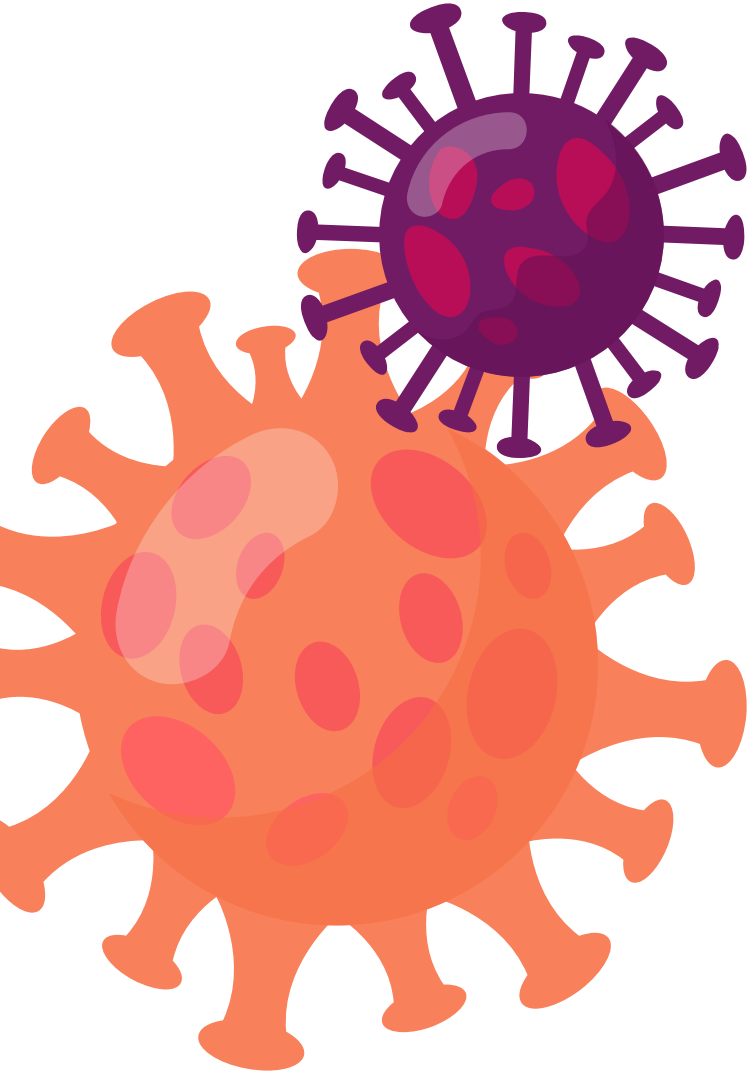

Nutrition for post COVID-19 recovery

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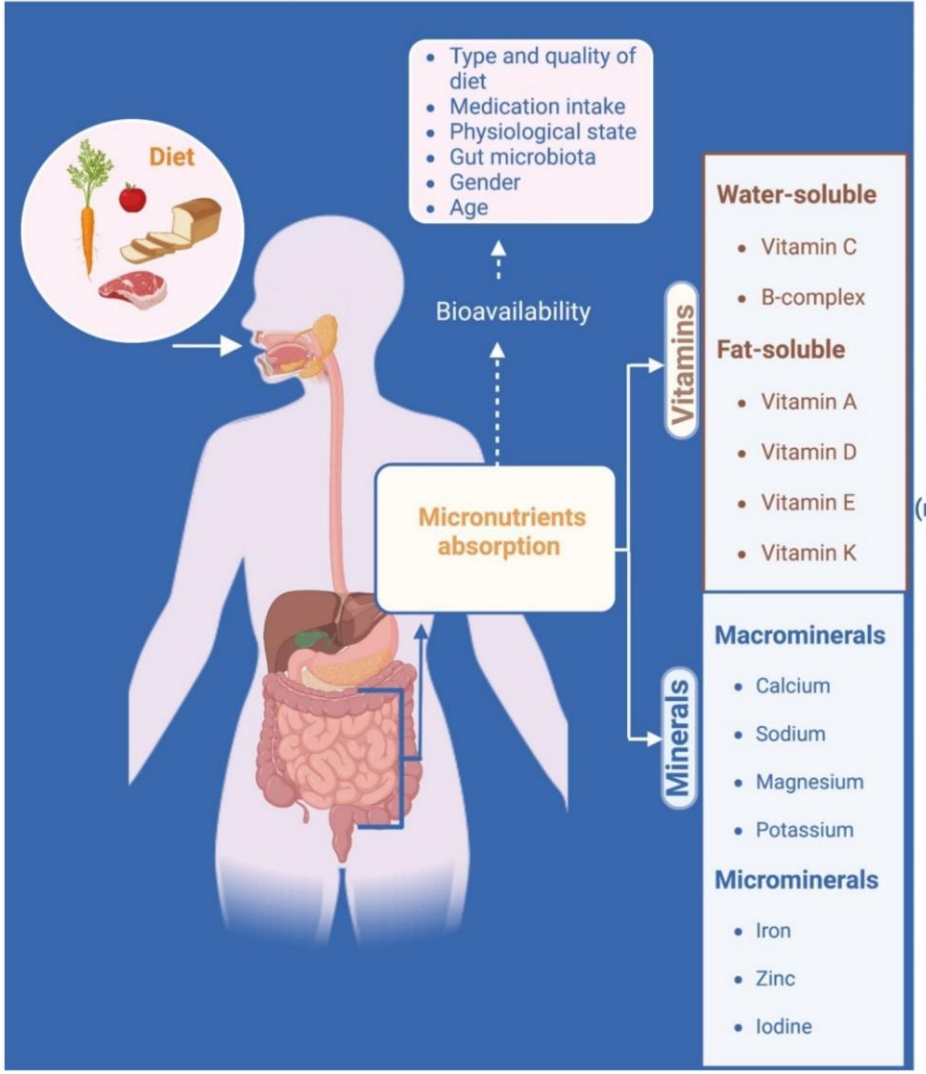
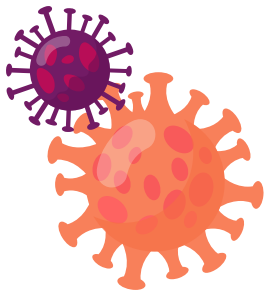
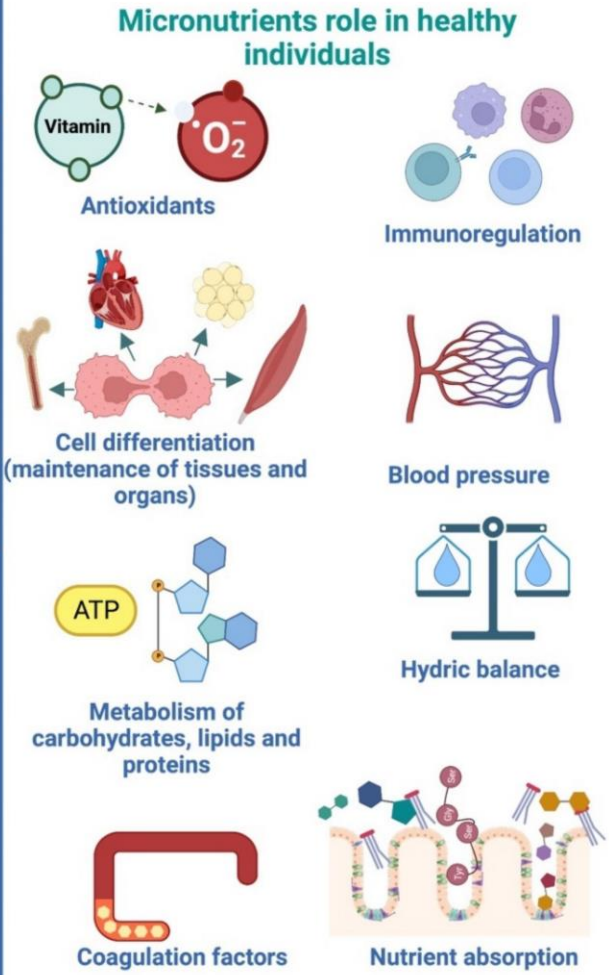
Disclosure

I have no actual or potential conflict of interest in relation to this program/presentation

Hernández-Flores TJ, et al. Int J Mol Sci. 2022;23(20)



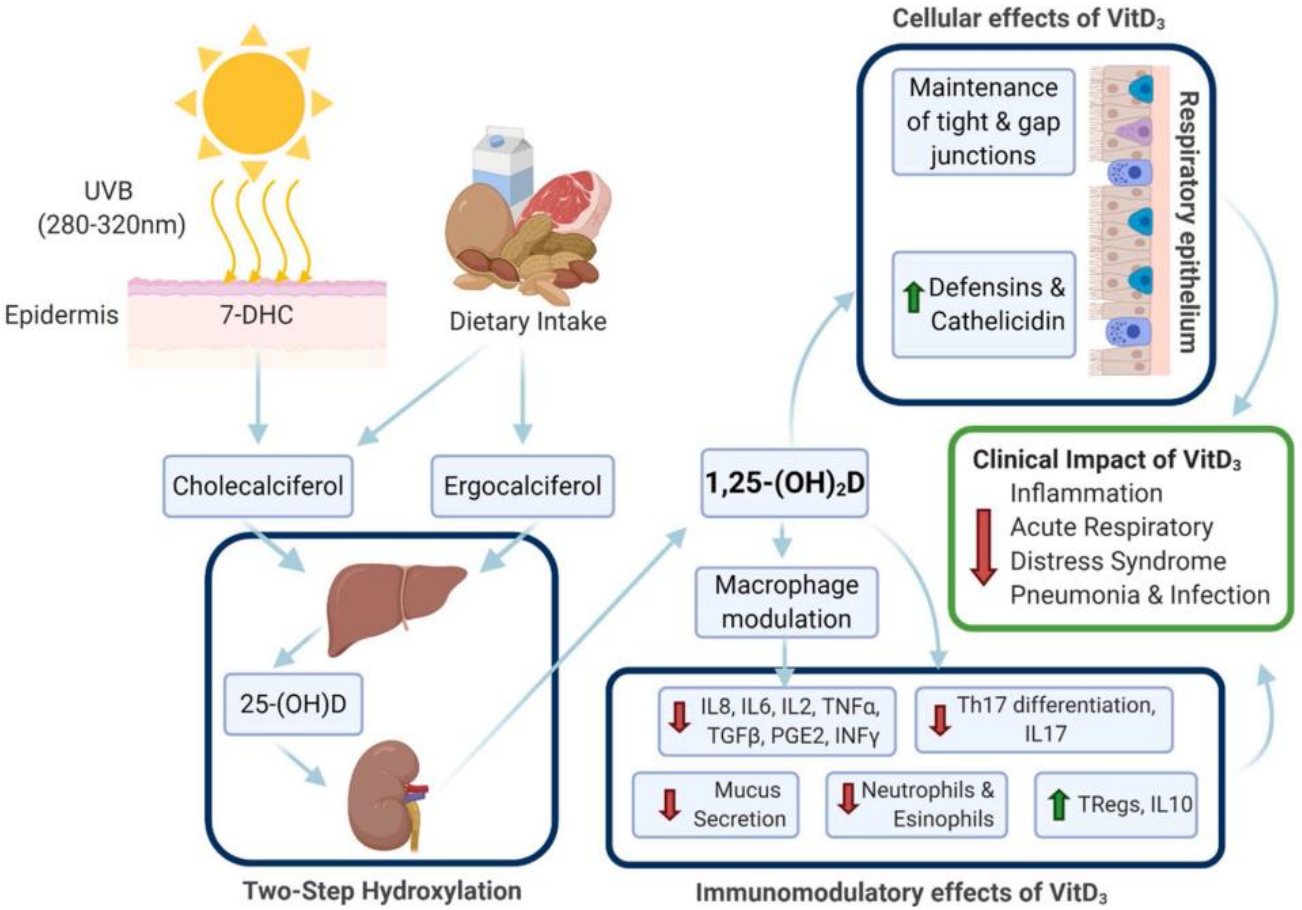




Vitamin D

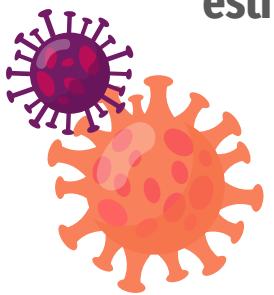
- Fat-soluble vitamin
- Vitamin D is critical for bone and mineral metabolism.
- vitamin D also has the potential to modulate innate and adaptive immune responses because the vitamin D receptor is expressed on immune cells such as B cells, T cells, and antigen-presenting cells, and because these cells can synthesize the active vitamin D metabolite.
- The rationale for using vitamin D is based largely on immunomodulatory effects that could potentially protect against COVID-19 infection or decrease the severity of illness

Immunomodulatory actions of vitamin D.



vitamin D deficiency and severity in COVID-19

- 72 observational studies (n=1,976,099) up to 31/05/2021
- Vitamin D deficiency/insufficiency [25(OH)D <30 ng/mL] **increased** the odds of
  - **developing COVID-19** (OR 1·46, 95% CI 1·28-1·65, p<0·0001, I 2=92%),
  - **severe disease** (OR 1·90, 95% CI 1·52-2·38, p<0.0001, I 2=81%) and
  - **death** (OR 2·07, 95% CI 1·28-3·35, p=0.003, I 2=73%).
- The **association** between vitamin D deficiency/insufficiency **and death** was **insignificant when studies with high risk of bias** or studies reporting unadjusted effect estimates **were excluded**.



Dissanayake HA, et al. J Clin Endocrinol Metab. 2021 Dec 11;dgab892. doi: 10.1210/clinem/dgab892. Online ahead of print.

Short term, high-dose vitamin D supplementation on viral clearance in mild COVID-19 patient

- P: asymptomatic to mild adult COVID-19 patient with hypovitaminosis D (n=40)
- I: vitamin D3 60,000 IU/d for 7 days or longer with therapeutic target 25(OH) D>50 ng/ml (n=16)
- C: placebo (n=24)
- O: Proportion of patients with SARS-CoV-2 RNA negative before D21 and change in inflammation

Table 2 Change in the levels of serum inflammatory markers in the two groups during follow up

	Intervention group (N=16)	Control group (N=24)	P-value
Δ Vitamin D (ng/ml)	42.4 (39 to 48.8)	5.1 (0 to 12.3)	<0.001*
Δ D-dimer(g/L)	−80.0 (−308.0 to 13.2)	−31.2 (−202 to 0)	0.241
Δ Fibrinogen (ng/ml)	−0.9 (−2.0 to −1.0)	−0.04 (−1.02 to 0.0)	0.001*
ΔCRP(ng/ml)	−0.3 (−1.4 to 0.2)	0.0 (−0.9 to 0.3)	0.507
Δ Procalcitonin (mg/L)	0.00 (−0.2 to 0.7)	−0.1 (−0.60 to 0.04)	0.260

- Vitamin D3 supplementation helps in achieving 25(OH)D>50 ng/ml in 75% of participants by D14
- Therapeutic, high-dose vitamin D3 supplementation led to SARS-CoV-2 RNA negative in additional 41.7% patients (62.5% vs 20.8%, p<0.001) and was useful for viral SARS-CoV-2 RNA clearance.

Rastogi A, et al. Postgrad Med J. 2020 Nov 12. doi:10.1136/postgradmedj-2020-139065.

Impact of daily high dose oral vitamin D therapy on the inflammatory markers in COVID-19 patients

- P: mild to moderate adult COVID-19 patient with hypovitaminosis D (n=130) complete 87
- I: vitamin D3 60,000 IU/d for 8 d (BMI 18-25) and 10 d (BMI>25) –no adverse effect of vitamin D
- C: none
- O: inflammatory markers on D9 (BMI 18-25) or D11 (BMI>25)

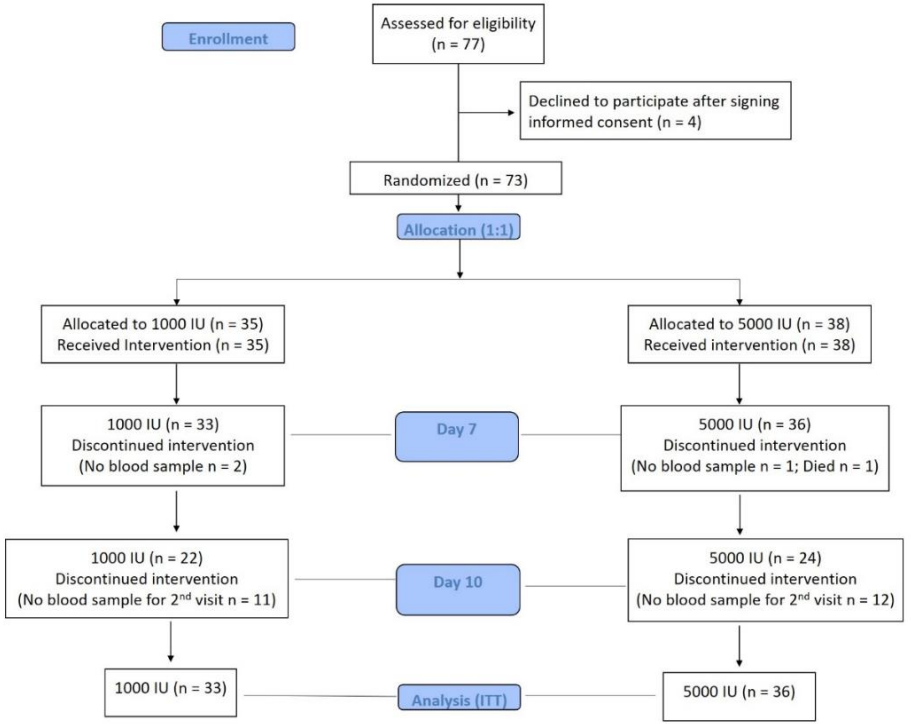
	Vitamin D group (n=44)		Non-vitamin D group (n=43)		P value#
	Baseline	Post-intervention	Baseline	Post-intervention	
25(OH)D, ng/mL	16 ± 6	89 ± 32*	17 ± 6	16 ± 7	<0.0001
CRP, mg/L	81 ± 66	16 ± 42*	11 (3-43)	5 (1-9)*	0.0001
IL-6, pg/mL	15 (5-57)	3 (0.9-6)*	3 (1-9)	4 (1-11)	0.0002
LDH, U/L	369 ± 159	274 ± 115*	244 (172-298)	207 (175-251)	0.002
Ferritin, ng/mL	431 (190-836)	334 (154-508)*	169 (63-526)	196 (57-456)	0.008

* P value < 0.05 pre vs. post intervention
# P value for difference between group

Lakkireddy M, et al. Sci Rep. 2021;11(1):10641.

Effects of a 2-Week 5000 IU vs. 1000 IU Vitamin D3 Supplementation on Recovery of Symptoms in Patients with Mild-Moderate Covid-19

- P: mild to moderate COVID-19 patients with sub-optimal vitamin D status (n=69)
- I: Vitamin D3 5000 IU daily for 2 week (n=36)
- C: Vitamin D3 1000 IU daily for 2 week (n=33)
- O: Anthropometric measurement, Fasting blood glucose, lipids, serum 25(OH)D, and inflammatory markers



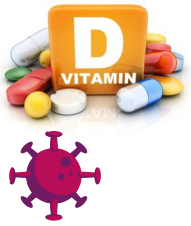
Sabico S, et al. Nutrients. 2021;13(7).

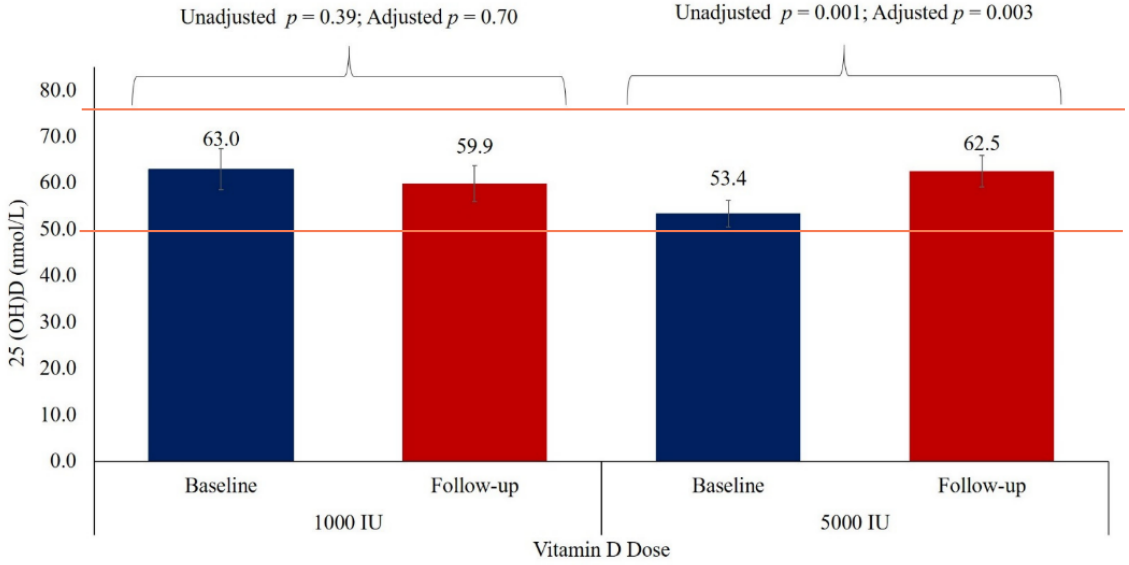
Parameters	All	1000 IU	5000 IU	*p*-Value
n	69	33	36	

	All	1000 IU	5000 IU	p-value
Age	49.8	53.5	46.3	0.03
BMI	30.7	32.0	28.2	0.02

Systolic BP (mmHg)	128.2 ± 17.2	128.3 ± 20.7	128.1 ± 13.4	0.96
Diastolic BP (mmHg)	74.0 ± 13.7	72.8 ± 16.5	75.1 ± 10.6	0.47
Temperature (°C)	37.5 ± 0.9	37.3 ± 0.9	37.7 ± 0.9	0.06
Pulse Rate	93.9 ± 17.2	93.2 ± 17.4	94.5 ± 17.4	0.76
Respiratory Rate	23.9 ± 4.7	24.7 ± 5.0	23.2 ± 4.2	0.19
Medical History (%)				
Hypertension	38 (5)	18 (54)	20 (56)	0.61
T2DM	35 (51)	17 (52)	18 (50)	0.76
Obesity	23 (33)	12 (36)	11 (31)	0.54
Hyperlipidaemia	9 (13)	4 (12)	5 (14)	1.0
CKD	5 (7)	4 (12)	1 (3)	0.19
Cardiovascular Disease	4 (6)	3 (9)	1 (3)	0.34
Asthma	3 (4)	2 (6)	1 (3)	0.60
Rheumatoid	2 (3)	1 (3)	1 (3)	1.0
Thyroid	2 (3)	1 (3)	1 (3)	1.0
Epilepsy	1 (1)	1 (3)	–	1.0
Supplements (%)				
Vitamin C	34 (47)	14 (40)	20 (53)	0.28
Symptoms (%)				
Fever	56 (77)	24 (69)	32 (84)	0.18
Dyspnea	52 (71)	26 (74)	26 (68)	0.58
Fatigue	43 (59)	22 (63)	21 (55)	0.51
Cough	37 (51)	21 (60)	16 (42)	0.28
Headache	33 (45)	13 (37)	20 (53)	0.17
Joint pain	24 (33)	12 (34)	12 (32)	0.85
Nausea	18 (25)	9 (26)	9 (24)	0.31
Diarrhea	16 (22)	8 (23)	8 (21)	0.17
Sore throat	14 (19)	5 (14)	9 (24)	0.17
Vomiting	14 (19)	8 (23)	6 (16)	0.42
Outcomes (N)				
ICU Admission	5	3	2	1.0
Mortality	1	–	1	–
Days to Discharge	7 (5–9)	7 (0–10)	6 (5–8)	0.14

Note: Data presented as N (%) for frequencies and mean ± SD for continuous variables.





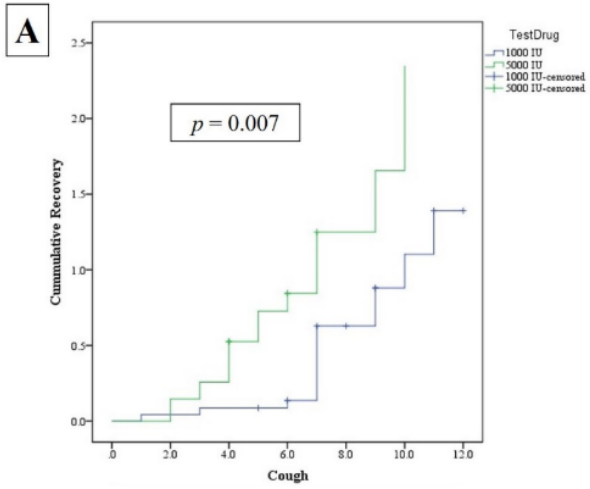
Vitamin D sufficiency: 25 (OH)D >75 nmol/L (>30 ng/mL)
Vitamin D insufficiency 25 (OH)D 50-75 nmol/L (20-30 ng/mL)
Vitamin D deficiency: 25(OH)D <50 nmol/L (<20 ng/mL)

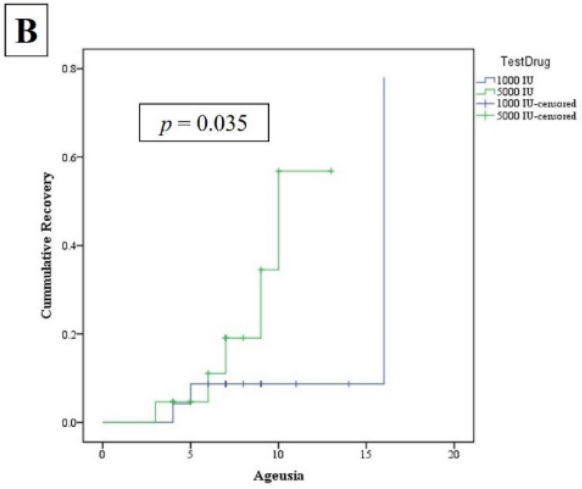
Sabico S, et al. Nutrients. 2021;13(7).

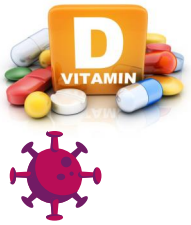
Table 2. Average Days to Resolve Covid-19 Symptoms according to Vitamin D Dose.

Symptoms	1000 IU	5000 IU	*p*-Value
Fever	9.9 ± 1.7	8.5 ± 0.9	0.97
Dyspnea	11.2 ± 1.6	8.9 ± 1.1	0.24
Fatigue	8.9 ± 0.5	7.7 ± 0.8	0.27
Cough	9.1 ± 0.8	6.2 ± 0.8	0.007
Headache	10.6 ± 0.9	8.7 ± 0.8	0.24
GI symptoms	9.7 ± 1.2	7.6 ± 0.7	0.89
Sore throat	9.5 ± 0.6	12.5 ± 0.7	0.15
Body Aches	9.2 ± 0.9	9.6 ± 0.9	0.68
Chills	17.6 ± 1.2	11.2 ± 1.1	0.14
Anosmia	16.3 ± 1.7	11.2 ± 1.1	0.14
Ageusia	16.9 ± 1.7	11.4 ± 1.0	0.035

Note: Data presented as estimated mean ± SE obtained from Kaplan–Meier survival analysis; *p*-value < 0.05 considered significant.

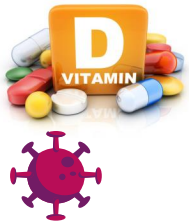






A 5000 IU daily oral vitamin D3 supplementation for 2 weeks reduces the time to recovery for cough and gustatory sensation loss among mild to moderate COVID-19 patients with vitamin D insufficiency

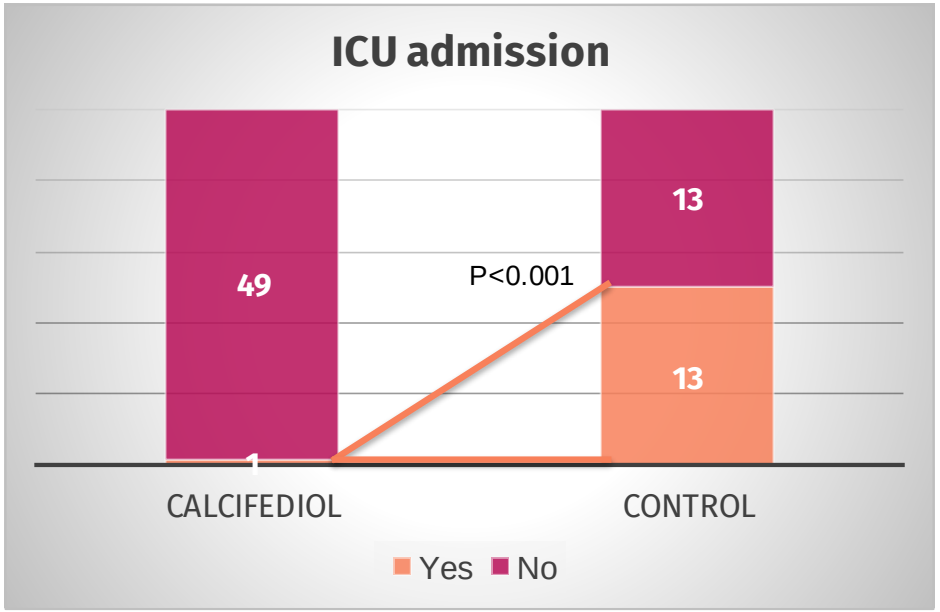
Sabico S, et al. Nutrients. 2021;13(7).



calcifediol treatment on ICU admission and mortality among hospitalized COVID-19 patient

- **P: 76 COVID-19 patients with pneumonia**
- **I: best available therapy + oral calcifediol (n=50)**
  - oral calcifediol 0.532 mg (21280 IU) on admission follow by 0.266 mg (15,960 IU) on day 3 and 7, and then weekly until discharge or ICU admission
- **C: best available therapy (n=26)**
- **O: ICU admission and mortality**

Calcifediol: all discharged alive
Control: 2 died, 14 discharged

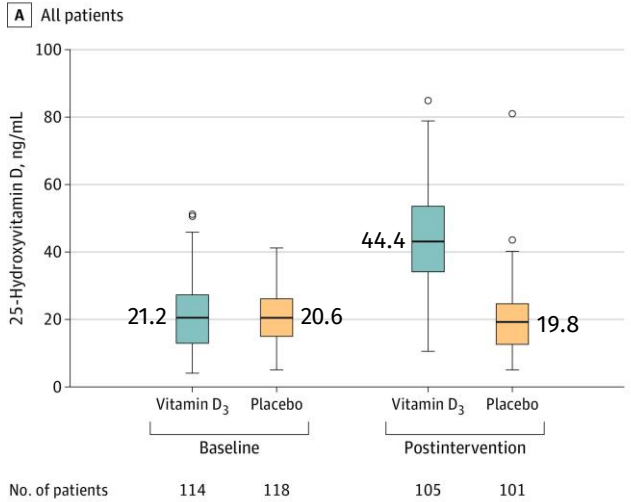


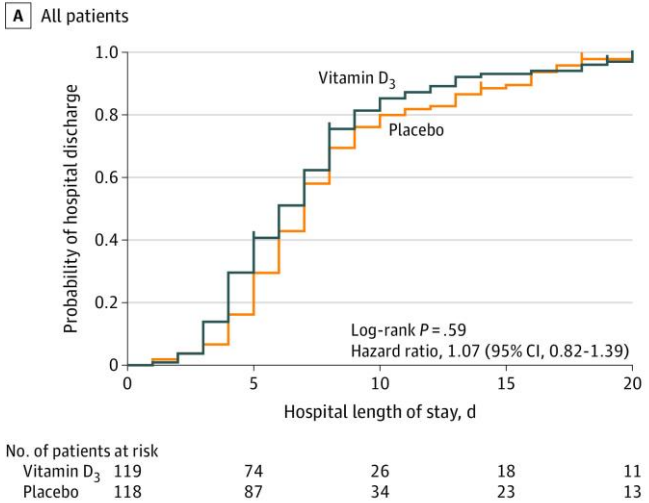
Multivariate Risk Estimate Odds Ratio for ICU admission 0.03 (95 %CI: 0.003-0.25)

Entrenas Castillo M, et al. J Steroid Biochem Mol Biol. 2020;203:105751

Effect of a Single High Dose of Vitamin D3 on Hospital Length of Stay in Moderate to Severe COVID-19 patients

- **P:** Moderate to Severe COVID-19 patients (n=240) in Sao Paulo, Brazil
- **I:** a single oral dose of 200,000 IU of vitamin D3 (n = 120)
- **C:** placebo (n = 120)
- **O:** length of stay, hospital mortality, ICU admission, need for MV

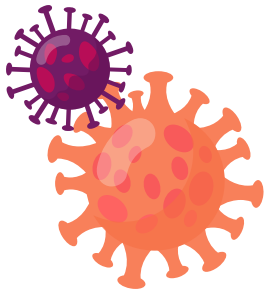


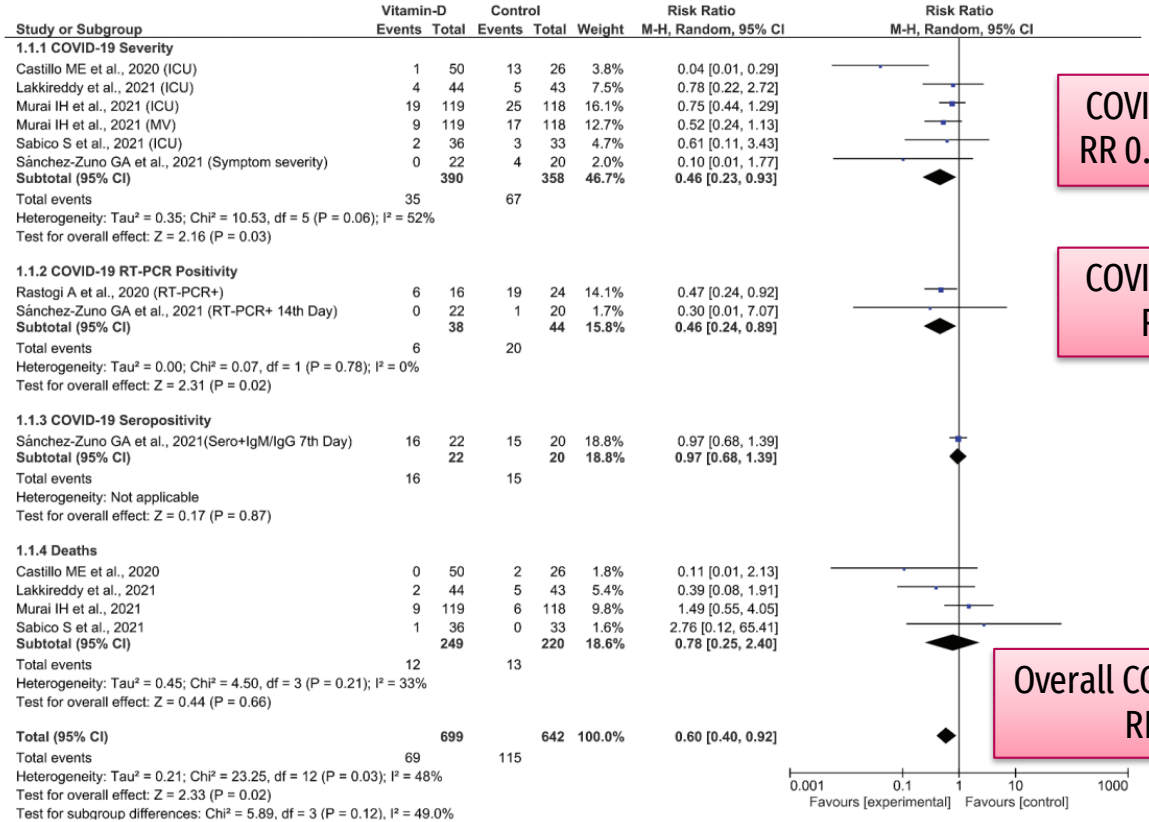


Murai IH, et al. JAMA. 2021;325(11):1053-60.

COVID-19 and vitamin D (Co-VIVID study):
a systematic review and meta-analysis of RCTs

6 RCTs with 551 COVID-19 patients were included.





COVID-19 severity
RR 0.46 (0.23, 0.93)

COVID-19 RT-PCR positivity
RR 0.46 (0.24, 0.89)

Overall COVID-19 related outcomes
RR 0.60 (0.40, 0.92)

Varikasuvu SR, et al. Expert Rev Anti Infect Ther. 2022;20(6):907-13.

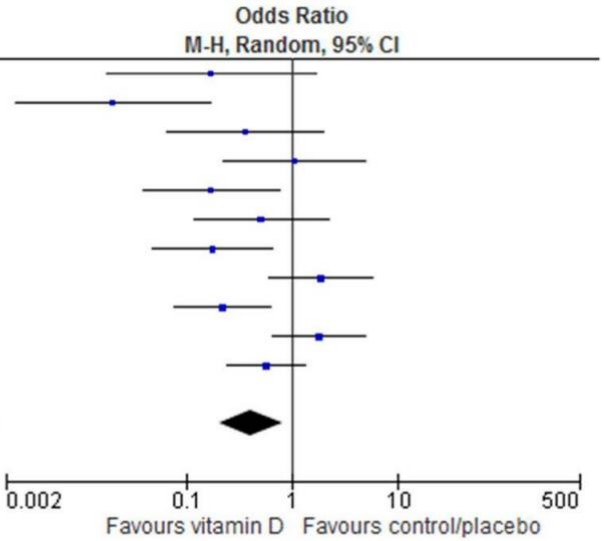
Vitamin D supplementation and clinical outcomes in COVID-19: a systematic review and meta-analysis

13 studies (10 observational, 3 RCTs) pooling data retrieved from 2933 COVID-19 patients.

Study or Subgroup	Vitamin D Events	Vitamin D Total	Control/Placebo Events	Control/Placebo Total	Weight	Odds Ratio M-H, Random, 95% CI
Jevalikar et al. (2021)	1	128	3	69	5.6%	0.17 [0.02, 1.70]
Entrenas Castillo et al. (2020)	1	50	13	26	6.1%	0.02 [0.00, 0.17]
Lakkireddy et al. (2021)	2	44	5	43	7.8%	0.36 [0.07, 1.98]
Hernandez et al. (2020)	2	19	20	197	8.5%	1.04 [0.22, 4.84]
Annweiler C et al. (2020)	10	57	5	9	8.8%	0.17 [0.04, 0.75]
Annweiler G et al. (2020)	3	16	10	32	8.9%	0.51 [0.12, 2.19]
Cangiano et al. (2020)	3	20	39	78	9.6%	0.18 [0.05, 0.65]
Murai et al. (2021)	9	119	5	118	10.6%	1.85 [0.60, 5.69]
Alcala-Diaz et al. (2021)	4	79	90	458	11.0%	0.22 [0.08, 0.61]
Cereda et al. (2021)	7	18	40	152	11.1%	1.78 [0.65, 4.91]
Giannini et al. (2021)	14	36	29	55	12.0%	0.57 [0.24, 1.34]
Total (95% CI)		**586**		**1237**	**100.0%**	**0.41 [0.20, 0.81]**
Total events	56		259			

Heterogeneity: $Tau^2 = 0.85$; $Chi^2 = 29.42$, df = 10 (P = 0.001); $I^2 = 66\%$

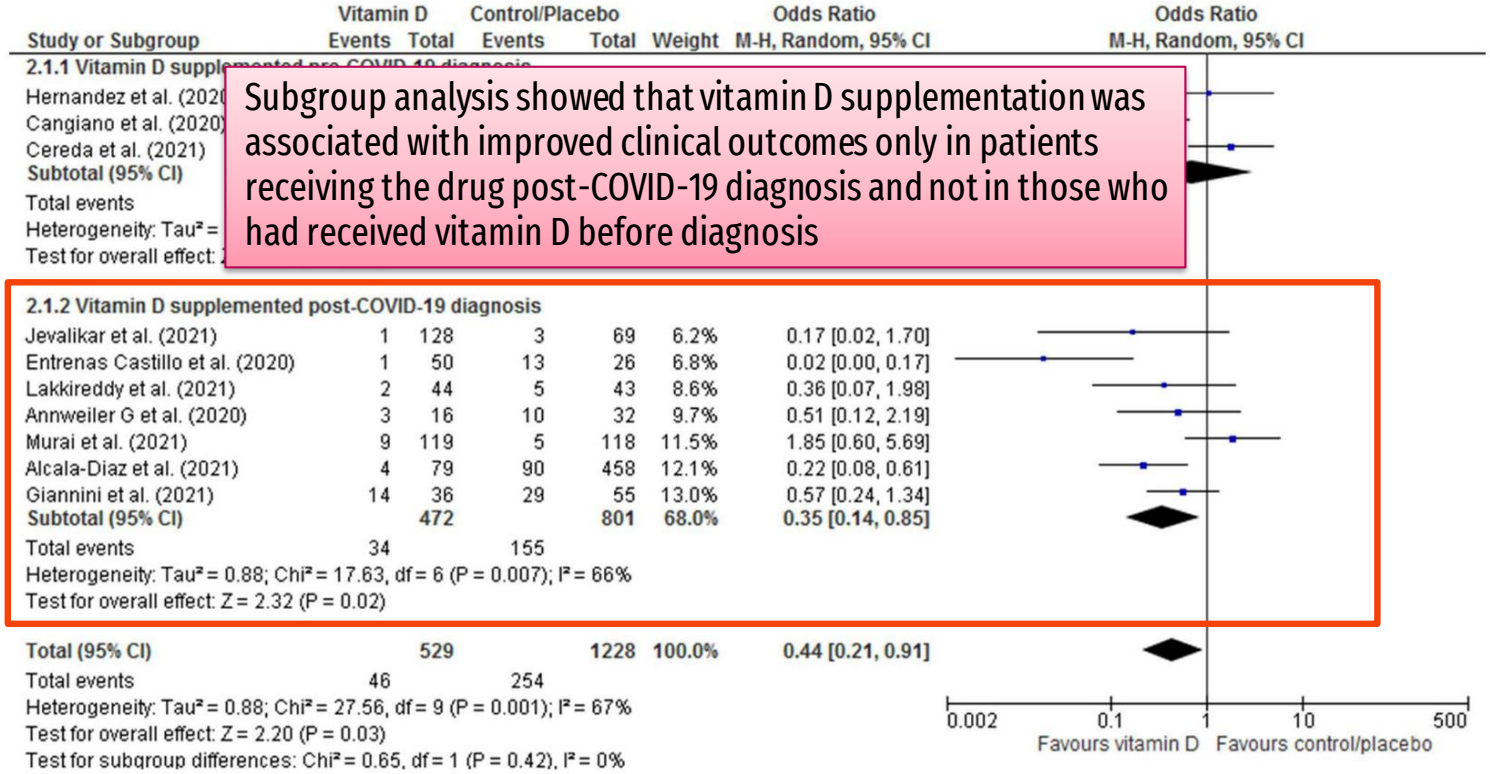
Test for overall effect: Z = 2.56 (P = 0.01)



ICU admission and Mortality
RR 0.41 (0.20, 0.81)

Pal R, et al. J Endocrinol Invest. 2022;45(1):53-68.

Vitamin D supplementation and clinical outcomes in COVID-19: a systematic review and meta-analysis



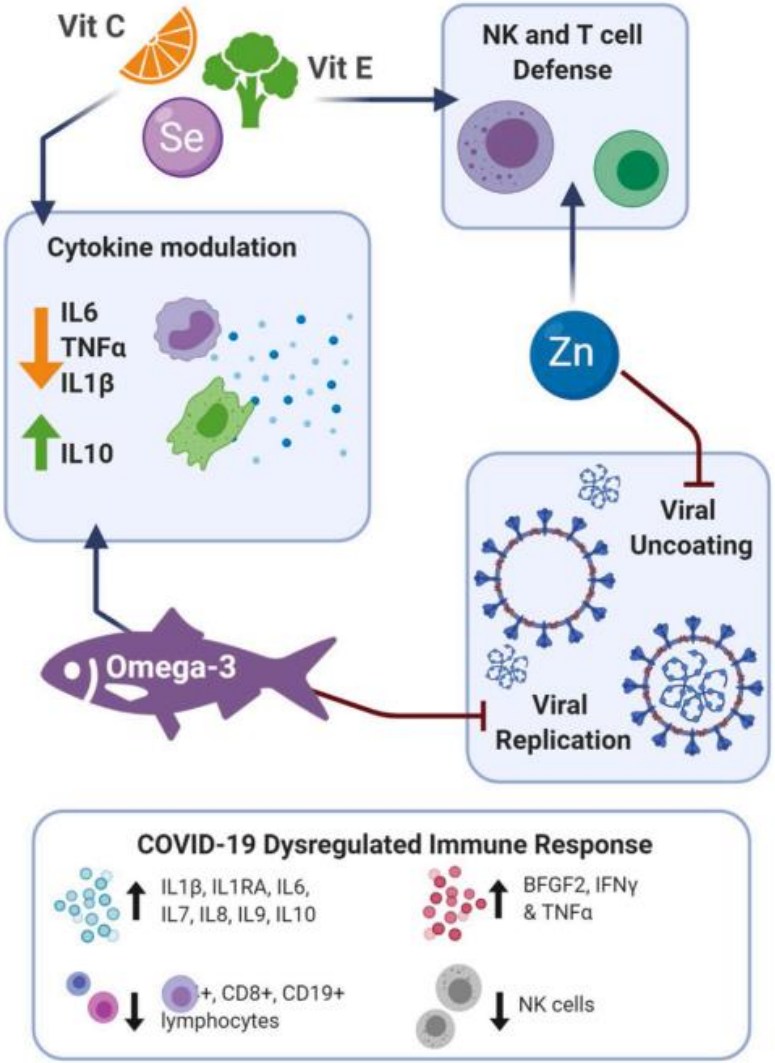
Pal R, et al. J Endocrinol Invest. 2022;45(1):53-68.

NIH COVID-19 treatment guidelines: Vitamin D

Last Updated: September 26, 2022

- There is **insufficient evidence** for the Panel to recommend either for or against the use of vitamin D for the prevention or treatment of COVID-19.
    - Although multiple observational cohort studies suggest that people with low vitamin D levels are at increased risk of SARS-CoV-2 infection and worse clinical outcomes after infection (e.g., higher mortality rates), clear evidence that vitamin D supplementation provides protection against infection or improves outcomes in patients with COVID-19 is still lacking
    - meta-analyses on the use of vitamin D for the prevention or treatment of COVID-19 have been published in peer-reviewed journals or have been made available as manuscripts ahead of peer review. However, most of these studies had significant limitations, such as small sample sizes or a lack of randomization and/or blinding. In addition, these studies used varying doses and formulations of vitamin D, enrolled participants with a range of COVID-19 severities, included different concomitant medications, and measured [illegible] study outcomes. All these factors make it difficult to compare results across studies.

https://www.covid19treatmentguidelines.nih.gov/therapies/supplements/vitamin-d/



Shakoor H, et al. Maturitas. 2021;143:1-9.

The use of IV vitamin C for patients with COVID-19: a case series

P: 17 COVID-19 patients requiring $FiO_2 \geq 0.3$
I: vitamin C 1 g intravenous q 8 h for 3 days (off label use) addition to standard treatment at median 3 d after admission
C: none
O: inflammatory marker, MV requirement, mortality

Baseline Demographic and Clinical profile

Age (mean±SD)	63.82 ±14.20
Female gender	7 (41%)
BMI (mean±SD)	32.71±8.74
Race	
African American	10 (59%)
Caucasian	4 (23%)
Asian	1 (6%)
Hispanic	2 (12%)
Comorbidities	
COPD/asthma	4 (24%)
Heart Failure	2 (12%)
Diabetes	8 (47%)
ESRD	2 (12%)
Immunosuppression	1 (6%)
Coronary artery disease	4 (23%)
Hypertension	8 (47%)
Medications	
Hydroxychloroquine	14 (82%)
Methylprednisolone	10 (59%)
Tocilizumab	4 (23%)
Clinical outcomes	
Need for intubation	3 (17.6%)
In-patient mortality	2 (12%)

Comparison of markers of disease severity pre and post treatment

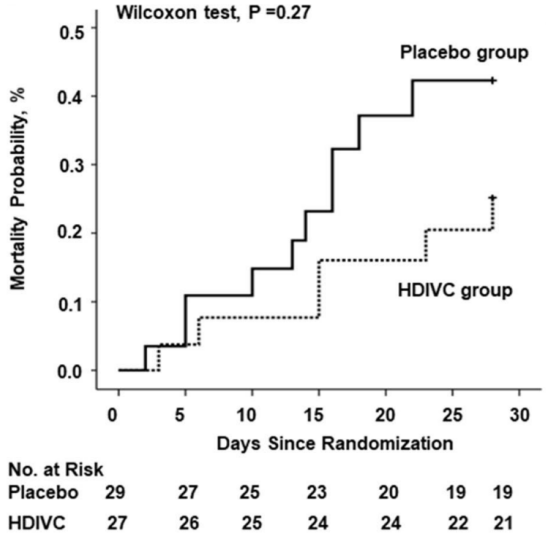
	Pre-treatment	Post-treatment	p value
D-dimer	2169.29 ± 2425.21	1728.43 ± 1341.28	p = 0.022
Ferritin	1392.07 ± 2031.62	1031.36 ± 974.84	p = 0.006
FiO2%	66.88 ± 25.59	47.06 ± 27.13	p = 0.186

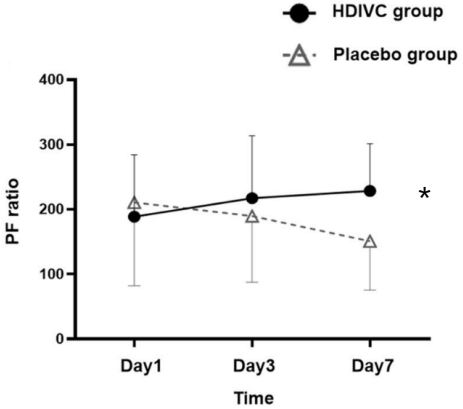
Moderate to severe covid-19 patients receiving IV vitamin C (3g/d) addition to standard treatment decrease inflammatory markers and tend to improve oxygenation

Hiedra R, et al. Expert Rev Anti Infect Ther. 2020;18(12):1259-61.

High-dose vitamin C in critically ill COVID-19 patients

- P: critically ill COVID-19 patients (n=56)--China
- I: vitamin C 12 g IV q 12 h within 4h of ICU for 7 d (n=27)
- C: placebo (n=29)
- O: MV-free day in 28 d, 28-d-mortality, SOFA scores, inflammation (IL-6)



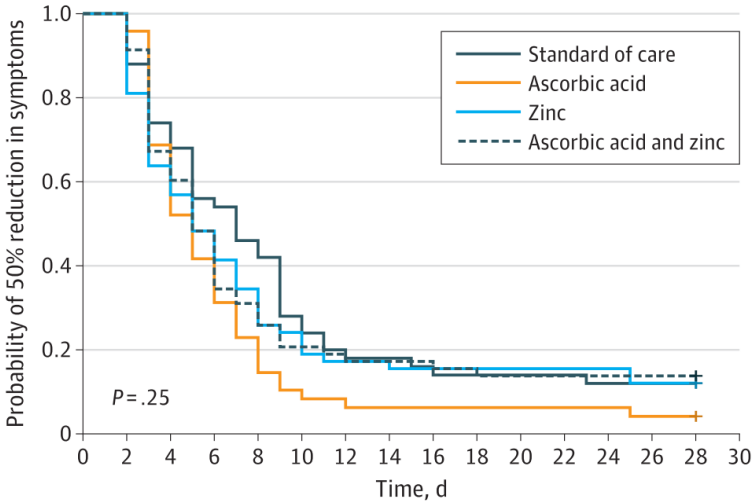


	HDIVC	Placebo	P
IL-6, pg/dL			
Day 1	22.6 (8.9-85.5)	54.7 (12.3-145.5)	0.61
Day 3	113.1 (21.8-288.7)	37.2 (5.6-85.3)	0.07
Day 7	**19.4 (10.6-29.2)**	**158.0 (15.3-259.6)**	**0.04**
CRP, mg/dL			
Day 1	39.9 (3.9-86.9)	56.8 (40.2-100.2)	0.19
Day 3	43.5 (3.4-65.7)	66.3 (29.8-107.4)	0.28
Day 7	29.5 (11.0-110.9)	30.2 (2.3-131.7)	0.68

Zhang J, et al. Ann Intensive Care. 2021;11(1):5.

Effect of High-Dose Zinc and Ascorbic Acid Supplementation Among Ambulatory COVID-19 Patients

- P: ambulatory COVID-19 patients (n=214)
- I: for 10 days after diagnosis
  - Vitamin C 8,000 mg/d (n=48),
  - Zinc gluconate 50 mg/d (n=58),
  - Vitamin C + Zinc gluconate (n=58)
- C: usual care (n=50)
- O:
  - Primary: the number of days required to reach a 50% reduction in symptoms
  - Secondary: days required to reach a total symptom severity score of 0, cumulative severity score at day 5, hospitalizations, deaths, adjunctive prescribed medications, and adverse effects of the study supplements



No. at risk

Standard of care	50	50	37	28	23	14	10	9	8	7	7	7	6	6	6	0
Ascorbic acid	48	48	33	20	11	5	4	3	3	3	3	3	3	2	2	0
Zinc	58	58	37	28	20	14	10	10	9	9	9	9	9	7	7	0
Ascorbic acid and zinc	58	58	39	28	18	12	11	10	10	9	8	8	8	8	8	0

The study was stopped for a low conditional power for benefit with no significant difference among the 4 groups for the primary end point

Thomas S, et al. JAMA Netw Open. 2021;4(2):e210369.

NIH COVID-19 treatment guidelines: Vitamin C

Last Updated: September 26, 2022

- There is insufficient evidence for the Panel to recommend either for or against the use of vitamin C for the treatment of COVID-19 in nonhospitalized patients.
  - Because patients who are not critically ill with COVID-19 are less likely to experience oxidative stress or severe inflammation, the role of vitamin C in this setting is unknown
- There is insufficient evidence for the Panel to recommend either for or against the use of vitamin C for the treatment of COVID-19 in hospitalized patients.
  - No controlled trials have definitively demonstrated a clinical benefit of vitamin C in critically ill patients with COVID-19, and the available observational data are inconclusive. Studies of vitamin C regimens in patients with acute respiratory distress syndrome (ARDS) or sepsis not related to COVID-19 have reported variable efficacy and few safety concerns.

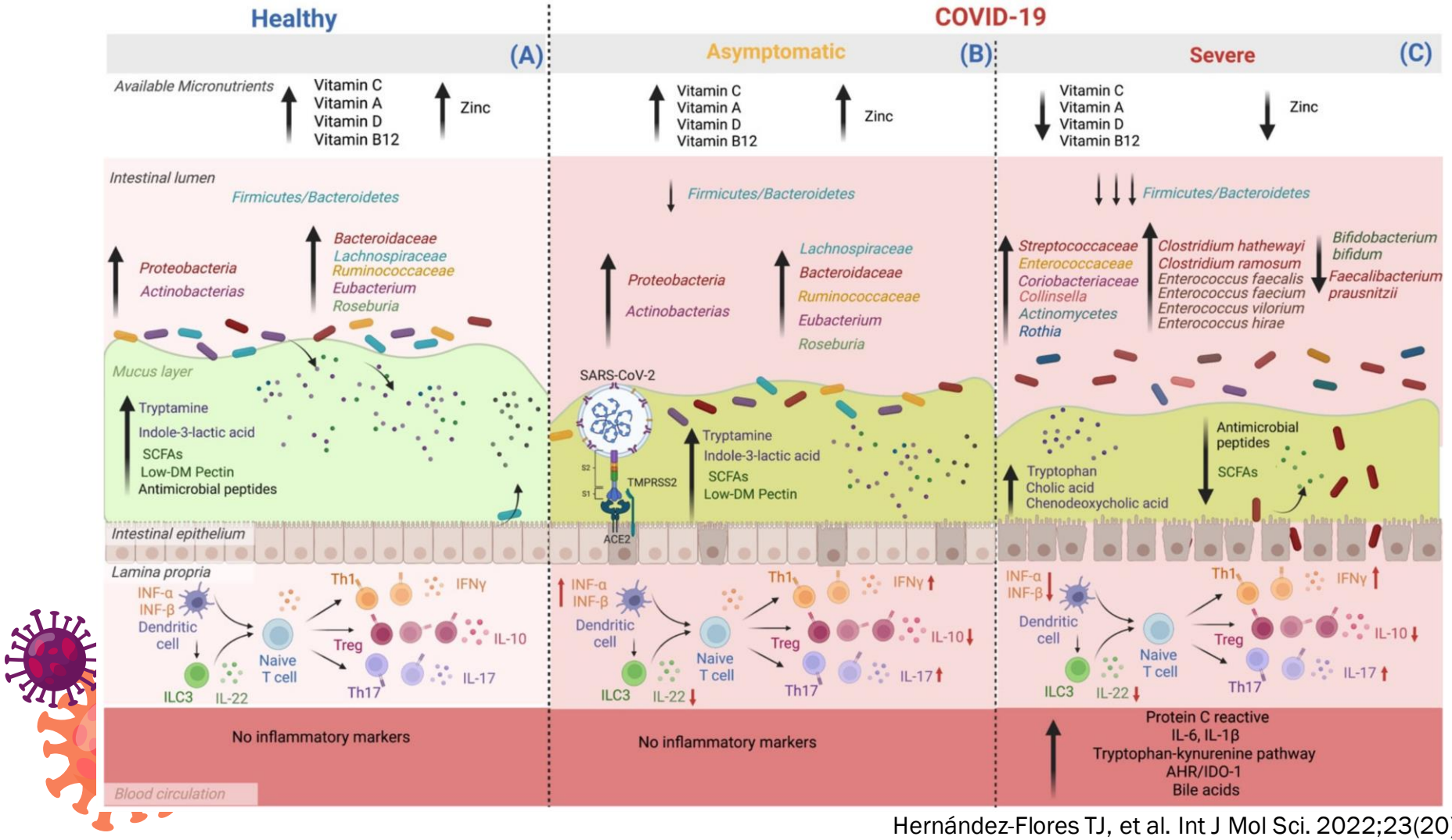
https://www.covid19treatmentguidelines.nih.gov/therapies/supplements/vitamin-c/

NIH COVID-19 treatment guidelines: Zinc

Last Updated: September 26, 2022

- There is **insufficient evidence** for the Panel to recommend either for or against the use of zinc for the treatment of COVID-19.
- The Panel **recommends against** using zinc supplementation above the recommended dietary allowance (i.e., zinc 11 mg daily for men, zinc 8 mg daily for nonpregnant women) for the prevention of COVID-19, except in a clinical trial (BIII)
    - The doses used in registered clinical trials for patients with COVID-19 vary between studies, with a maximum dose of zinc sulfate 220 mg (50 mg of elemental zinc) twice daily.
    - Long-term zinc supplementation can cause copper deficiency (The use of zinc supplementation for durations as short as 10 months)
    - In addition, oral zinc can decrease the absorption of medications that bind with polyvalent cations.[4]
    - Because zinc has not been shown to have a clinical benefit and may be harmful, the Panel recommends against using zinc supplementation above the recommended dietary allowance for the prevention of COVID-19, except in a clinical trial

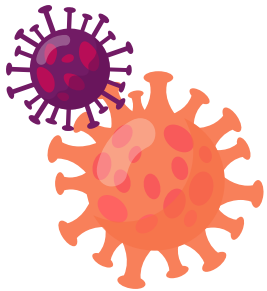
https://www.covid19treatmentguidelines.nih.gov/therapies/supplements/zinc/



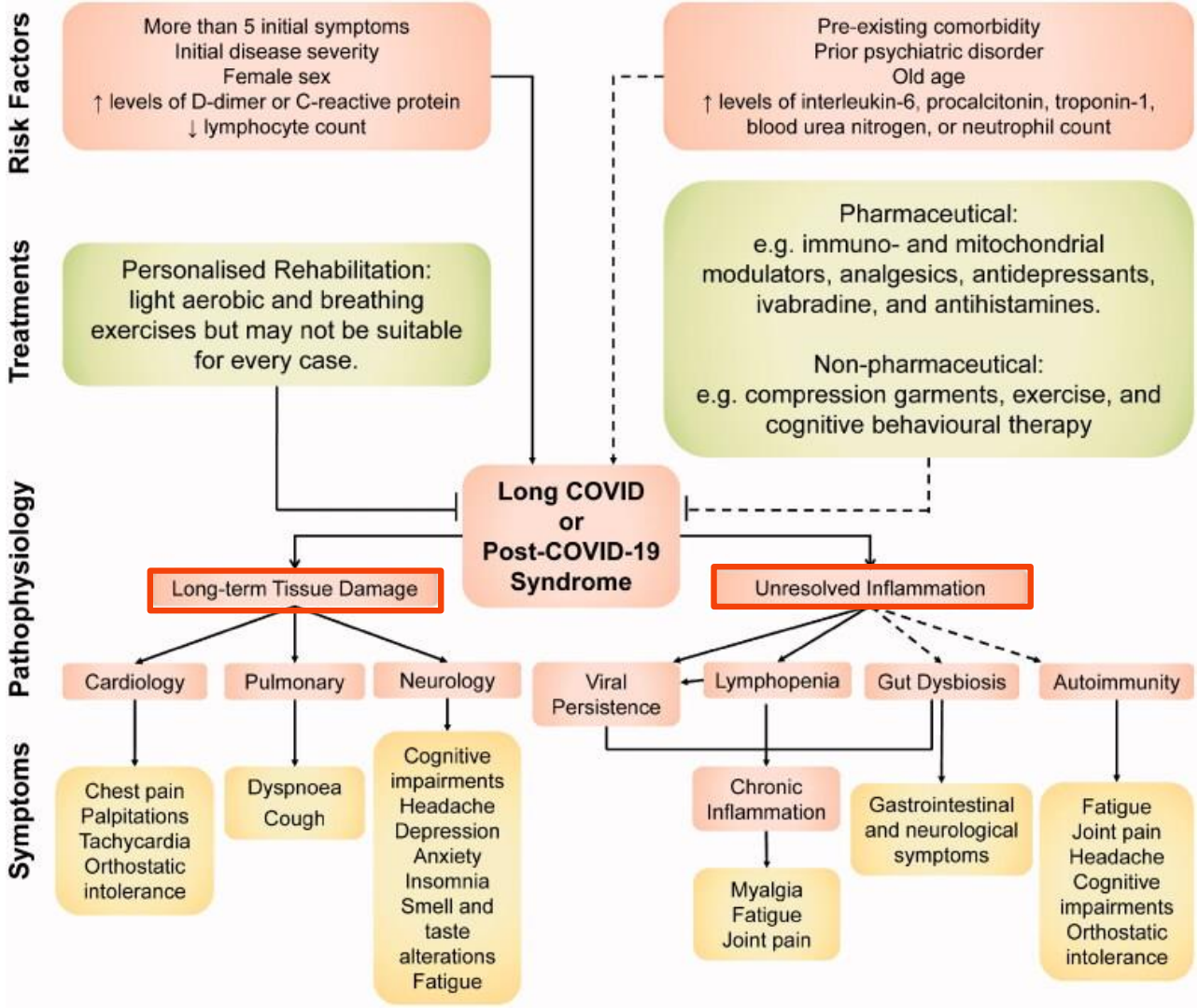
Hernández-Flores TJ, et al. Int J Mol Sci. 2022;23(20).

What is Post-COVID-19 Syndrome

- Post-COVID19 syndrome is generally defined as “the persistence of signs and symptoms that develop during or following an infection consistent with COVID-19 which continue for more than 12 weeks and are not explained by an alternative diagnosis.”



Barrea L, et al. Nutrients. 2022;14(6).



Yong SJ. Infect Dis (Lond). 2021;53(10):737-54.

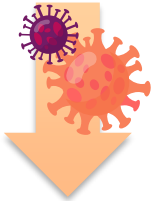
Physiopathologic pathways of post–COVID-19 sarcopenia

Pre-existing conditions in old adults

Biological age
Inflammaging
⇧Senescent cells
⇧ROS
⇧ACE and ⇧CD6 receptor
CMV +

Individual health condition
Multimorbidity
Obesity-Diabetes-Hypertension
Suboptimal muscle performance
Frailty-Disabilty
Vitamin D deficiency-Poor oral health-Malnutrition?

SARS-CoV-2



Immunological

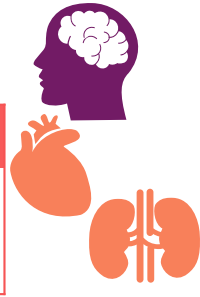
⇧⇧⇧Hyperinflammation

Dysfunction of monocytes-macrophages

Vascular

⇧ Vascular endothelial growth factor

Endothelial damages & micro- macro vascular thrombosis



Altered diet

Anosmia & Ageusia & Xerostomia & Dysphagia

Altered gut microbiota

⇩Food intake ⇩Food variety

⇧Catabolism

⇧Mitochondrial dysfunction & Autophagy
⇩Mitochondrial biogenesis
⇩Muscle synthesis
⇧Myofibrillar breakdown
⇧⇧⇧ Muscle degradation

Physical inactivity

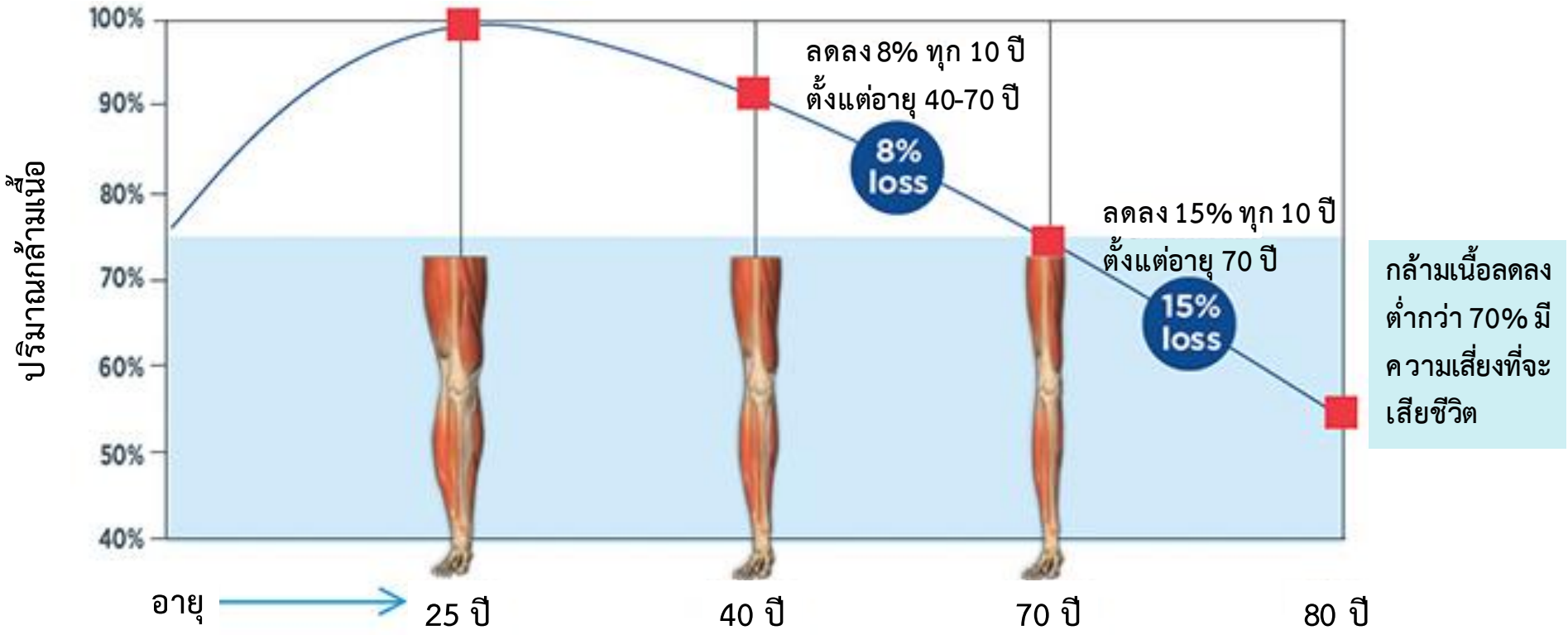
Bedrest, Lockdown/Quarantine

Hospitalization

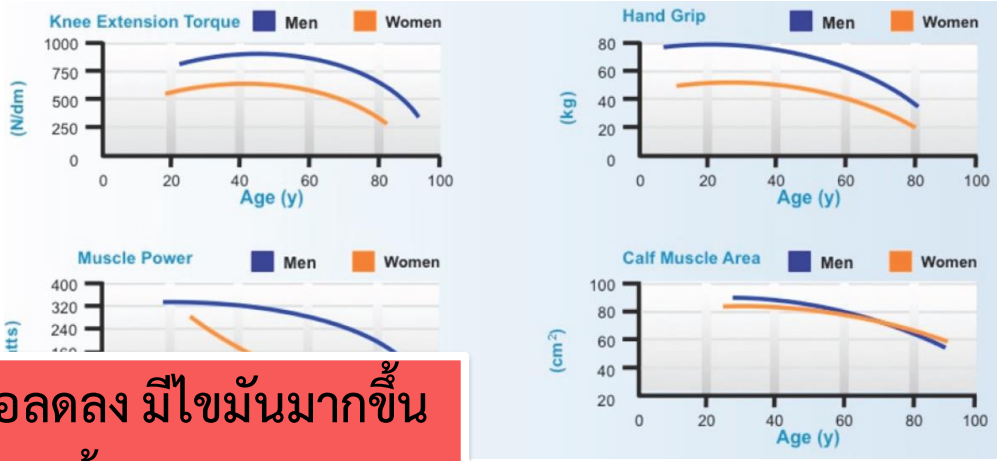
Various treatments

Rodriguez-Sanchez I, et al. Clin Geriatr Med. 2022;38(3):533-44.

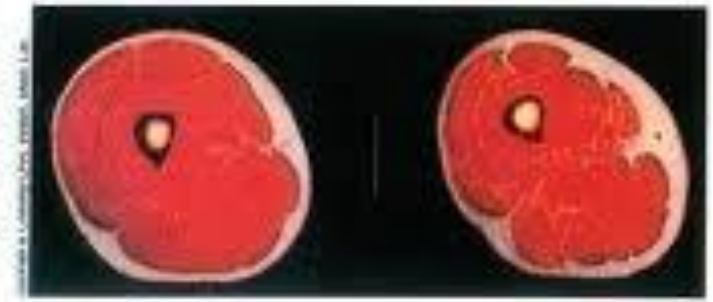
กล้ามเนื้อลดลงตามอายุ

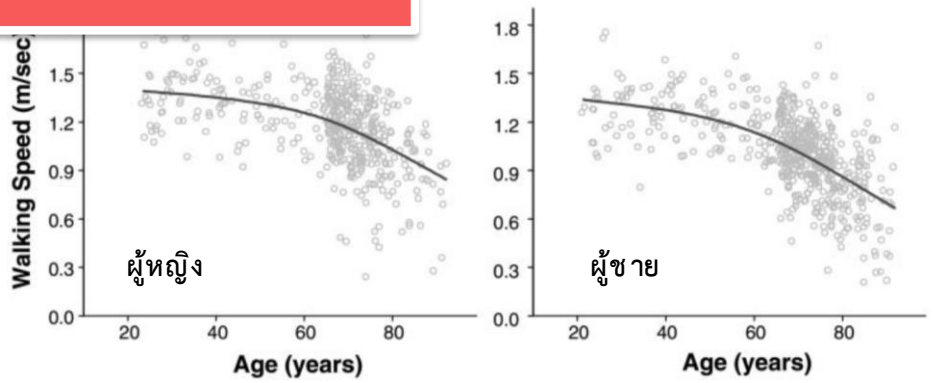


กล้ามเนื้อลดลงต่ำกว่า 70% มีความเสี่ยงที่จะเสียชีวิต



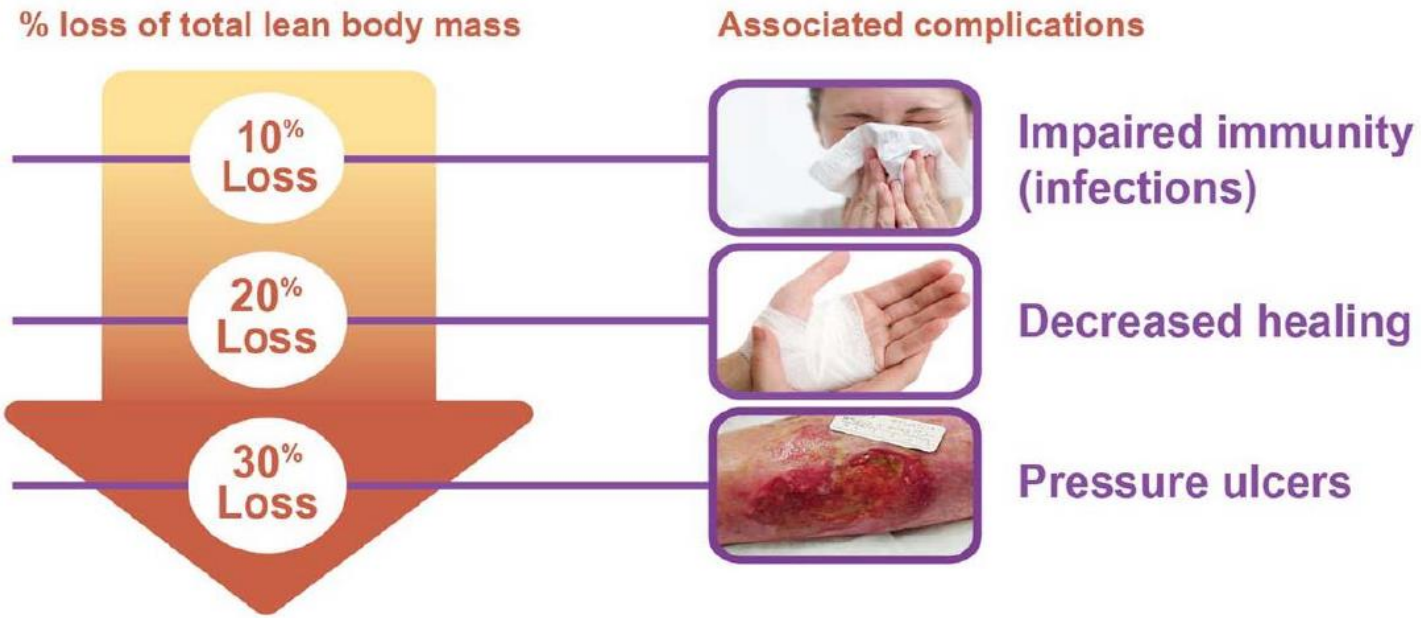
อายุมากขึ้น กล้ามเนื้อลดลง มีไขมันมากขึ้น
ความแข็งแรงของกล้ามเนื้อลดลง เดินช้าลง





Lauretani F, et al. J Appl Physiol (1985). 2003;95(5):1851-60.

Impact of muscle loss



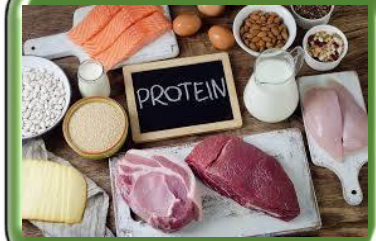
Loss of lean mass approaching 40% increases the risk of death – usually from pneumonia

Demling RH. *Eplasty*. 2009; 9:e9.

Recommendations for maintaining healthy muscle with aging

Enhanced Nitrogen retention

- Including carbohydrate in the meal
- Optimizing the amino acids composition in the protein
- Including more slowly digested protein
- Spreading ingestion of meal over time
- Ingesting full protein rather than free amino acids



- Older adults have greater protein needs to compensate for anabolic resistance and hypermetabolic disease.
- Older adults may also have decreased intake due to age-related appetite loss, medical conditions, financial limits.
- Optimal intake of at least 1.0 to 1.5 g protein/kg BW/day is recommended; individual needs depend upon the severity of malnutrition risk.

Exercise

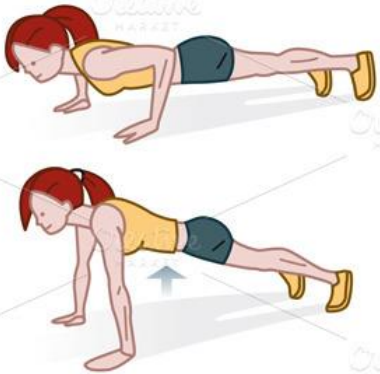
- Regular exercise helps maintain skeletal muscle strength and function in older adults.
- Resistance training has limited but positive effects on recovery of muscle in older people.
- A combination of resistance training and adequate dietary protein/amino acid intake for healthy muscle aging is recommended.

Deutz, NE, et al. Clin Nutr. 2014 Dec;33(6):929-36.

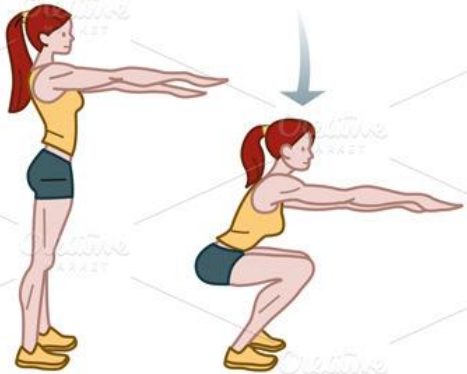
STRENGTH EXERCISES ROUTINES

Woman

FLEXION

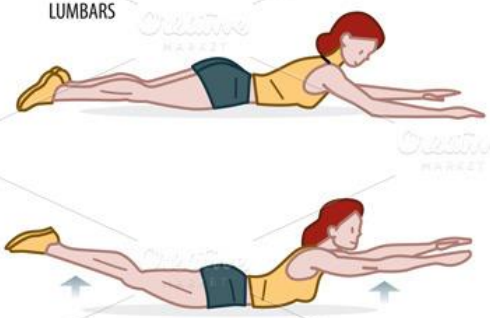


SQUAT

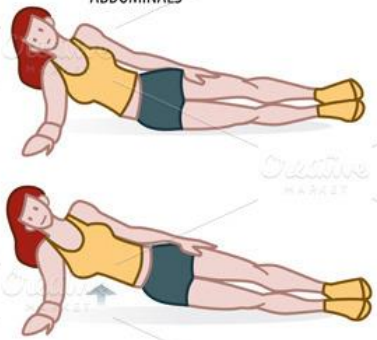


TRICEPS

LUMBARS



ABDOMINALS



SQUAT WITH DUMBBELL

STRENGTH EXERCISES ROUTINES

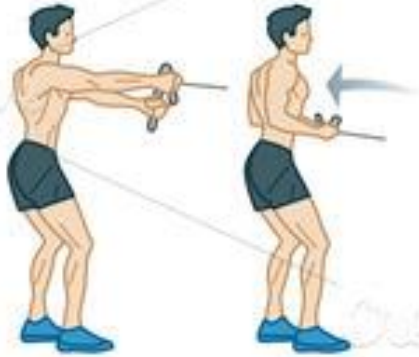
man

SQUAT WITH DUMBBELL

ABDOMINALS

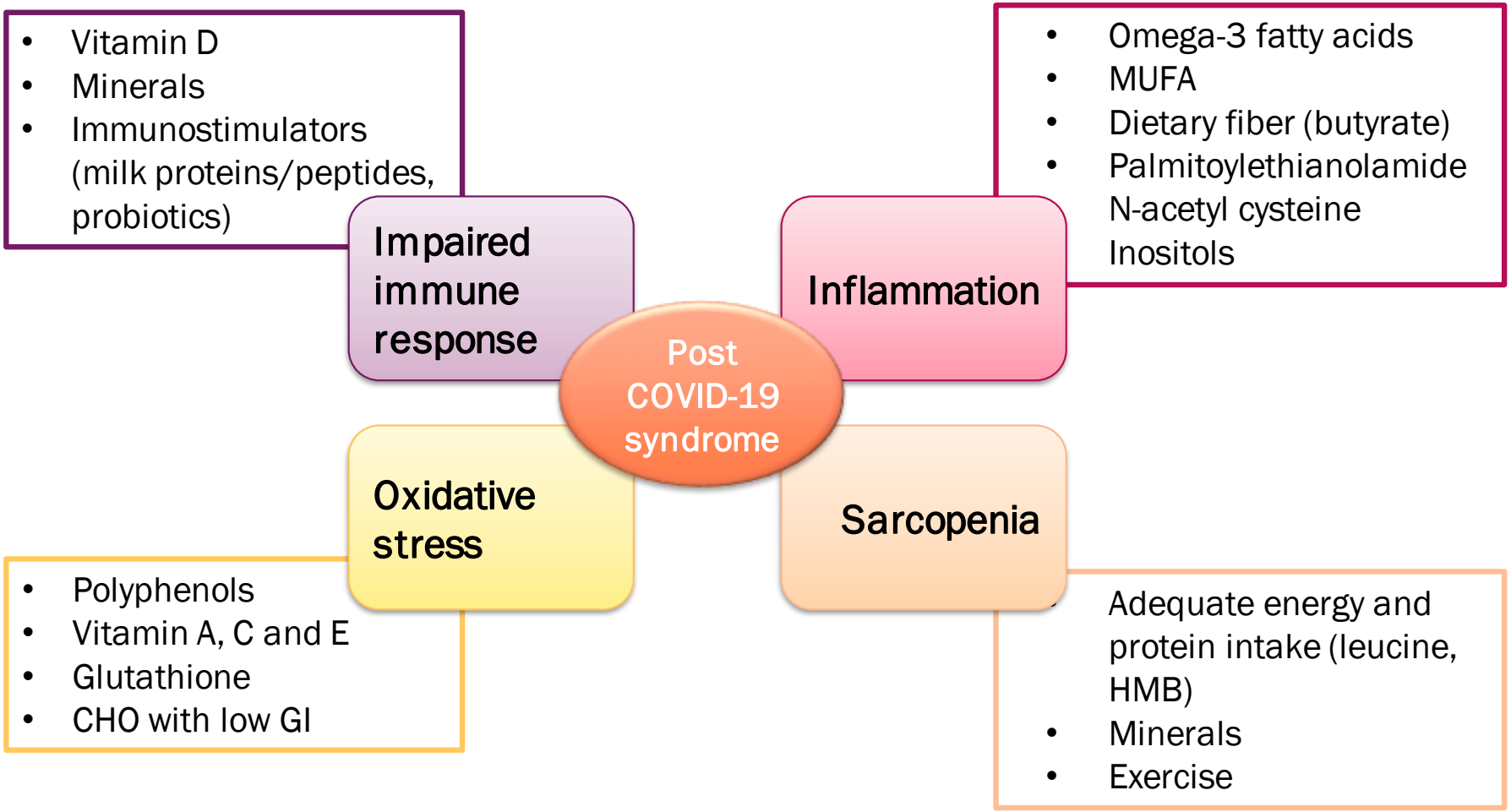
BENCH PRESS

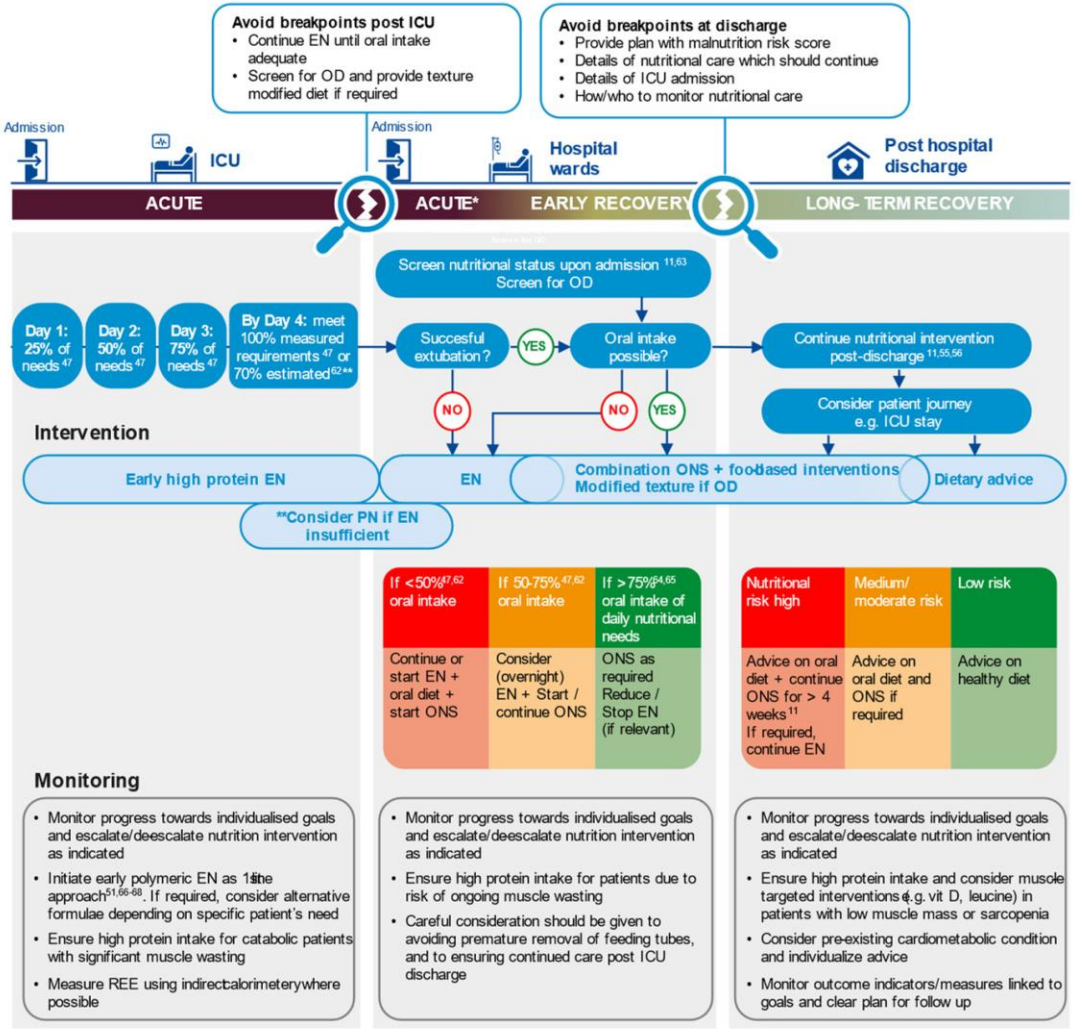
ROWING



ROWING WITH DUMBBELL

HIGH PULLEY


Vitamin D
Minerals
Immunostimulators (milk proteins/peptides, probiotics)
Impaired immune response
Omega-3 fatty acids
MUFA
Dietary fiber (butyrate)
Palmitoylethianolamide
N-acetyl cysteine
Inositols
Inflammation
Post COVID-19 syndrome
Oxidative stress
Polyphenols
Vitamin A, C and E
Glutathione
CHO with low GI
Sarcopenia
Adequate energy and protein intake (leucine, HMB)
Minerals
Exercise



Cereda E, et al. Nutrients. 2021;13(9).

Recommendations for nutritional rehabilitation: eating well to regain the strength after COVID-19.

Eat on schedule	• Eating plan: regular meals/snacks are a part of patients routine • Eating regularly: provide the body with the needed nutrients/calories to restore strength and immune function
Protein	• Daily allowance: 25 – 40 grams at each meal and 10 – 20 grams at each snack . • Protein from fish, poultry, dairy, beans: stimulate muscle growth and prevent a continued muscle' breakdown • Use ready-to-drink protein shakes, homemade shakes, protein powders
Calories	• Daily allowance: at least 35 – 47 calories/kg of weight • Reduce body' stress, and match rebuilding the strength • Enlarge the protein portions with vegetables, fruits, whole grains, other starches (e.g.; brown rice, potatoes, whole grain bread), which have high concentrations of carbohydrates and proteins • Use olive oil, nut butters, and other healthy fats to push calories .Monitor the weight: the aim is to return to the pre-Covid-19 weight, or to obtain a reasonable weight (in case of an overweight patient)

Recommendations for nutritional rehabilitation: eating well to regain the strength after COVID-19.

Hydration	• Drink on somewhat of a schedule .Drink with each meal and consume about 1 – 2 cup of fluid in between meals .Good examples of fluids: shakes, water, juice, milk, tea
Vitamin C	• Daily allowance: 500 mg • Keep the immune system healthy • Eat a food with vitamin C with each meal: an orange with breakfast, some sweet red pepper (in a salad or on sandwich) at lunch, and some tomato sauce with dinner and/or mango for dessert
Vitamin D	• Daily allowance: 800 – 2000 IU • Get outside at least 3 times/week for 30 minutes (with exposure on hands, arms, legs and face) • Eat some foods (e.g. fatty fish such as salmon, fortified milk, eggs)
Zinc	• Daily allowance: 5 – 10 mg if adequate intake along with food. • If deficiency in Zinc, then a 20 – 40 mg daily supplement is indicated for 2 weeks • Mineral essential for a healthy immune system

Ghram A, et al. Postgrad Med. 2022;134(2):143-7.

Recommendations for nutritional rehabilitation: eating well to regain the strength after COVID-19.

Calcium	• Daily allowance: 1–1.2 g • Important nutrient for bone health • Eat a calcium-rich food at different meals and snacks throughout the day 9Drink on somewhat of a schedule .Drink with each meal and consume about 1–2 cup of fluid in between meals .Good examples of fluids: shakes, water, juice, milk, tea
Omega-3 fatty acids (omega-s3: ALA, EPA, DHA)	• Daily allowance: 500 mg of EPA and DHA .Reduce excess inflammation .Found in fatty fish like salmon, tuna, sardines, herring, sea bass and mackerel. .Chia seeds, ground flaxseeds and edamame: healthy type of omega-3s .Eat fatty fish 2 times/week 10..Gut:..Probiotics:
Gut health, probiotics and prebiotics	• first-line defense against infection Probiotics: good strains of microorganisms/bacteria that aid in a diversity of ways. • They are found in fermented foods like yogurt with active culture, kefir, pickled vegetables, tempeh, kombucha tea, kimchi, miso and sauerkraut. • Eat 1 portion of yogurt/day with active cultures or make a shake with kefir .Prebiotics (i.e.; the food that probiotics live on.) which keep healthy the digestive tract, are found in fruits, vegetables, beans and whole grains

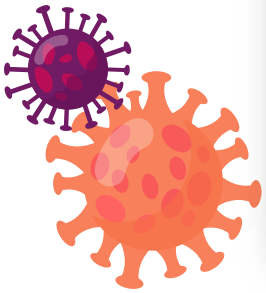
2.5–3 L/day of fluids to avoid dehydration

- Monounsaturated fatty acids
- Tocopherols
- Polyphenols

- Vitamins, mineral, and phytochemicals with antioxidant and anti-inflammatory properties
- Soluble and fermentable fibre

- Carbohydrate with low-glycemic index
- Soluble and fermentable fibre

- Protein with high biological value
- Omega 3 fatty acids (fish)

Malnourished or defied patients:

- Supplements with minerals and vitamins (in particular vitamin D)
- Nutraceuticals with antioxidant and anti-inflammatory activities (quercetin, resveratrol, catechins, glutathione, inositol, or combinations)
- Immuno-boosters (milk peptides and probiotics)