobind Inc., Lake Forest, CA 92630, USA). Following this, the analysis was performed in duplicate, 50µl of the specimen was used.

Statistical analysis

The data obtained were analyzed using descriptive and inferential statistics. Categorical variables were presented as absolute frequencies and percentages, while continuous variables were summarized as mean $\pm$ standard deviation. For comparisons, Student's t-test was used when the assumption of normality was met; otherwise, a one-way ANOVA was used. Associations between categorical variables were analyzed using the chi-square test (X^2). ACEs were analyzed, classifying participants into four classifications based on score of adversity: 0, 1, 2–3, ≥ 4 . In all analyses, a p-value < 0.05 was considered statistically significant. These statistical analyses were performed using Prisma software.

Ethical considerations

Furthermore, the study adhered to the statements of the Declaration of Helsinki, and the local ethics committee approved the study protocol with the registration UJAT-CIEI-2026-031.

Results

Characteristics of the sample

The study population consisted of 88 older adults, with a mean age of 66.1 ± 6.0 years. Females predominated, representing 71.59% of the sample, compared to 28.40% males. Regarding adverse experiences, the majority of participants reported no adverse events (35.22%). However, a significant proportion reported some degree of adverse experience, with classifications score: 0= 35.2%, 1=29.54%, 2-3=25.04%, and >4=10.22%. Other data such as marital status, occupation, family nest, comorbidity, drug use, sports activity, alcohol consumption, cigarette consumption are described in Table 1.

Table 1. General characteristics of older adults.

Variable		n= 88 (100%)
Age in years	Mean $\pm$ DE (range)	66.1 $\pm$ 6.0 (60-83)
	Sex	
	Male	25(28.40)
Marital status	Female	63(71.59)
	With Partner	34(38.63)
	Without partner	54(61.36)
Occupation	Employed	19(21.59)
	Unemployed	69(78.40)
Household composition	Living alone	19(21.59)
	Living with family	69(78.40)
Comorbidity	≤ 1	58(65.90)
	≥ 2	34(38.63)
Medication use	Yes	59(67.04)
	No	29(32.95)
Physical activity	Yes	20(22.72)
	No	68(77.27)
Alcohol consumption	Yes	8(9.09)
	No	80(90.90)
Smoking	Yes	3 (3.40)
	No	85(96.59)
Adverse childhood experiences	0	31 (35.22)
	1	26(29.54)
	2-3	22(25.04)
	>4	9(10.22)

Nota: DE: Standard deviation.

Adverse childhood experiences and vitamin D levels.

To analyze the potential effects of the number of ACEs on vitamin D levels in older adults, sociodemographic and clinical data were correlated with the number of ACEs, as shown in Table 2. Firstly, Vitamin D levels observed according to the four categories were ACEs =0 (47.64), ACEs =1 (49.58), ACEs =2-3 (45.24) and ACEs $\geq$ 4 (42.56). Secondly, the analyzed based on the age of older adults reveal a statical significant (ACEs 0= 48.92, ACEs 1=50.31, ACEs 2-3=46.87 and ACEs $\geq$ 4=43.15, $p = 0.041$). In addition, occupation was stratified on two group employed (EM) and unemployed (UEM), and significant difference ($p=0.49$) was found in ACEs 0 (EM=, UEM=), ACEs 1 (EM=, UEM=), ACEs 2-3 (EM=, UEM=) and ACEs $\geq$ 4 (EM=, UEM=) groups. In the same form, the analysis based on physical activity was stratified on two group (Yes= you practice any exercise) and (No= does not practice any exercise) showed significant difference ($p = 0.028$) in ACEs 0 (yes=, no=), ACEs 1 (yes=, no=), ACEs 2-3 (yes=, no=) and ACEs $\geq$ 4 (yes=, no=) groups. The table 2 showed the other variables studied.

Table 2. Adverse childhood experiences and the general characteristics.

		VITAMIN D (MEAN)				
<i>Variable</i>		ACE=0	ACE=1	ACE =2-3	ACE =>4	P
Vitamin D levels (mean)		47.64	49.58	45.24	42.56	0.621
Age (years)	66.1 ± 6.0	48.92	50.31	46.87	43.15	0.041
Sex	Male	45.98	47.66	43.02	41.72	0.067
	Female	46.85	48.72	44.11	41.03	
Marital status	With Partner	48.39	50.12	46.02	43.88	0.058
	Without partner	48.77	50.63	46.12	43.54	
Occupation	Employed	46.38	47.92	44.08	41.27	0.049
	Unemployed	49.12	51.08	46.55	44.02	
Household composition	Living alone	45.97	47.36	43.82	40.95	0.089
	Living with family	46.11	47.28	43.67	40.88	
Comorbidity	≤1	48.95	50.72	46.31	43.21	0.072
	≥2	48.22	51.56	41.51	44.37	
Medication use	Yes	46.21	45.12	50.62	38.94	0.093
	No	47.02	49.11	44.38	41.62	
Physical activity	Yes	48.83	50.74	46.27	43.58	0.028
	No	49.88	52.03	47.45	44.91	
Alcohol consumption	yes	45.71	47.18	43.26	40.73	0.131
	No	47.36	48.92	44.67	42.01	
Smoking	Yes	48.41	50.36	46.18	43.36	0.061
	No	46.02	47.31	43.58	40.97	

Discussion

First, the analysis of vitamin D and ACE did not show statistical significance. However, we observed a trend in the overall means shown in Table 2, indicating that older adults with more adverse childhood experiences tended to have lower vitamin D levels. Furthermore, recent studies suggest that vitamin D not only influences nutritional status, but may also be influenced by psychosocial factors, such as chronic stress and lifestyles resulting from early exposure to adversity (Zmijewski, 2019). This finding suggests that adversity experienced during childhood may

have biological and behavioral effects throughout life, persisting into old age and potentially influencing nutritional biomarkers such as vitamin D. Recent studies have indicated that ACEs can disrupt multiple physiological systems related to aging, increasing susceptibility to chronic diseases and functional decline (Toth et al., 2023; De Rubeis et al., 2023).

One possible explanation for this relationship involves the chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis induced by early-life stress. ACEs have been linked to prolonged cortisol release, neuroendocrine dysfunction, and a chronic low-grade inflammatory state throughout life (Lin et al., 2021). Persistent inflammation can disrupt vitamin D metabolism by reducing its synthesis, activation, or bioavailability. Furthermore, this chronic inflammation has been linked to oxidative stress and increased vitamin D catabolism, which would explain the lower concentrations observed in older adults with greater exposure to adverse experiences. Similarly, recent research suggests that vitamin D plays a role in regulating the HPA axis and in modulating neuroinflammatory processes associated with stress and depression (Zmijewski, 2019; Shu et al., 2025).

In addition to the biological mechanisms involved, psychosocial and behavioral factors may also contribute to this association. The people exposed to ACEs often exhibit symptoms of depression, anxiety, social isolation, sedentary lifestyles, and poor dietary habits in adulthood (De Rubeis et al., 2023; Lin et al., 2021). These conditions may reduce outdoor activity and sun exposure, which are the primary sources for vitamin D synthesis. In our study, physical activity showed a statistically significant association with vitamin D levels, supporting the hypothesis that lifestyle-related factors may influence the impact of ACEs on nutritional status. Physically active older adults had higher vitamin D concentrations, possibly due to increased physical activity and sun exposure. Similar findings have been reported by Gu et al. (2024), who observed that physical activity contributes to improved vitamin D metabolism and reduced frailty in older adults.

Furthermore, age was also found to be significantly associated with vitamin D levels. Aging is associated with a reduction in cutaneous vitamin D synthesis, decreased renal function, and reduced gastrointestinal absorption (Wang et al., 2024; Albuloshi et al., 2022). Therefore, the biological effects of ACEs may accumulate over time and manifest more intensely in old age, a critical stage during which the body's physiological capacity declines and vulnerability to chronic inflammation, frailty, and metabolic disorders increases. This supports the life-course perspective, which proposes that adverse childhood experiences may contribute to accelerated biological aging (Toth et al., 2023).

Similarly, occupation was associated with vitamin D levels in our study population. Previous studies have shown that ACE are associated with lower educational attainment, fewer job opportunities, and socioeconomic

disadvantages in adulthood (Petrucelli et al., 2019). These factors may indirectly affect vitamin D levels through poorer diet quality, limited access to health care, increased psychological distress, and reduced participation in outdoor activities.

Another important aspect that cannot be overlooked is the neuropsychiatric role of vitamin D. There is evidence that vitamin D receptors are widely distributed in brain regions such as the hypothalamus, pituitary gland, adrenal cortex, and throughout the HPA axis, which are involved in emotional regulation (Ceolin et al., 2023). Vitamin D deficiency has been associated with depression, cognitive decline, and anxiety conditions frequently reported in individuals with high exposure to ACEs (Albolushi et al., 2022; Shu et al., 2025). Therefore, vitamin D could serve not only as a nutritional biomarker but also as a potential neurobiological mediator linked to childhood adversity and to physical and mental impairments in old age.

Conclusions

Although there was no statistically significant association between ACE and vitamin D levels in older adults, the observed trend toward lower vitamin D concentrations as ACE increases should not be ignored. These results support the possibility that ACE exerts biological and behavioral effects that persist throughout life and are capable of influencing nutritional biomarkers such as vitamin D during aging.

Furthermore, geographical, social, and cultural contexts underscore the need for further research on adverse childhood experiences (ACEs) in countries such as Mexico to better understand their impact on the population's health and, in this way, enrich the global understanding of how these factors shape ACEs in older adults. Similarly, understanding the impact of ACEs in Mexico and other Latin American countries is crucial for addressing and mitigating their effects on the older adult population, laying the groundwork for international policies and the development of tailored strategies, and reducing public health costs

Conflict of interest

The authors declare no conflict of interest.

Use of artificial intelligence (IA)

The authors declare that they did not use any generative artificial intelligence applications, software, or websites in the writing of the manuscript, the design of tables and figures, or the analysis and interpretation of the data.

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