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Overcoming Adherence Barriers in Adult ADHD: A Narrative Review of Cumulative Vitamin D Supplementation Strategies

Joanna Katarzyna Żukowska
https://orcid.org/0009-0003-8597-5447
j.zukowska21@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Agata Chrobak
https://orcid.org/0009-0004-3370-5290
a.chrobakk@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Ewa Kacynel
https://orcid.org/0009-0002-8290-9818
evakatsynel@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Wiktoria Myślicka
https://orcid.org/0009-0005-5209-6504
vika.myslitskaya01@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Lizaveta Zhukava
https://orcid.org/0009-0007-8328-2232
zhukavalizaveta@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Darya Volkava
https://orcid.org/0009-0009-2811-146X
darjawolkawa@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Volha Sakovich
https://orcid.org/0009-0009-1768-1512
sakovich.olka@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Kai-Chiun Weng
https://orcid.org/0009-0006-5519-537X
a0939303669@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Kateryna Bessmylna
https://orcid.org/0009-0009-9220-9162
kateryna.bessmylna@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Alesia Kravets
https://orcid.org/0009-0003-2532-4458
alesiakravets.a@gmail.com
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland

Corresponding Author

Joanna Katarzyna Żukowska, j.zukowska21@gmail.com

Abstract

Background. Vitamin D is an essential neurosteroid affecting the central nervous system and dopaminergic pathways. Adults with attention-deficit/hyperactivity disorder (ADHD) are particularly susceptible to its deficiency. Adherence to daily supplementation can be a major challenge for them. ADHD-specific executive dysfunction and memory deficits make daily routines demanding, often causing treatment discontinuation. This untreated deficiency exacerbates core symptoms of the disorder.

Aim. This narrative review provides a rationale for using cumulative, infrequent vitamin D dosing to reduce memory reliance and improve adherence among adults with ADHD.

Materials and methods. We searched the PubMed, Scopus, and Google Scholar databases. Data from guidelines, meta-analyses, reviews, randomized controlled trials (RCTs), and qualitative research on neurobiology, pharmacokinetics, safety, and behavioral sciences were synthesized regarding therapeutic adherence.

Results. Adults with ADHD exhibit high rates of daily medication non-adherence due to their cognitive profile. Intermittent cumulative dosing (e.g., 10,000 IU weekly or 30,000 IU monthly) is as effective as daily dosing in maintaining optimal 25-hydroxyvitamin D [25(OH)D] levels. Large trials show that monthly boluses (up to 100,000 IU) are safe and do not increase the risk of hypercalcemia. Nearly 78% of patients prefer infrequent dosing, facilitating behavioral strategies like habit anchoring by reducing memory demands.

Conclusion. Replacing daily supplementation with a cumulative regimen bypasses ADHD-specific cognitive barriers. Integrating infrequent dosing with behavioral techniques improves long-term adherence. Future RCTs are needed to develop tailored clinical guidelines.

Key words: Attention Deficit Hyperactivity Disorder; Adult ADHD; Medication Adherence; Vitamin D Deficiency; Executive Dysfunction.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a clinically heterogeneous neurodevelopmental syndrome characterized by developmentally inappropriate levels of inattention, hyperactivity, and impulsivity.[1] Historically, this disorder was conceptualized almost exclusively as a childhood condition that patients naturally outgrow during adolescence.[2,3] Contemporary longitudinal studies have completely revised this assumption, demonstrating that even over 90% of individuals diagnosed in childhood enter adulthood with persistent, though often fluctuating, deficits that may recur even after a previous stable symptom remission period.[4] Globally, the prevalence of persistent and symptomatic adult ADHD is currently estimated at 2.58% - 6.76%, representing a significant public health challenge.[1]

Recently, there has been a marked global trend of increasing ADHD diagnoses among adults, largely driven by individuals seeking professional evaluation for escalating functional difficulties arising from previously unrecognized symptoms. The phenomenon where these difficulties become fully apparent only in adulthood – particularly in patients with milder traits – is explained in the literature by the concept of „environmental scaffolding". During childhood, a supportive family environment effectively buffers and masks the symptoms by taking on the burden of planning, maintaining routines, and prompting daily tasks. It is only when this external support is lost in adulthood that the underlying deficits are fully unmasked.[5]

A major clinical challenge encountered in caring for patients with ADHD is the remarkably high rate of treatment discontinuation. Current literature regarding ADHD treatment indicates that patients exhibit low persistence with newly prescribed regimens, frequently abandoning their medication within the first month of therapy.[6] This trend of declining adherence becomes even more pronounced over time. Within one year of initiating medication, only 40% to 50% of adolescents and adults continue their treatment, compared to a 65% continuation rate observed in children. By the second year, persistence among adults and adolescents falls further to just 20% to 30%, with young adults (18-24 years old) demonstrating the highest rates of early dropout globally. This apparent difficulty in sustaining long-term therapy may be largely attributed to the core symptoms of ADHD itself, such as forgetfulness. Consequently, to support continued treatment, cost-effective strategies such as simple SMS-based reminder interventions have been tested, showing promising preliminary results in both pediatric and adult populations.[7] Although current research predominantly focuses on adherence to ADHD-specific pharmacotherapy, the underlying behavioral barriers driving these discontinuation rates are likely generalizable to all medications and dietary supplements utilized by this patient population.

Given that patients struggle to maintain adherence even to medications that provide relatively rapid symptomatic relief, they are highly likely to face an even greater challenge in remembering to supplement vitamin D – a compound whose deficiencies are not immediately apparent and whose clinical benefits are delayed. Research indicates that vitamin D deficiencies are significantly more pronounced in individuals with ADHD compared to healthy controls,[8] and crucially, these deficits directly correlate with the severity of the disorder's core symptoms.[9] Normalizing cholecalciferol to optimal serum levels has been shown to positively impact patient functioning. Consequently, targeted vitamin D supplementation in cases of suboptimal levels remains one of the few strictly evidence-based and clinically recommended dietary interventions for this specific patient population.[9,10]

Research objective. Therefore, the aim of this narrative review is to highlight the scale of the clinical challenge faced by both adult ADHD patients and their healthcare providers, and to propose a viable, evidence-based solution. We postulate that reducing the dosing frequency of vitamin D – by

transitioning to cumulative weekly or monthly boluses – can effectively circumvent the daily, tedious burden placed on the novelty-driven cognitive profile, replacing it with an equally efficacious yet more structurally manageable alternative. By bypassing inherent executive deficits and reducing the frequency of unrewarding daily tasks, this strategy has the potential to significantly increase long-term adherence and persistence to supplementation. Ultimately, this approach aims not only to improve overall patient functioning but also to alleviate the broader healthcare burden by mitigating the somatic and psychiatric complications of chronic vitamin D deficiency in this vulnerable population.

2. Research materials and methods

In order to conduct this narrative review, a comprehensive literature search was performed using primary scientific databases, including PubMed, Scopus, and Google Scholar. The search targeted peer-reviewed articles published predominantly between 2015 and 2026 to ensure the inclusion of the most contemporary neurobiological and clinical data. Clinical guidelines, systematic reviews, meta-analyses, observational studies, randomized controlled trials (RCTs), and qualitative research were included. Keywords and MeSH terms utilized in the search strategy included: “adult ADHD,” “treatment adherence,” “executive dysfunction,” “vitamin D deficiency,” and "vitamin D/administration and dosage". Articles not published in English, as well as single case reports lacking a broader population context, were excluded from the synthesis.

3. Research results

3.1. Treatment adherence barriers and executive dysfunction in ADHD

According to the World Health Organization (2003),[11] adherence is defined as “the extent to which a person's behavior – taking medication, following a diet, and/or executing lifestyle changes – corresponds with agreed recommendations from a health care provider.” In clinical practice, pharmacological adherence is frequently quantified using indices such as the PDC (Proportion of Days Covered), with a widely accepted threshold for adequate adherence set at >80%. However, despite this relatively lenient criterion, long-term adherence to chronic somatic therapies in the general population remains remarkably poor, at approximately 50%.[12,13] Furthermore, true adherence rates may be even lower, as objective measurement methods are difficult to standardize. Clinical observations are often artificially inflated by „white-coat adherence” – a phenomenon characterized by transiently improved medication-taking behavior occurring in the five days preceding and following a healthcare encounter.[14]

Crucially, as highlighted in the literature, therapeutic non-adherence cannot be viewed solely as a patient-driven failure. It is a systemic issue heavily influenced by the healthcare provider and the design of the treatment regimen itself, which must be carefully aligned with the expectations of the patient-provider alliance.[12] Consequently, effective interventions aimed at improving adherence must comprehensively address all these structural aspects.

The symptoms associated with ADHD can significantly exacerbate difficulties in maintaining adherence to long-term therapies. This applies to both the pharmacological management of ADHD itself and the treatment of co-occurring chronic somatic diseases. As recent studies indicate, sub-optimal adherence (<80%) to methylphenidate and atomoxetine affects up to 42.6% and 40.0% of patients, respectively; furthermore, only 13.8% of the methylphenidate group and 18.2% of the atomoxetine group maintained treatment for more than 365 days.[15] Considering that these medications alleviate core ADHD symptoms – thus providing relatively rapid and noticeable clinical relief – one can reasonably expect that adherence to therapies lacking immediate, easily perceivable benefits will be at least equally poor.

In the context of somatic care, research demonstrates that the severity of ADHD symptoms correlates with significantly lower adherence to medications for conditions such as asthma.[16] Persistence is also markedly impaired in this population, likely due to routine fatigue and the mental burden associated with remembering daily medication regimens. This pattern extends to other chronic conditions; for instance, in antihypertensive pharmacotherapy, ADHD significantly increases the risk of early treatment discontinuation. Age-stratified analyses reveal that this is particularly evident among middle-aged (HR = 1.11; 95% CI: 1.01–1.23) and older adults (HR = 1.14; 95% CI: 1.01–1.29). Moreover, adults with ADHD have a substantially higher probability of overall non-adherence to cardiological treatment regimens within 1 to 5 years of initiation (OR = 1.45; 95% CI: 1.26–1.67).[17] Alarmingly, even a potential threat to life is an insufficient motivator to achieve optimal treatment adherence, as evidenced by studies involving ADHD patients diagnosed with type 1 diabetes (T1DM). Not only does this specific group exhibit significantly higher HbA1c levels, indicating poorer chronic glycemic control, but they also face a markedly increased risk of acute diabetic complications, such as diabetic ketoacidosis (DKA), severe hypoglycemia, and related hospitalizations.[18]

It is well established that simply identifying non-adherence in clinical practice can be challenging and requires specific interviewing skills.[12] Among individuals with ADHD, research indicates a significant discrepancy in reporting: while objective measures of missed

doses reveal non-adherence rates as high as 40–43%, patients self-report missing only about 25% of their doses.[19] The detected prevalence of non-adherence drastically increases when relying on objective tracking rather than subjective estimations. Evidently, patients with ADHD consistently underestimate their deviations from prescribed regimens. Notably, this discrepancy does not arise from intentional deception; rather, it is a direct consequence of the time-blindness and impairments in retrospective memory inherent to the disorder, particularly regarding routine, mundane events that do not require significant conscious effort.

The fundamental reason why these individuals experience amplified difficulties with daily medication adherence lies in the pronounced executive dysfunction characteristic of ADHD. Executive functions are a set of cognitive processes and mental skills that enable goal-directed behavior through planning, sustained focus, maintenance of motivation, and self-control. Although the majority of research concerning the impact of ADHD on treatment compliance has been conducted in pediatric populations, this problem tends to exacerbate as patients transition into adolescence and adulthood. Longitudinal analyses demonstrate that one year after initiating therapy, treatment was maintained by 65% of children (95% CI: 60–70), compared to only 47% of adolescents (95% CI: 43–51), 39% of young adults (95% CI: 36–42), and 48% of older adults (95% CI: 44–52). The highest proportion of premature treatment discontinuation is observed during the critical developmental window between 18 and 19 years of age. Furthermore, over a five-year follow-up period, only 50–60% of the pediatric population and a mere 30–40% of adolescents and adults remained on their prescribed pharmacotherapy.[7]

Numerous authors highlight the transition to independence as a period highly susceptible to adherence deterioration.[7,20,21] Patients frequently report that the newfound autonomy associated with adulthood is significantly more challenging to navigate than the highly regulated environments of their childhood.[22] A plausible explanation for this phenomenon lies in the sudden loss of „environmental scaffolding" – the external structure and habit-maintenance previously provided by parents and caregivers. Left to navigate daily routines independently, the young adult often lacks the necessary compensatory mechanisms to sustain their previous level of functioning and therapeutic persistence.

Naturally, various strategies have been developed in an attempt to provide the tools necessary to support patients in daily medication adherence; however, their long-term efficacy remains largely unsatisfactory. For instance, in a study examining PrEP (Pre-Exposure Prophylaxis) adherence among adolescents using a mobile application that generated daily alarm

notifications, the observed increase in adherence was not statistically significant. Furthermore, user engagement with the application drastically declined over time, with the majority of patients abandoning the tool entirely within three months, suggesting minimal long-term clinical utility.[23]

Conversely, a contrasting pattern emerges when the frequency of the stimulus is modified. Upon investigating the impact of SMS reminders on adherence in a population with type 2 diabetes (T2D), it was found that patients who received occasional text messages – specifically triggered only when a dose was missed, rather than daily – skipped significantly fewer doses of oral medication compared to the control group. Notably, participants highly valued the reminder in this approach.[24]

Based on these findings, it can be concluded that standard, daily reminder systems are fundamentally ineffective for many patients. The monotony of daily digital alerts, particularly for individuals with ADHD, inevitably leads to rapid sensory habituation, causing the brain to unconsciously filter out the notification as background noise. Consequently, therapeutic optimization should focus on interventions that provide an external cue at a significantly reduced frequency. An intermittent stimulus is far more likely to be registered as „novelty" within the neurodivergent brain, thereby successfully capturing the patient's attention and effectively prompting the required clinical action.

3.2. Neurobiological role of vitamin D and clinical implications of deficiency

Although vitamin D has traditionally been viewed as a basic regulator of calcium and phosphate homeostasis, contemporary neurobiology calls for a broader understanding of its clinical role. In its active form (1,25-dihydroxycholecalciferol), this molecule functions far beyond skeletal maintenance. It acts as a potent neurosteroid, exerting profound immunomodulatory and neuroprotective effects within the central nervous system. As highlighted by Cui et al.,[25] multiple studies consistently demonstrate that vitamin D plays an indispensable role in maintaining normal brain function, largely through the modulation of various neurotransmitter pathways. The expression of Vitamin D Receptors (VDR) in the substantia nigra, as confirmed by immunohistochemical analyses, indicates a robust neuroanatomical link between vitamin D and central dopaminergic circuits. Research demonstrates that vitamin D exerts marked neuroprotective effects by preventing the apoptosis of dopaminergic neurons and stimulating dopamine synthesis, whereas its clinical deficiency may alter adult neurogenesis within the hippocampus.[25] Growing evidence highlights the critical role of this molecule in broader

cognitive functioning and behavioral modulation. It is actively involved not only in the maturation and survival of dopaminergic (DA) neurons but also in the functional release of dopamine. At the molecular level, one proposed mechanism by which vitamin D influences this system is through the regulation of tyrosine hydroxylase expression, the critical rate-limiting enzyme in dopamine biosynthesis.[25] The essential nature of vitamin D for the dopaminergic system is particularly evident in rodent models. Adult rats with developmental vitamin D deficiency exhibit spontaneous hyperlocomotion – driven by elevated baseline dopamine levels within the synapse – and display a heightened behavioral sensitivity to amphetamines.[26] Such a phenotype parallels the core behavioral and pharmacological hallmarks of ADHD, highlighting the potential role of vitamin D deficiency in the disorder's pathophysiology.

Clinical data confirm that ADHD spectrum disorders are accompanied by pronounced vitamin D deficiencies. Extensive meta-analyses reveal that within the pediatric ADHD population, mean serum concentrations of this compound are 6.93 ng/mL lower compared to healthy controls (95% CI: -9.34 to -4.51 ng/mL; $P < 0.001$). Furthermore, lower vitamin D status is significantly associated with a more than 2.5-fold increased likelihood of an ADHD diagnosis (OR: 2.57; 95% CI: 1.09–6.04; $P = 0.03$).[27] This pattern is well illustrated by a large-scale case-control study involving 1,331 cases and 1,331 healthy children: patients with ADHD exhibited a mean vitamin D concentration of only 16.6 ± 7.8 ng/mL (median 16), whereas their healthy peers demonstrated an average of 23.5 ± 9.9 ng/mL ($P < 0.001$). Severe deficiency (<10 ng/mL) and moderate deficiency (10–20 ng/mL) were recorded significantly more frequently within the ADHD cohort. Conversely, optimal concentrations exceeding 30 ng/mL were maintained by only 8.1% of ADHD subjects, compared to 14.3% in the control group ($P < 0.001$).[28]

Crucially, the clinical consequences of these deficiencies are not limited to childhood; they persist into adulthood, directly impacting the clinical presentation of the disorder. In adults with ADHD, reduced 25-hydroxyvitamin [25(OH)D] concentrations not only reach statistical significance but also demonstrate a moderate-to-strong negative correlation with symptom severity. Research indicates that lower vitamin D levels are associated with higher scores on clinical scales assessing hyperactivity, impulsivity, and depressive symptoms.[9] Interestingly, adult patients with ADHD are also overrepresented in the extreme deciles (the highest and lowest 10%) of serum vitamin D concentrations. Researchers hypothesize that this polarized distribution reflects a divided population: individuals with profound, untreated deficiencies, and those who – either following a formal deficiency diagnosis or attempting experimental self-treatment of their symptoms – intensively supplement vitamin D.[8]

As observed, individuals with ADHD are highly susceptible to low vitamin D concentrations, which in turn can lead to the exacerbation of their core symptoms. This deficiency is likely to cause a further deterioration in executive functioning, making it even more challenging for these patients to initiate and sustain goal-directed behaviors aimed at correcting the deficiency – namely, consistent supplementation. Standard interventions, such as daily smartphone reminders and alarms, may not necessarily be sufficient to break this vicious cycle. Consequently, there is an urgent clinical need for an alternative solution that would make adherence to vitamin D supplementation a more manageable task, specifically tailored to accommodate the unique cognitive profile of these patients.

3.3. Pharmacokinetics and efficacy of intermittent dosing

A viable solution to this problem, at least for a subset of patients, could be reducing the dosing frequency of vitamin D supplementation. In the general population, the strict requirement of daily intake is one of the primary reasons for abandoning treatment, and transitioning to a monthly regimen could effectively improve therapeutic compliance.[29] Patient preferences and the resulting improvements in treatment persistence are well illustrated by a study conducted by Sakai et al.[30] In their research, osteoporosis patients were given the option to switch from daily or weekly regimens to once-monthly oral minodronate (MIN 50 mg). The majority – 65% of the cohort – expressed a desire to transition to the less frequent schedule. As the main reasons for this preference, most often cited were “less frequent dosing more convenient” (87.3%) and “easier to remember to take medication” (54.8%). Moreover, patients with a history of missing doses under previous regimens were significantly more willing to make the change. Treatment persistence proved to be significantly higher in the switch group, with nearly all patients with abnormal bone metabolism markers demonstrating normalization after the switchover. 77.9% of the surveyed participants deemed the monthly dosing more convenient, and the belief that a “monthly schedule fits lifestyle better” increased markedly by the end of the study.[30] If such a clear preference and objective improvement in persistence are observed even in patients without the attention and prospective memory deficits inherent to ADHD, the impact on individuals with this neurodevelopmental disorder is likely to be profound. For ADHD patients open to a less frequent than daily dosing schedule, this approach could represent a breakthrough intervention, finally enabling them to resolve their vitamin D deficiencies effectively and consistently.

Fortunately, the unique pharmacokinetic profile of cholecalciferol makes less frequent dosing not only behaviorally desirable but also biologically well-founded. Serum 25(OH)D, the primary functional indicator of vitamin D status, exhibits a significantly extended half-life. As demonstrated by Ilahi et al.,[31] following a large administered dose, it takes approximately 70 days for mean serum concentrations to fall below the desirable threshold of 32.1 ng/mL. In accordance with this prolonged retention, current clinical guidelines formally support flexible supplementation protocols. For adult patients, the recommended therapeutic regimens for cholecalciferol include 4,000 IU daily, 7,000 or 10,000 IU weekly, 20,000 or 30,000 IU biweekly, or 30,000 IU monthly. Furthermore, calcifediol – the main circulating metabolite – is included as an alternative, second-line option that can be similarly adapted to these varied schedules, thereby confirming the overall safety and efficacy of intermittent administration.[32] The therapeutic equivalence of these distinct frequencies is strongly supported by randomized controlled trials. For instance, Ish-Shalom et al.[33] investigated female patients assigned to protocols of either 1,500 IU daily, 10,500 IU once weekly, or 45,000 IU once every 28 days of vitamin D3 supplementation. After two months of intervention, serum 25(OH)D concentrations reached 33.2 ± 8.5 ng/mL, 29.2 ± 8.9 ng/mL, and 37.1 ± 10.3 ng/mL, respectively. Importantly, statistical analysis revealed no significant differences among these outcomes. Taken together, the existing literature consistently emphasizes that tailoring the dosing schedule to individual patient preferences substantially enhances long-term adherence, conclusively proving that infrequent, cumulative dosing is just as effective as a daily regimen.[31–33]

3.4. Safety profile of cumulative doses

Concerns regarding the safety of such cumulative doses are effectively dispelled by a large randomized clinical trial conducted by Malihi et al.[34] The study enrolled 5,110 participants, with an intervention group of 2,558 patients receiving a monthly dose of 100,000 IU of vitamin D3. Follow-up had a median duration of 3.3 years, extending up to a maximum of 4.2 years. The findings revealed that even these substantial doses did not trigger an increase in patient-reported kidney stone events, hospitalizations for urolithiasis, or hypercalcemia. Furthermore, to investigate whether the risk of supplementation-induced complications depends on a patient's initial vitamin D status, the researchers stratified participants by their baseline 25(OH)D concentrations (<75 nmol/L versus ≥75 nmol/L). The analysis revealed that the high-dose intervention did not increase the incidence of kidney stones in either subgroup. This clearly indicates that the safety profile of this supplementation protocol is independent of baseline serum levels, proving to be equally safe regardless of whether the patient started with a deficiency or an already optimal concentration. Notably, among all subjects who underwent follow-up serum calcium assessments, not a single incident of hypercalcemia was recorded. Furthermore, the safety of these doses

aligns with established upper limits. According to current guidelines,[32] the Tolerable Upper Intake Level for adults with normal body weight for daily cholecalciferol prophylaxis is 4,000 IU/day. Because cholecalciferol exhibits a prolonged half-life and is safely stored in adipose tissue, intermittent high-dose boluses, at the doses discussed above, can effectively provide the necessary supplementation while maintaining a wide margin of safety.

Consequently, clinicians can safely prescribe an infrequent, cumulative dosing schedule to ADHD patients who stand to benefit from this approach, provided the patients themselves express a preference for it.

3.5. Comparative analysis of supplementation models

The proposed model of care integrates pharmacological changes with behavioral reinforcement strategies. To systematize the differences between the conventional approach and the proposed solution, a comprehensive comparison is presented in Table 1.

Table 1. Comparison of the standard daily regimen versus the proposed cumulative approach.

COMPARATIVE CRITERION	STANDARD REGIMEN (DAILY)	PROPOSED REGIMEN (CUMULATIVE)
FREQUENCY AND TYPICAL DOSE	Daily (e.g., 1,000 – 4,000 IU)	Weekly (e.g., 7,000 – 10,000 IU) or monthly (e.g., 30,000 IU)
BURDEN ON PROSPECTIVE MEMORY	Very high (requires adherence to a strict, daily routine)	Minimal (infrequent, single administration event)
PRIMARY BEHAVIORAL SUPPORT TOOLS	Smartphone alarms, relying on prompts from others (e.g., partners/caregivers), keeping medication in plain sight (visual cues)	Behavioral anchoring to stable, recurring routines
ADHERENCE RISK IN ADHD	Rapid habituation to alarms, high risk of treatment fatigue and therapy discontinuation	Significantly reduced, utilizing natural behavioral anchors independent of daily discipline

PSYCHOSOCIAL IMPACT	High risk of guilt, stigmatization, and frustration upon missed doses	Restoration of patient agency, strengthening of the therapeutic alliance
SAFETY PROFILE AND EFFICACY	Established golden standard, high safety margin	Pharmacokinetically equivalent; confirmed safety profile (no elevated risk of hypercalcemia or nephrolithiasis)

4. Discussion

4.1. Clinical implications and the physician's role

An analysis of the available literature clearly indicates that among the numerous dietary and supplementation interventions considered in the context of ADHD, vitamin D emerges as an important neurosteroid conditioning the proper functioning of the dopaminergic system.[9,10,35] Given how prevalent deficiencies of this compound are in the general population, its even higher occurrence in adults with ADHD is a particularly significant clinical problem. This deficit not only exacerbates the core symptoms of the disorder but also directly impairs the executive functions necessary to maintain the supplementation itself, trapping the patient in a self-perpetuating vicious cycle of non-adherence.

In this context, the role of the attending physician – whether a psychiatrist, family doctor, internist, or another specialist – requires particular vigilance and a proactive approach to the issue of adherence. A confirmed ADHD diagnosis, or even a strong clinical suspicion of the disorder, should serve as a red flag, indicating a high upfront risk of difficulty maintaining daily pharmacotherapy. An appropriately conducted medical interview becomes a crucial tool here. While monitoring serum 25(OH)D concentration remains the optimal standard, in settings with limited access to laboratory tests, the clinician must rely on a thorough anamnesis. Instead of asking the patient a trivial question like "Do you take vitamin D every day?", which often elicits socially desirable responses, the doctor should inquire about actual use of the preparation, e.g., "Have you finished the package I prescribed at the last visit?" This conversational approach enables an indirect yet highly reliable estimate of the Proportion of Days Covered (PDC).

When a physician identifies an issue with regularity, they should be careful not to make the patient feel guilty. Patients with ADHD struggle daily with a significant burden of stigmatization regarding their organizational failures. The necessity of remembering daily pharmacotherapy often breeds deep frustration, exacerbating treatment fatigue and its discontinuation. The doctor-patient relationship should evolve toward a strong therapeutic alliance, based on shared decision-making. It is the physician's responsibility to actively propose an alternative in the form of less frequent, cumulative dosing (e.g., once a month or once a week) and to support the patient in the regimen that best suits their preferences.

4.2. Behavioral strategies: Habit stacking and event-based anchoring

It should be noted, however, that the doctor must not leave the patient alone with the task of remembering the medication; rather, they should equip them with effective behavioral tools. As research shows,[36] relying solely on smartphone reminder apps and alarms is ineffective for building habits over the long term. Significantly better results in establishing lasting health behaviors are achieved through the technique of habit stacking. The physician can help the patient link the moment of taking a monthly dose of the vitamin with a strong, regular, and certain point in their calendar – for example, payday or the day bills are paid. Another unconventional yet practical solution for female patients is to link supplementation to the menstrual cycle; storing vitamin D capsules alongside hygiene products ensures the medication is taken on the first day of bleeding, without relying on overburdened prospective memory (provided the patient has a relatively regular cycle).

A key condition for the success of the habit stacking technique, however, is the selection of a sufficiently stable base activity (a so-called anchor). Patients with ADHD very often report that attempts to maintain adherence by linking medications to daily, fluid routines fail because they forget to perform the baseline activity itself. This is perfectly illustrated by qualitative research, in which one patient explicitly describes this cognitive trap: "I tried to adhere because I wanted to take it when I was eating and that was the main problem because I always forget breakfast to eat or I eat very late like 2 or something."[37] Therefore, the optimal baseline events for less frequent doses are those that are maximally stable and unchanging – those that do not depend solely on the patient's internal discipline and memory but constitute a regular external or biological factor that affects them in a predetermined manner.

The implementation of such personalized and empathetic solutions brings mutual benefits. It increases satisfaction for both patients, who regain a sense of agency in the treatment process,

and physicians, who observe real improvements in health outcomes. From a broader perspective, effective prophylaxis and early correction of vitamin D deficiencies, before severe complications develop, provide significant relief to the healthcare system.

4.3. Limitations

While this paper synthesizes emerging evidence to propose a novel clinical approach, several limitations must be acknowledged. First, as a narrative review, this manuscript does not employ the exhaustive, protocol-driven search strategies and quantitative data synthesis characteristic of systematic reviews or meta-analyses. Consequently, the selection of literature is inherently susceptible to selection bias. Second, the rationale for intermittent, high-dose cholecalciferol supplementation in adult ADHD relies heavily on extrapolating pharmacokinetic, safety, and adherence data derived from the general population, osteoporosis treatment cohorts, and pediatric ADHD studies. At present, there is a substantial insufficiency of randomized controlled trials (RCTs) specifically evaluating the efficacy, optimal frequency, and clinical outcomes of weekly/monthly bolus dosing in the adult ADHD demographic. Third, the neurobiological pathways linking vitamin D status to dopaminergic function are not yet fully elucidated in human subjects and require further rigorous clinical investigation. Additionally, various clinical, genetic, and lifestyle confounding factors may significantly influence both baseline 25(OH)D concentrations and individual responses to cumulative dosing. Therefore, while the proposed intervention offers a promising, neurobiologically sound hypothesis for improving adherence, these conclusions should be interpreted with caution until confirmed by targeted, large-scale clinical trials.

5. Conclusions

Based on the analysis of the available literature, the following conclusions can be drawn:

1. The standard requirement for daily vitamin D supplementation poorly aligns with the cognitive profile of adults with ADHD, leading to non-adherence, worsening deficiencies, and a secondary exacerbation of the disorder's symptoms.

2. The use of cumulative, less frequent doses of cholecalciferol – administered either in a weekly (e.g., 7,000 – 10,000 IU) or monthly (e.g., 20,000 – 30,000 IU) regimen – provides a potentially effective and safe alternative that minimizes the burden on the patient's prospective memory.
3. Optimizing treatment requires a shift from traditional reminders toward individualized habit-stacking techniques based on stable external or biological factors.
4. Clinicians should actively identify ADHD patients as a group at high risk for vitamin D deficiency and proactively offer flexible supplementation regimens, while avoiding stigmatization for organizational difficulties.
5. The formal inclusion of this personalized regimen in psychiatric and primary care standards requires confirmation through future, dedicated randomized controlled trials (RCTs).

Disclosure

Author Contributions:

Conceptualization: J.Ż., L.Z.; Methodology: W.M., K.B., D.V.; Investigation: J.Ż., E.K., K.B., V.S., A.C.; Data Curation: A.K., E.K., K.-C.W.; Writing – original draft: Introduction and Search Strategy: L.Z., K.B.; ADHD and Adherence section: K.-C.W., J.Ż.; Vitamin D and Neurobiology: D.V., E.K., W.M.; Behavioral interventions: J.Ż., A.K.; Results synthesis and Conclusions: J.Ż., V.S., A.C.; Writing – Review & Editing: J.Ż., L.Z., W.M., K.B., D.V., E.K., A.K., K.-C.W., V.S., A.C.

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During the preparation of this work, the authors used Gemini for the purpose of linguistic refinement of the manuscript, including translation support and ensuring adherence to academic English writing

standards. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the substantive content of the publication.

References

1. Song P, Zha M, Yang Q, Zhang Y, Li X, Rudan I. The prevalence of adult attention-deficit hyperactivity disorder: A global systematic review and meta-analysis. *J Glob Health*. 2021;11:04009. https://doi.org/doi:10.7189/jogh.11.04009

2. Sibley MH, Swanson JM, Arnold LE, et al. Defining ADHD symptom persistence in adulthood: optimizing sensitivity and specificity. *J Child Psychol Psychiatry*. 2017;58(6):655-662. https://doi.org/doi:10.1111/jcpp.12620

3. Caye A, Rocha TBM, Anselmi L, et al. Attention-Deficit/Hyperactivity Disorder Trajectories From Childhood to Young Adulthood: Evidence From a Birth Cohort Supporting a Late-Onset Syndrome. *JAMA Psychiatry*. 2016;73(7):705. https://doi.org/doi:10.1001/jamapsychiatry.2016.0383

4. Sibley MH, Arnold LE, Swanson JM, et al. Variable Patterns of Remission From ADHD in the Multimodal Treatment Study of ADHD. *Am J Psychiatry*. 2022;179(2):142-151. https://doi.org/doi:10.1176/appi.ajp.2021.21010032

5. Asherson P, Agnew-Blais J. Annual Research Review: Does late-onset attention-deficit/hyperactivity disorder exist? *J Child Psychol Psychiatry*. 2019;60(4):333-352. https://doi.org/doi:10.1111/jcpp.13020

6. Schein J, Childress A, Adams J, et al. Treatment patterns among adults with attention-deficit/hyperactivity disorder in the United States: a retrospective claims study. *Curr Med Res Opin*. 2021;37(11):2007-2014. https://doi.org/doi:10.1080/03007995.2021.1968814

7. Brikell I, Yao H, Li L, et al. ADHD medication discontinuation and persistence across the lifespan: a retrospective observational study using population-based

databases. *Lancet Psychiatry*. 2024;11(1):16-26. https://doi.org/doi:10.1016/S2215-0366(23)00332-2

8. Landaas ET, Aarsland TIM, Ulvik A, Halmøy A, Ueland PM, Haavik J. Vitamin levels in adults with ADHD. *BJPsych Open*. 2016;2(6):377-384. https://doi.org/doi:10.1192/bjpo.bp.116.003491

9. Esra D, Havva K. Evaluation of the relationship between vitamin levels and symptom severity in adults with attention-deficit/hyperactivity disorder. *Sci Rep*. 2026;16(1):9329. https://doi.org/doi:10.1038/s41598-026-41493-4

10. Pinto S, Correia-de-Sá T, Sampaio-Maia B, Vasconcelos C, Moreira P, Ferreira-Gomes J. Eating Patterns and Dietary Interventions in ADHD: A Narrative Review. *Nutrients*. 2022;14(20):4332. https://doi.org/doi:10.3390/nu14204332

11. World Health Organization. *Adherence to long-term therapies: evidence for action*. World Health Organization; 2003. Accessed April 15, 2026. https://iris.who.int/handle/10665/42682

12. Brown MT, Bussell JK. Medication Adherence: WHO Cares? *Mayo Clin Proc*. 2011;86(4):304-314. https://doi.org/doi:10.4065/mcp.2010.0575

13. Foley L, Larkin J, Lombard-Vance R, et al. Prevalence and predictors of medication non-adherence among people living with multimorbidity: a systematic review and meta-analysis. *BMJ Open*. 2021;11(9):e044987. https://doi.org/doi:10.1136/bmjopen-2020-044987

14. Osterberg L, Blaschke T. Adherence to Medication. *N Engl J Med*. 2005;353(5):487-497. https://doi.org/doi:10.1056/NEJMra050100

15. Shim JK, Lee SI, Kim SG, Ko Y, Youn H, Lee J. Clinical Features of Adults With Attention Deficit/Hyperactivity Disorder, Focusing on Their Adherence to Medication. *Psychiatry Investig*. 2026;23(2):236-241. https://doi.org/doi:10.30773/pi.2025.0283

16. Silverstein GD, Arcoleo K, Rastogi D, Serebrisky D, Warman K, Feldman JM. The Relationship Between Pediatric Attention-Deficit/Hyperactivity Disorder Symptoms and Asthma Management. *J Adolesc Health*. 2023;73(5):813-819. https://doi.org/doi:10.1016/j.jadohealth.2023.02.028

17. Yao H, Zhou Y, Li L, et al. ADHD and adherence to antihypertensive medication treatment: a multinational cohort study. *BMC Med*. 2026;24(1):122. https://doi.org/doi:10.1186/s12916-026-04714-1

18. Zare Dehnavi A, Elmitwalli I, Alsharif HOH, et al. Effects of ADHD and ADHD treatment on glycemic management in type 1 diabetes: A systematic review and meta-analysis of observational studies. *Diabetes Res Clin Pract*. 2024;209:111566. https://doi.org/doi:10.1016/j.diabres.2024.111566

19. Schaefer MR, Wagoner ST, Young ME, et al. Subjective Versus Objective Measures of Medication Adherence in Adolescents/Young Adults with Attention-Deficit Hyperactivity Disorder. *J Dev Behav Pediatr*. 2019;40(1):54-59. https://doi.org/doi:10.1097/DBP.0000000000000602

20. Wenderlich AM, Baldwin CD, Fagnano M, Jones M, Halterman J. Responsibility for Asthma Management Among Adolescents With and Without Attention-Deficit/Hyperactivity Disorder. *J Adolesc Health*. 2019;65(6):812-814. https://doi.org/doi:10.1016/j.jadohealth.2019.05.023

21. Chiang JL, Maahs DM, Garvey KC, et al. Type 1 Diabetes in Children and Adolescents: A Position Statement by the American Diabetes Association. *Diabetes Care*. 2018;41(9):2026-2044. https://doi.org/doi:10.2337/dci18-0023

22. Ginapp CM, Macdonald-Gagnon G, Angarita GA, Bold KW, Potenza MN. The lived experiences of adults with attention-deficit/hyperactivity disorder: A rapid review of qualitative evidence. *Front Psychiatry*. 2022;13:949321. https://doi.org/doi:10.3389/fpsyt.2022.949321

23. Kawichai S, Songtaweesin WN, Wongharn P, et al. A Mobile Phone App to Support Adherence to Daily HIV Pre-exposure Prophylaxis Engagement Among Young Men Who Have Sex With Men and Transgender Women Aged 15 to 19 Years in Thailand: Pilot Randomized Controlled Trial. *JMIR MHealth UHealth*. 2022;10(4):e25561. https://doi.org/doi:10.2196/25561

24. Vervloet M, Van Dijk L, Santen-Reestman J, et al. SMS reminders improve adherence to oral medication in type 2 diabetes patients who are real time electronically monitored. *Int J Med Inf*. 2012;81(9):594-604. https://doi.org/doi:10.1016/j.ijmedinf.2012.05.005

25. Cui X, Gooch H, Petty A, McGrath JJ, Eyles D. Vitamin D and the brain: Genomic and non-genomic actions. *Mol Cell Endocrinol*. 2017;453:131-143. https://doi.org/doi:10.1016/j.mce.2017.05.035

26. Kesby JP, Cui X, Burne THJ, Eyles DW. Altered dopamine ontogeny in the developmentally vitamin D deficient rat and its relevance to schizophrenia. *Front Cell Neurosci*. 2013;7. https://doi.org/doi:10.3389/fncel.2013.00111

27. Khoshbakht Y, Bidaki R, Salehi-Abargouei A. Vitamin D Status and Attention Deficit Hyperactivity Disorder: A Systematic Review and Meta-Analysis of Observational Studies. *Adv Nutr*. 2018;9(1):9-20. https://doi.org/doi:10.1093/advances/nmx002

28. Kamal M, Bener A, Ehlayel MS. Is high prevalence of vitamin D deficiency a correlate for attention deficit hyperactivity disorder? *ADHD Atten Deficit Hyperact Disord*. 2014;6(2):73-78. https://doi.org/doi:10.1007/s12402-014-0130-5

29. Dalle Carbonare L, Valenti MT, Del Forno F, Caneva E, Pietrobelli A. Vitamin D: Daily vs. Monthly Use in Children and Elderly-What Is Going On? *Nutrients*. 2017;9(7):652. https://doi.org/doi:10.3390/nu9070652

30. Sakai A, Ikeda S, Okimoto N, et al. Clinical efficacy and treatment persistence of monthly minodronate for osteoporotic patients unsatisfied with, and shifted from,

daily or weekly bisphosphonates: the BP-MUSASHI study. *Osteoporos Int*. 2014;25(9):2245-2253. https://doi.org/doi:10.1007/s00198-014-2756-8

31. Ilahi M, Armas LA, Heaney RP. Pharmacokinetics of a single, large dose of cholecalciferol. *Am J Clin Nutr*. 2008;87(3):688-691. https://doi.org/doi:10.1093/ajcn/87.3.688

32. Płudowski P, Kos-Kudła B, Walczak M, et al. Guidelines for Preventing and Treating Vitamin D Deficiency: A 2023 Update in Poland. *Nutrients*. 2023;15(3):695. https://doi.org/doi:10.3390/nu15030695

33. Ish-Shalom S, Segal E, Salganik T, Raz B, Bromberg IL, Vieth R. Comparison of Daily, Weekly, and Monthly Vitamin D3 in Ethanol Dosing Protocols for Two Months in Elderly Hip Fracture Patients. *J Clin Endocrinol Metab*. 2008;93(9):3430-3435. https://doi.org/doi:10.1210/jc.2008-0241

34. Malihi Z, Lawes CMM, Wu Z, et al. Monthly high-dose vitamin D3 supplementation and self-reported adverse events in a 4-year randomized controlled trial. *Clin Nutr*. 2019;38(4):1581-1587. https://doi.org/doi:10.1016/j.clnu.2018.07.034

35. Kozyra M, Zimnicki P, Kaczerska J, Śmiech N, Nowińska M, Milanowska J. Relationship between the diet and psychiatric diseases such as depression, anxiety and attention-deficit hyperactivity disorder (ADHD). *J Educ Health Sport*. 2020;10(8):93-104. https://doi.org/doi:10.12775/JEHS.2020.10.08.011

36. Stawarz K, Cox AL, Blandford A. Beyond Self-Tracking and Reminders: Designing Smartphone Apps That Support Habit Formation. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM; 2015:2653-2662. https://doi.org/doi:10.1145/2702123.2702230

37. Khan MU, Aslani P. Exploring factors influencing initiation, implementation and discontinuation of medications in adults with ADHD. *Health Expect*. 2021;24(S1):82-94. https://doi.org/doi:10.1111/hex.13031