

Effects of Bodybuilding Supplements on the Kidney

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Kidney and Nephrotoxins

۱۳۰۱-۱۴۰۱ مهر-تهران

- ✓ Bodybuilding, or “the use of progressive resistance exercise to develop muscle building by hypertrophy”, has become increasingly popular both recreationally and competitively.
- ✓ Resistance training, including noncompetitive-style training, is recommended for both athletes and the general population to improve physical performance, appearance, health, and aid in weight management.
- ✓ Competitive bodybuilding requires dedication to rigorous training and strict dietary regimes.

J. Strength Cond. Res. 2021, 35, 2546–2551



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Review

Nutritional and Non-Nutritional Strategies in Bodybuilding: Impact on Kidney Function

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Abstract: Bodybuilders routinely engage in many dietary and other practices purported to be harmful to kidney health. The development of acute kidney injury, focal segmental glomerular sclerosis (FSGS) and nephrocalcinosis may be particular risks. There is little evidence that high-protein diets and moderate creatine supplementation pose risks to individuals with normal kidney function though long-term high protein intake in those with underlying impairment of kidney function is inadvisable. The links between anabolic androgenic steroid use and FSGS are stronger, and there are undoubted dangers of nephrocalcinosis in those taking high doses of vitamins A, D and E. Dehydrating practices, including diuretic misuse, and NSAID use also carry potential risks. It is difficult to predict the effects of multiple practices carried out in concert. Investigations into subclinical kidney damage associated with these practices have rarely been undertaken. Future research is warranted to identify the clinical and subclinical harm associated with individual practices and combinations to enable appropriate and timely advice.



Citation: Tidmas, V.; Brazier, J.; Hawkins, J.; Forbes, S.C.; Bottoms, L.; Farrington, K. Nutritional and Non-Nutritional Strategies in



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Non Nutritional Supplements	Nutritional Supplements
Anabolic Steroids	<u>Creatine</u>
GH	Vitamins
IGF	Protein (Whey, Casein.....)
<u>L-Thyroxine</u>	Amino Acids / BCAA
Beta 2 Agonist	Glutamine
<u>Antiestrogens</u>	<u>L-arginine</u>
<u>Aromatase Inhibitors</u>	Pre-work out: Energy Drinks
Beta HCG	<u>L-carnitine</u>
Erythropoietin	Liver Albumin
	Omega 3



Protein Supplementation

- ✓ Bodybuilders generally employ different nutritional strategies during specific phases of training, such as **bulking** (calorie excess to increase muscle mass) or **cutting** (pre-competition calorie reduction to reduce body fat and increase muscle definition).
- ✓ UK government guidelines recommend protein intakes of 0.75–0.8 g/kg/day . This is increased up to 1.4–2.0 g/kg/day for athletes. This is safe, aids training adaptations and optimises building and maintenance of muscle mass.

BMJ Open 2018, 8, e020017



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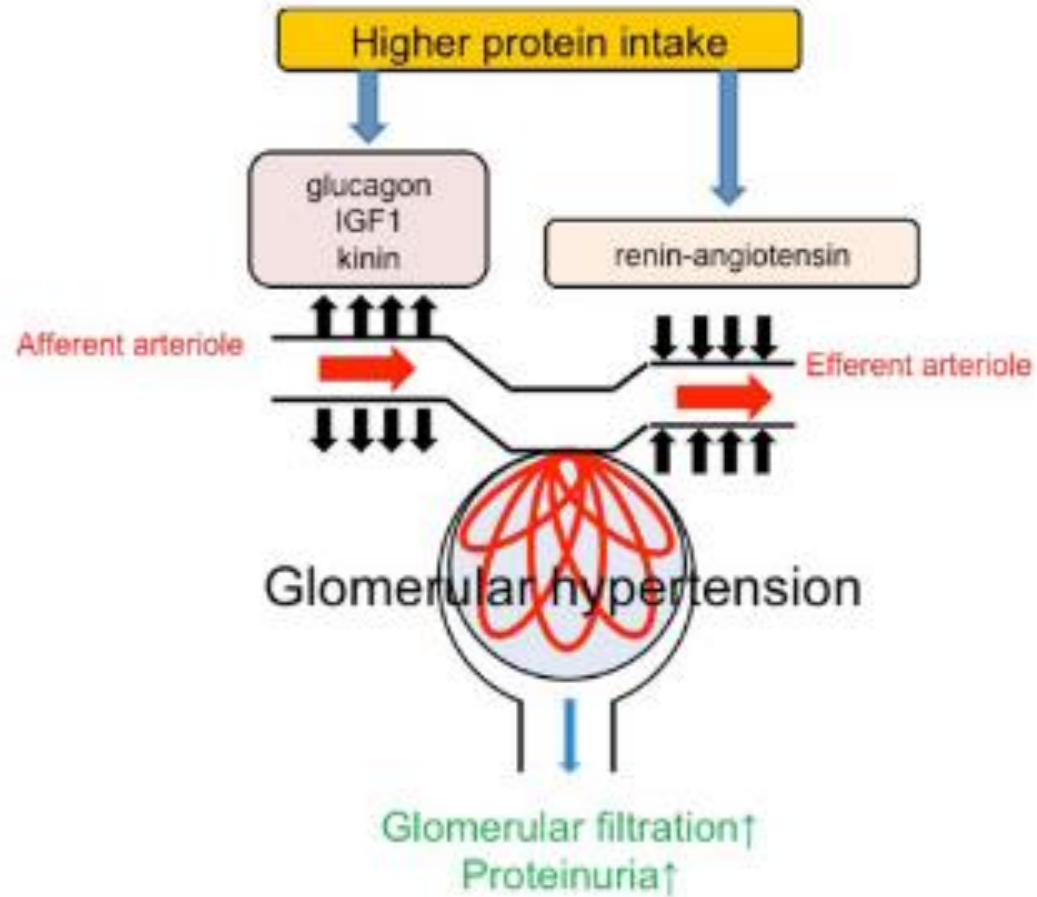


Fig. 1 Pathogenic mechanism of glomerular hyperfiltration and glomerular hypertension. Protein overload induces contraction of efferent arterioles and dilation of afferent arterioles through various vasoactive molecules, which is a cause of glomerular hypertension



HIGH-PROTEIN DIETS AND KIDNEY HEALTH

Table 1. Established or Theoretical Renal-Associated Consequences of HP Intake

Glomerular hemodynamics

Hyperfiltration

Hyperemia

Accelerated GFR decline

Increased urinary protein (albumin) excretion

Fluid electrolyte, and acid-base status

Natriuresis

Kaliuresis

Diuresis

Metabolic acidosis

Increased water consumption

Blood pressure

Hypertension

Orthostatic hypotension

Nephrolithiasis risk

Hyperuricosuria

Hypercalciuria

Hypocitraturia

Reduction in urinary pH

Renal osteodystrophy

Exacerbation of bone disease

Metabolic

Dyslipidemia

Hyperuricemia

Weakness

Fatigue

Exacerbation of uremia

AJKD, Vol 44, No 6 (December), 2004: pp 950-962



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- ✓ There are some case reports and case series that high protein intake (more than 3g/kg/day) was associated with kidney injury like **FSGS, AKI**.
- ✓ In longer-term epidemiological studies, higher levels of protein intake are associated with a **more rapid decline in kidney function**.
- ✓ There is evidence that high-protein diets can cause issues for those with **pre-existing kidney insufficiency**.

Nephrol. Dial. Transplant. 2019,35, 98–106.



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Creatine Supplementation

- ✓ Creatine supplementation has become increasingly popular in athletes of all levels, due to increasing lean muscle mass and strength, **improved post-exercise recovery** and **injury prevention**.
- ✓ Typically, ~ 0.3 g/kg/day or 20 g/day are ingested daily for 5–7 days to load muscles with creatine. Following this, 3–5 g/day is used as maintenance.

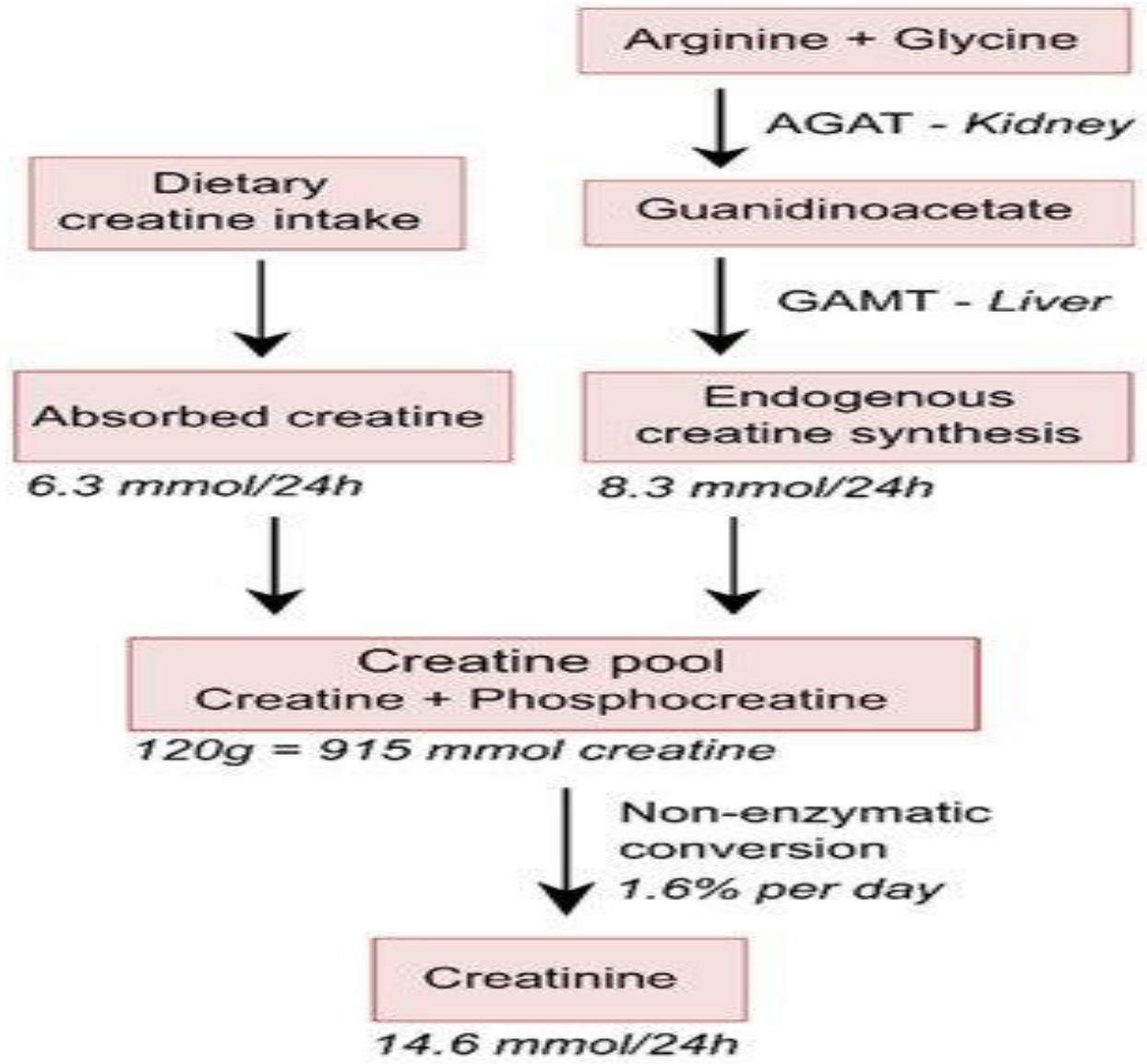
Sports Nutr. 2017, 14, 1–18



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- ✓ The capacity of renal AGAT, a key enzyme involved in creatine synthesis, is progressively decreased with progression of CKD and is virtually absent in dialysis patients.
- ✓ It has been suggested that loss of endogenous synthesis capabilities and reduced consumption of creatine rich foods can result in creatine deficiency.
- ✓ Creatine deficiency is associated with clinical manifestations similar to **sarcopenia**, with **fatigue**, **impaired quality of life** and **impaired cognition**.

Nutrients 2019, 11, 1044



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- ✓ The kidney conditions most frequently associated with creatine supplementation in bodybuilders are **AIN** and **ATN**, which have occurred in individuals consuming relatively low doses. It is possible that **other agents** were also being consumed.
- ✓ prolonged use of high maintenance doses of creatine (9.7 ± 5.7 g/day) with a high protein intake (1.2–3.1 g/kg/day) and resistance training for up to four years has been shown to have no apparent detrimental effects on creatinine clearance and albuminuria.



RESEARCH ARTICLE

Open Access

Does long-term creatine supplementation impair kidney function in resistance-trained individuals consuming a high-protein diet?

Rebeca Lugaresi¹, Marco Leme¹, Vitor de Salles Painelli¹, Igor Hisashi Murai¹, Hamilton Roschel^{1,2,4}, Marcelo Tatit Sapienza³, Antonio Herbert Lancha Junior¹ and Bruno Gualano^{1,2*}

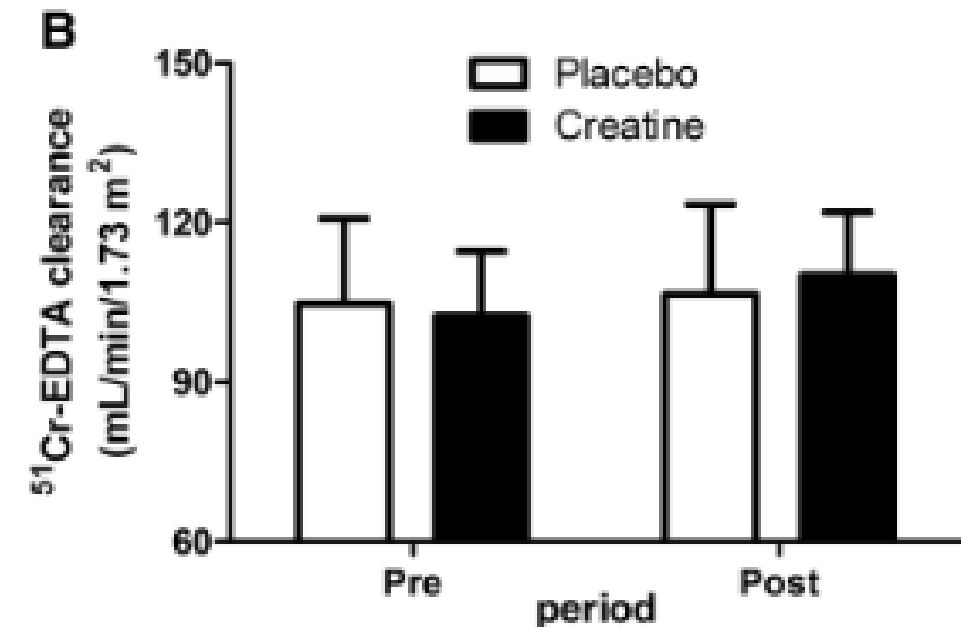


Figure 2 ⁵¹Cr-EDTA clearance before (Pre) and after 12 weeks (Post) of either creatine (n = 12) or placebo (n = 14) supplementation in resistance-trained individuals consuming a high-protein diet. Panel A: individual data. Panel B: mean ± standard deviation. No significant difference between groups across time (group x time interaction) was observed (F = 0.21, p = 0.64). Note: Conversion factors for units: glomerular filtration rate in mL/min/1.73 m² to mL/s/1.73 m², ×0.01667.



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- ✓ Within tissues or solutions, creatine is gradually and irreversibly converted to creatinine, which is filtered by the kidneys and excreted via urine.
- ✓ However, creatine can also be converted into **sarcosine**, resulting in the production of **methylamine**, and via subsequent deamination, the formation of **formaldehyde**, which is potentially cytotoxic.
- ✓ Creatine supplementation (21 g/day for 14 days) significantly increased the serum levels of methylamine and formaldehyde , although both remained within the upper limits of normal.

J. Sports Sci. 2009, 27, 759–766



Anabolic Androgenic Steroids

- ✓ AAS are used by professional athletes such as bodybuilders and powerlifters to enhance performance, increase muscle mass and decrease body fat.
- ✓ There has been an alarming increase in AAS popularity.
- ✓ Use of AAS has been deemed to pose a significant public health issue. All major sports organisations have banned their use.
- ✓ Anabolic Steroids that use by BB consist of **nandrolone** injection, **testosterone** injection, oral **methandrostenolone**.
- ✓ Use of AAS has been associated with a range of kidney conditions, including **AKI**, **AIN**, **FSGS** and **nephrosclerosis**.

Med. Sci. Sports Exerc. 2021, 53, 1778–1794



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Contents lists available at ScienceDirect

Annals of Epidemiology

journal homepage: www.annalsofepidemiology.org

Review article

The global epidemiology of anabolic-androgenic steroid use: a meta-analysis and meta-regression analysis

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Table 3
Regional prevalence rates, 95% CIs, and heterogeneity statistics

	N	p%	95% CI	Q	df (Q)	I ²
Middle East	7	21.7	13.5–32.9	138.8*	6	95.7
Trans-Region	2	6.0	0.1–79.5	281.4*	1	99.6
South America	5	4.8	1.2–16.7	397.0*	4	99.0
Europe	81	3.8	2.4–5.8	60009.6*	80	99.9
North America [†]	126	3.0	2.7–3.4	14752.7*	125	99.2
Oceania [†]	38	2.6	2.1–3.3	2705.0*	37	98.6
Africa [†]	11	2.4	1.2–4.8	208.7*	10	95.2
Asia	1	0.2	0–3.5	0 ^{ns}	0	0

df (Q) = Q's degrees of freedom; I² = heterogeneity index; N = number of studies; ns = not significant; p% = prevalence (%); Q = heterogeneity statistic.

* P < .001.

[†] p% is significantly lower than p% in the Middle East (P < .05).



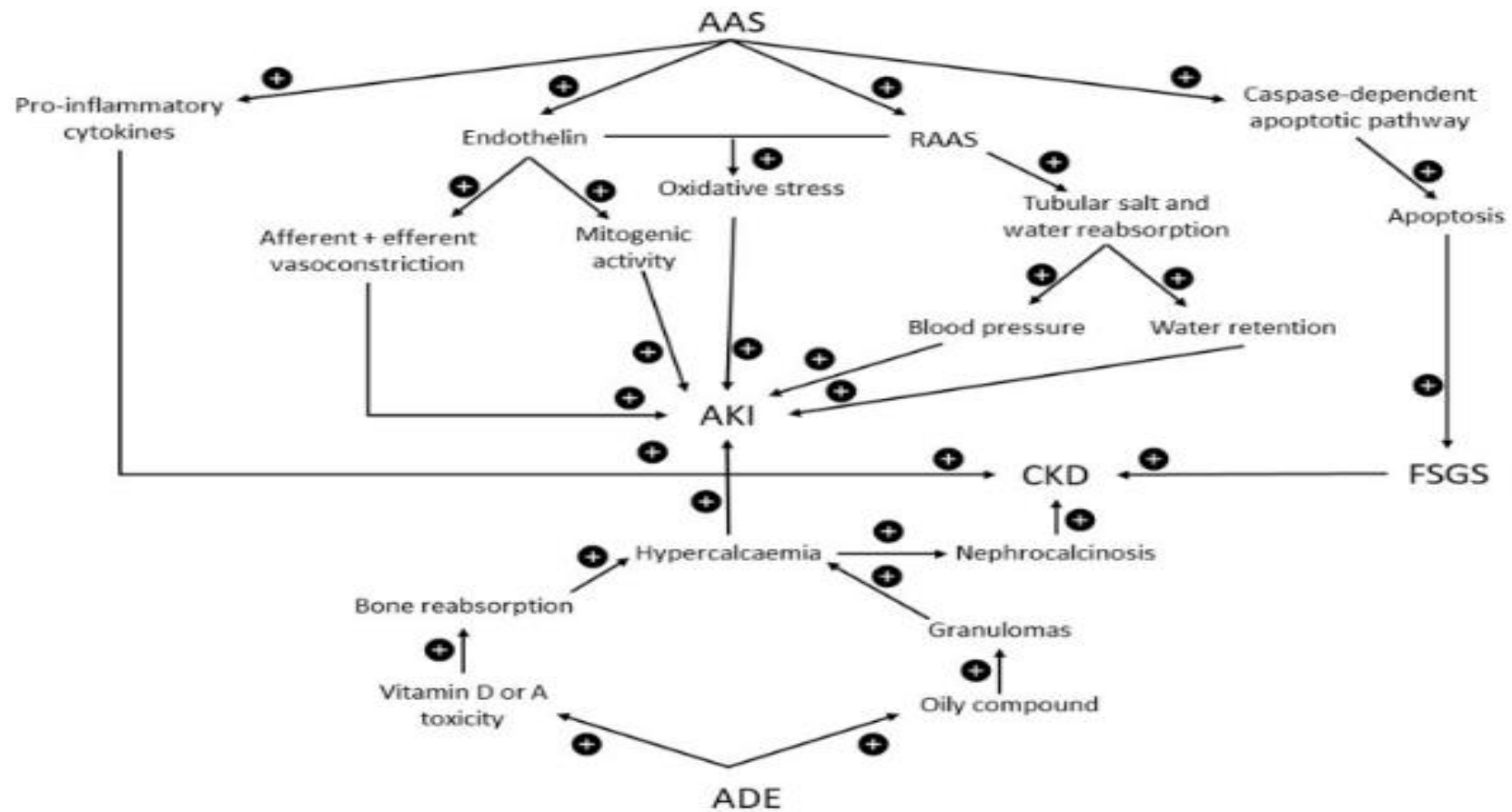


Figure 3. Possible mechanisms and pathophysiology of kidney injury due to exposure to AAS and intramuscular vitamins A, D and E. ADE = intramuscular vitamins A, D and E. AAS = anabolic androgenic steroids. RAAS = renin–angiotensin–aldosterone system. FSGS = focal segmental glomerulosclerosis. CKD = chronic kidney disease. AKI = acute kidney injury. + = increased effect.

Development of Focal Segmental Glomerulosclerosis after Anabolic Steroid Abuse

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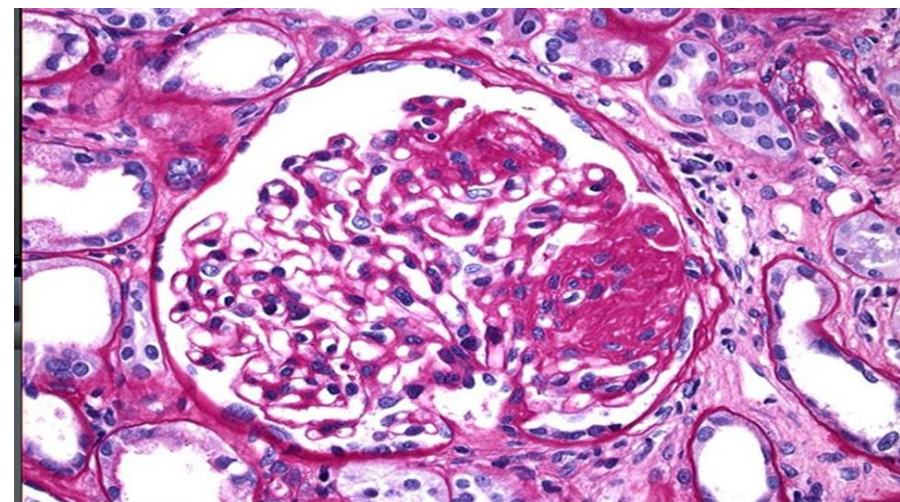
CLINICAL RESEARCH

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Table 3. Renal biopsy findings

Patient	Pattern	Light Microscopy		
		Global Sclerosis	Segmental Sclerosis	TA/IF (%)
1	FSGS with collapsing features	16 of 22	4 of 22	80
2	FSGS, perihilar variant, glomerulomegaly	4 of 17	8 of 17	40
3	FSGS NOS	4 of 7	3 of 7	85
4	FSGS NOS, glomerulomegaly	4 of 6	1 of 6	60
5	FSGS NOS, glomerulomegaly	0 of 13	2 of 13	15
6	Glomerulomegaly	0 of 15	0 of 15	<5
7	FSGS with perihilar lesions, focal cellular and collapsing features	9 of 15	3 of 15	40
8	FSGS with perihilar lesions, focal collapsing features	7 of 61	15 of 61	15
9	FSGS, perihilar variant	5 of 8	2 of 8	60
10	FSGS NOS, glomerulomegaly	9 of 17	6 of 17	90

NA, not available; NOS, not otherwise specified; TA/IF, tubular atrophy and interstitial fibrosis; FPE, foot p



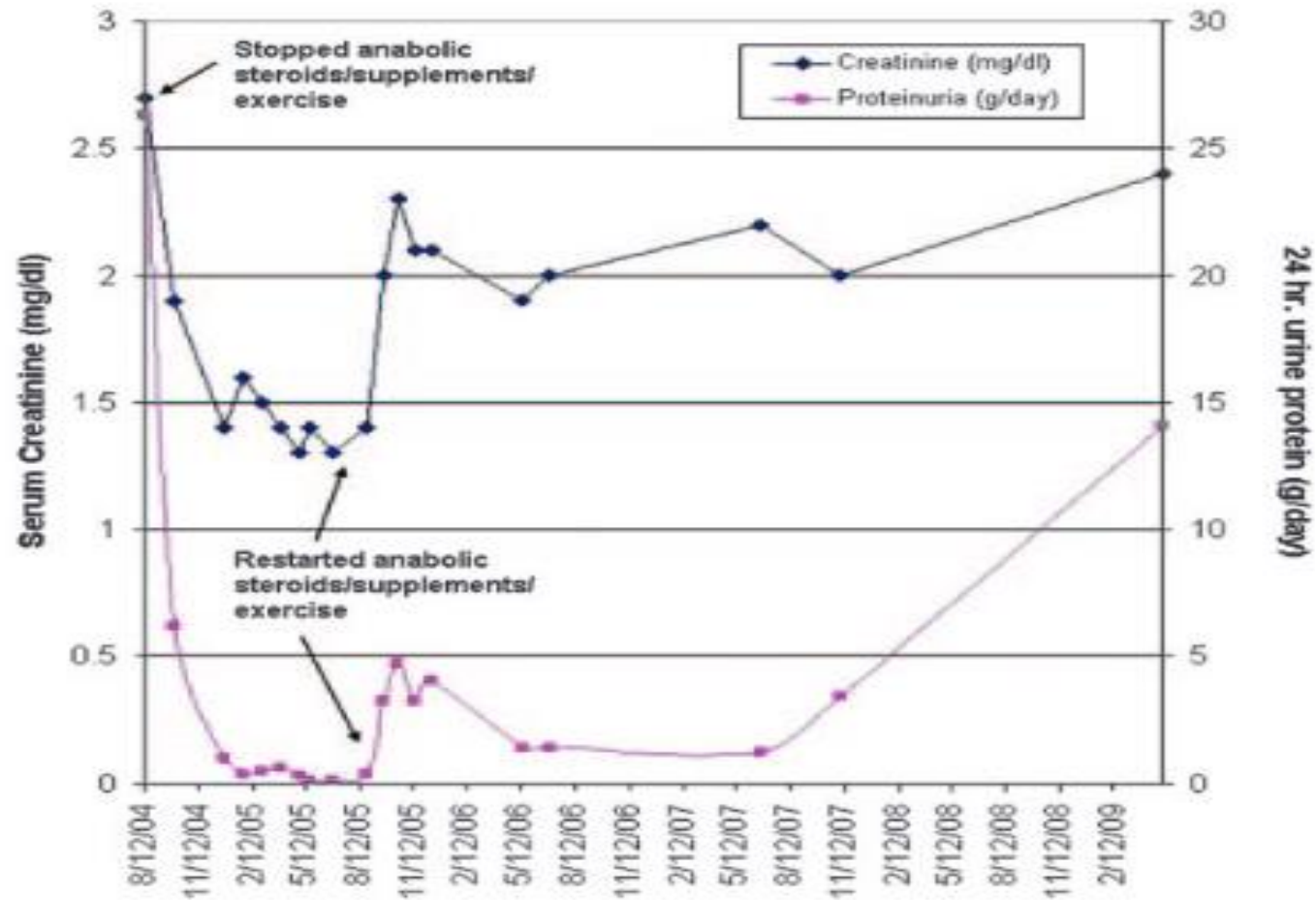


Figure 2. Serum creatinine (left axis) and proteinuria (right axis) over time are shown for patient 1. Note the dramatic initial improvement in both parameters followed by relapse after re-starting training with AASs and supplements.

Vitamins

- ✓ Bodybuilders are known to inject high doses of vitamins A, D and E contained within an oily substance known as compound 'ADE', the consumption of which is damaging to human health and kidney function.
- ✓ Compound 'ADE' was originally used by veterinary professionals to treat cattle and horses experiencing vitamin deficiency and infections, in quantities not exceeding 5 mL per 120-day fattening period for cattle. Bodybuilders often exceed this.
- ✓ The main reason that compound 'ADE' is used by bodybuilders is not for the vitamins per se but the oily carrier, which when injected into muscle produces a foreign body reaction and a local false hypertrophy, increasing the volume of the muscle through local fluid retention rather than muscle anabolism.



Original article

Acute kidney injury due to excessive and prolonged intramuscular injection of veterinary supplements containing vitamins A, D and E: A series of 16 cases

Elizabeth De Francesco Daher^{a,*}, Lorena Vasconcelos Mesquita Martiniano^a, Laio Ladislau Lopes Lima^a, Newton Carlos Viana Leite Filho^a, Louize Emanuele de Oliveira Souza^a, Paulo Henrique Palácio Duarte Fernandes^a, Sonia Leite da Silva^b, Geraldo Bezerra da Silva Junior^b

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ABSTRACT

Background: Despite well-documented risks, injectable supplements containing high doses of vitamins are commonly used.

Objectives: To describe acute kidney injury (AKI) as a complication of vitamin intoxication.

Methods: Our series consisted of 16 patients with kidney complications resulting from the use of veterinary intramuscular injection supplements of vitamin A, D and E. The patients

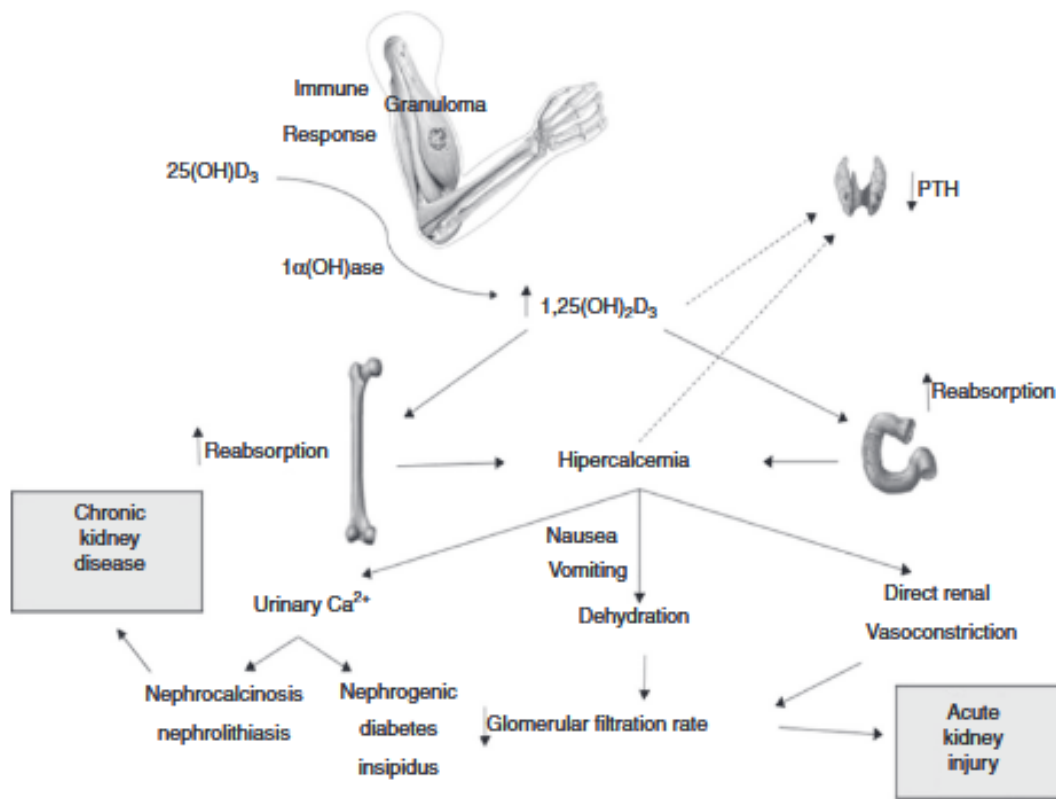


Fig. 1 – Possible mechanisms involved in the pathophysiology of kidney injury associated with hypercalcemia and injectable vitamins A, D and E supplements.

Please cite this article in press as: De Francesco Daher E, et al. Acute kidney injury due to excessive and prolonged intramuscular injection of veterinary supplements containing vitamins A, D and E: A series of 16 cases. Nefrología. 2016. <http://dx.doi.org/10.1016/j.nefro.2016.05.017>



The Case | Renal failure in a bodybuilder athlete

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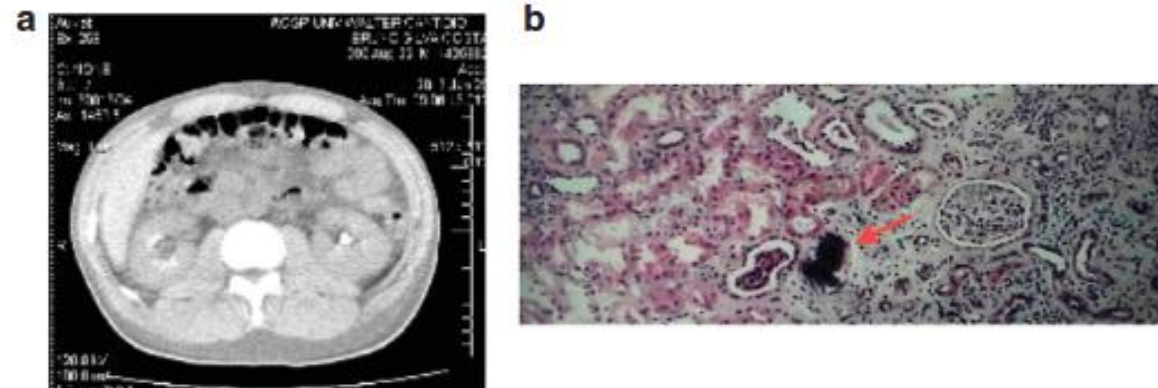


Figure 1 | Main renal findings. (a) Computed tomography showing nephrocalcinosis and left renal stone. (b) Renal biopsy with interstitial calcium deposits (red arrow), surrounding tubular atrophy and interstitial fibrosis.



NSAID

- ✓ NSAIDs are easily accessible, and their use is highly prevalent, accounting for around 5% of prescribed treatments worldwide. NSAIDs are popular in sports medicine, with a self-reported prevalence of up to 50% among athletes.
- ✓ They can counteract muscle inflammation, pain and soreness during, and in response to, exercise, and thus improve performance by increasing pain tolerances and delaying fatigue.
- ✓ However, using high-dose NSAIDs reduce **increments in muscle strength** and **hypertrophic gains** from resistance exercise, thus potentially reducing performance.
- ✓ Regular high-dose NSAID administration significantly increases risks, in particular predisposing to the development of AKI and accelerating the progression of CKD.

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Dehydration and Diuretics

- ✓ The final days before bodybuilding competitions has been coined ‘**peak week**’, during which the majority of competitors were found to implement strategies to maximise their physical appearance for aesthetic purposes.
- ✓ Bodybuilders often self-prescribe potentially harmful dosages of drugs, such as **diuretics and insulin**, which have resulted in dangerous outcomes, such as hypokalaemic paralysis.
- ✓ The majority of strategies involve dehydration and sodium depletion in the final days before competition, which have been linked to increased risk of kidney dysfunction .



Other Supplements/Stimulants and Exertional Rhabdomyolysis

- ✓ One dietary supplement (DS) of interest used by bodybuilders is “**Hydroxycut**”, a weight-loss and muscle-building product, comprising of **Garcinia cambogia**, **Cissus quadrangularis**, **caffeine**, **Ma Huang** (ephedra) and **green tea** in various quantities over the years of its production.
- ✓ Caffeine is also considered the most popular pre-workout stimulant for bodybuilders, whereby improvements in strength performance requires large supplementation of ~5–6 mg/kg. The upper range of the safe caffeine dosage of ~6 mg/kg.
- ✓ Both consuming “**Hydroxycut**” and **caffeine** have been linked to the development of **rhabdomyolysis** and lead to kidney failure.





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