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ARTICLE

EAST framework to promote adherence to nutritional supplementation: a strategy to mitigate COVID-19 within health workers

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Abstract

Cooperative and caring behaviors are key drivers of human social progress, especially during catastrophes or pandemic events. While COVID-19 pandemics was arriving to Colombia in absence of any approved therapeutic strategy or vaccine, and based on evidence from other viral diseases, we anticipated to hypothesize the protective role of some nutritional supplements such as Vitamin D and C against SARS-CoV2. Therefore, for health workers, we proposed a voluntarily nutritional supplementation plan to fortify their immune system aiming to prevent or mitigate eventual COVID-19 infection and disease. Using the behavioral EAST framework, all our health workers ($n = 1{,}063$) were invited *via* email to participate voluntarily in a supplementation strategy for a period of 3 months. 77.4% accepted participation, and among them, we identified a group with optimal adherence to the proposed supplementation plan (20%) and a predominant group with no adherence at all (57.29%). Adherence seemed to be associated to a risk perception bias that was predominant in female workers and those workers performing in working areas with higher risk of infection. Of importance, adherence to the supplementation strategy was associated to a lower percentage of COVID-19 diagnostics (12%) as compared with that observed in non-adherence participants (19%). Moreover, the sustained adherence during the time of intervention seemed to promote adoption of this target behavior, as up to 35% of the adherent participants remained attached (on their own) to the supplementation habit, 3 months after the end of the intervention. All these data show the potential relevance of EAST frameworks as tools to trigger health care and altruistic behaviors to avoid the spread of pandemic diseases. In line with other authors, our observations suggest that nutritional vitamin D and C supplementation could mitigate the risk of COVID-19, highlighting the behavioral and biological relevance of this type of interventions during emerging or re-emerging infectious diseases.

Keywords: EAST framework; nutritional supplementation; Vitamin D and C; mitigation of COVID-19

Introduction

Currently ongoing and impacting socioeconomics and public health, COVID-19 has become one of the most relevant epidemiological events during the last 100 years. As an early pandemic spreading in absence of any approved vaccine or therapeutical strategy, a huge demand on the scientific community and governments emerged to lead alternative strategies and public policies to mitigate viral dissemination and disease progression, especially on developing countries.

As an organization committed to health, we understand behavior and lifestyle as main drivers to prevent disease. Hence, we anticipated the potential role of nutritional supplementation with vitamins D and C as an easy, safe and affordable strategy to strength the immune system against COVID-19, specifically within health workers in centers facing the first waves and peaks of the pandemics. We proposed this strategy based on the current knowledge that vitamin D plays a protective role against several respiratory viruses (Colotta *et al.*, 2017; Gibbons *et al.*, 2022), and that along with Vitamin C, have been shown to mitigate abnormal pro-inflammatory responses induced in the lungs, as the case of SARS-CoV2 (Holford *et al.*, 2020).

Vitamin D is a critical and essential micronutrient for health, calcium homeostasis and the function of our immune system (Martens *et al.*, 2020; Fleet, 2022). This micronutrient can be obtained mainly by autonomous synthesis in our skin induced by exposition to the sun; or alternatively, can be taken, in a lesser extent, from diet sources such as milk, fish, and eggs (DeLuca, 2004; Lamberg-Allardt, 2006). However, modern lifestyles and behavioral patterns including sedentarism and malnutrition are the current origin of a global vitamin D deficiency/insufficiency levels that are directly linked to a higher susceptibility and prevalence of respiratory viral infections and pro-inflammatory diseases (Malacova *et al.*, 2019).

On the other hand, vitamin C, or ascorbic acid, is a nutrient critical for some anti-oxidative and anti-inflammatory processes in the respiratory tract, that has been also associated with protection against several lung viral infections. Since this nutrient is not synthesized for primates, vitamin C supply for humans is strictly dependent on diet derived from fruits and some vegetables, or alternative supplementation (Neethu *et al.*, 2022).

Public health efforts to avoid global Vitamin D and C insufficiency and its derived effects are focused mainly on nutritional supplementation. Specifically, for COVID-19, an increasing number of clinical trials and researchers have highlighted the potential role of these nutritional supplements as a preventive strategy for disease progression (Martineau *et al.*, 2017; Grant *et al.*, 2020; Holford *et al.*, 2020; Saponaro *et al.*, 2020; Shah *et al.*, 2022; Wimalawansa, 2022). Although, evidence is still needed to deeply understand its efficacy, the general consensus approves its implementation as nutritional adjuvants based on its remarkably safety, low toxicity, high affordability, and their role as modulators of the immune system mitigating abnormal pro-inflammatory responses (Martineau *et al.*, 2017; Amrein *et al.*, 2020; Ahmad, 2022).

Thus, we implemented a Vitamin D- and C-based nutritional supplementation plan to strength the immune system within health workers facing risk of COVID-19 infection in their working area. To enhance adherence to this strategy

we used the EAST behavioral framework to promote *easy* access to an *attractive* (safe and free) nutritional supplementation strategy; focused on *social norm and compromise* behaviors as drivers to trigger individual and collective caring among the health workers. For this, we designed an automatic mechanism for a monthly delivery of free supplements and linked it to social norm nudges and collective compromise to adopt a caring habit of daily supplementation at the beginning of the working day (*timely*).

Methods

EAST behavioral framework: Easy, Attractive, Social, Timely

The EAST framework was developed by the Behavioral Insight Team (Service *et al.*, 2014) and is based on four simple principles to encourage a behavior: Make it easy, attractive, social, and timely. This framework has been widely implemented by policy makers and academics to encourage target behaviors related to health, education, and economics, among others.

Hence, to promote the target behavior: *adherence to nutritional supplementation*, we designed an automatic mechanism of monthly and free vitamin D supplement delivery at working place (**easy and attractive**), along with a supplementation tracker to keep it at a visible place, as a strategy to share '**socially'** with others their commitment for individual and collective caring. In addition, during the first delivery of supplements, this cooperative behavior was encouraged by signing a team compromise for self and collective caring during COVID-19 pandemics. The onset of social behavior was additionally nudged by our communication pieces and leaders encouraging the uptake of the supplements at the beginning of the workday (**timely**) and replicating the organizational message on the behavioral relevance of the strategy, its potential protective effect and the benefit for their health, the workforce, and their families (**attractive**).

From the EAST framework, we focused also on the social context as it can influence human decisions driving individuals' perceptions of collective norms to some target behavioral patterns or intentions, encouraging a specific behavior through direct communication strategies between groups or team members (Hogg and Reid, 2006). Hence, we used a set of explicit direct communications to promote vitamin D and C supplementation within health workers (see Supplementary data S1), as an altruistic and cooperative caring behavior to mitigate COVID-19, specifically, during the first critical peaks of the pandemics when vaccine or treatment protocols were not available.

Social norms are key drivers for health-related behaviors and its role and extent have been demonstrated in several models of health-related lifestyles (Ajzen, 1991; Dempsey *et al.*, 2018). This behavioral pattern has evolved as an 'instinctive' trait that enhanced cooperation, caring and social evolution in humans. Classically, social norms are defined as 'rules and standards that are understood by members of a group, and that guide decisions without the force of law' (Cialdini and Trost, 1998, p. 152), but can be perceived also as a cultural default to engage (or not) in specific behaviors (Ajzen, 1991). Optimal implementation of social norm improves healthy behaviors, including health workers, by enhancing the frequency of specific behaviors and as

a result, the group members may see it as the default normal behavior (Lapinski *et al.*, 2013; Kypri *et al.*, 2014; Cotterill *et al.*, 2019).

Participants

All health workers from our organization (1,063) were invited to participate voluntarily, including physicians, nurses, practitioners, assistants, security guards and general services workers, providing care or attention to the general users (or patients) that were suspected (or not known) to be COVID-19-positive patients. Administrative or medical staff performing on remote modality were also invited to participate. Invitations were sent *via* email and after matching inclusion criteria, signing informed consent and data authorization, the participants were enrolled in the strategy (see Supplementary data S2 and S3). Approval for data usage and the supplementation strategy was given by the internal ethical and compliance team and the Department of Laboral Health Security (see Supplementary Data S4).

Nutritional supplementation

The nutritional supplementation plan with vitamin D and C was established based on their previously reported safe dose for human health, that has been also associated with antiviral or anti-inflammatory activity (Pludowski *et al.*, 2018; Amrein *et al.*, 2020; Holford *et al.*, 2020). For Vitamin D, 5000 international units (IU)/day; and Vitamin C, 500 mg/day. Accordingly, each month we provided participants with two flasks containing 30 capsules, each of them with 5,000 international units (IU) of vitamin D and 500 mg of vitamin C, respectively (Farma D License 2018M-0017969, and La Santé License 2016M-000487-R2) (see Supplementary Data S5). In addition, participants were provided with a kit containing a supplementation tracker, the compromise letter, and some pedagogic images with orientations on the oral administration and recommendations on diet and physical outdoor activities to enhance better absorption (see Supplementary Data S1). The supplementation plan was implemented for three months and reminder emails were sent every month.

Potential risk of infection by working mode

Risk of infection for each role of the participants was established according to the guidelines from Occupational Safety and Health Administration USA (OSHA, 2023). Briefly: *Low risk:* Performing administrative duties in non-public areas of healthcare facilities, away from other staff members. *Medium:* Providing care to the general public who are not known or suspected COVID-19 patients. Working at busy staff work areas within a healthcare facility. *High*: Entering a known or suspected COVID-19 patient's room. Providing care for a known or suspected COVID-19 patient not involving aerosol-generating procedures. *Very high*: Performing aerosol-generating procedures (e.g., intubation, cough induction procedures, bronchoscopies, some dental procedures and exams, or invasive specimen collection) on known or suspected COVID-19 patients. Collecting or handling specimens from known or suspected COVID-19 patients.

Data collection and statistical analysis

Participation data was registered from enrollment forms on the Microsoft Forms platform and confirmed by informed consent, data authorization (see Supplementary Data S6) and reception of vitamin supplements. Adherence to supplementation was registered by an individual monthly self-report of number of days per week taking the supplements; and validated via phone call interview (for some participants). Infection and disease progression data was obtained from clinical records provided by the internal health services and the department of occupational safety and health-Comfama. Data of infection from some participants was validated via phone calls and surveys. All forms, surveys and phone calls scripts can be accessed in the supplementary material (see Supplementary Data S7). Data base cleaning and data optimization was performed in Microsoft Excel. Statistical analysis and figures were performed using GraphPad Prism version 9.5.0 for Windows, GraphPad Software, San Diego, California USA, www.graphpad.com

Results

Perceived risk bias for COVID-19 infection can influence adherence to the nutritional supplementation strategy

The COVID-19 pandemics became a public health crisis in absence of any approved vaccine or therapeutic protocol. To minimize risk of infection or disease progression within health workers during the first peaks of the pandemics, we implemented a vitamin D- and C-based nutritional supplementation strategy to strength their immune system. Using the behavioral EAST framework, we invited all health workers from Comfama to participate voluntarily in a cooperative caring strategy of nutritional supplementation to mitigate COVID-19. From all health workers, a total of 823 participants (77.4%) were initially enrolled on the strategy. The next table shows the main demographic distribution of the enrolled participants.

Our EAST framework approach was aimed to promote high adherence to nutritional supplementation. Therefore, to understand whether the intention of participation (Figure 1(a)) could derive into the target behavior, we registered the adherence to the suggested daily frequency of supplementation. For this, via online surveys, we collected monthly data on the average number of days per week taking the supplements. In line with this, we found three categories of behavior: (i) participants with high adherence to the supplements (five or more times per week), (ii) medium–low adherence (three times or less per week) and null adherence (once or less per week). Figure 1(b) shows the distribution of average overall adherence level among the participants during the whole intervention (3 months). In general, we found that the main proportion of participants (57%) showed no adherence (null) to the strategy, whereas around 20% of the participants were highly (17%) or mid-low (3%) adherent to the nutritional supplementation plan, being female workers the most adherent participants (Table 1).

Perception of risk is a potential bias affecting adherence for health-related behaviors (Cotterill *et al.*, 2019; Young and Goldstein, 2021). To understand whether perception of risk to COVID-19 infection at working areas was a potential bias explaining adherence to our supplementation plan, we compared, for each role within

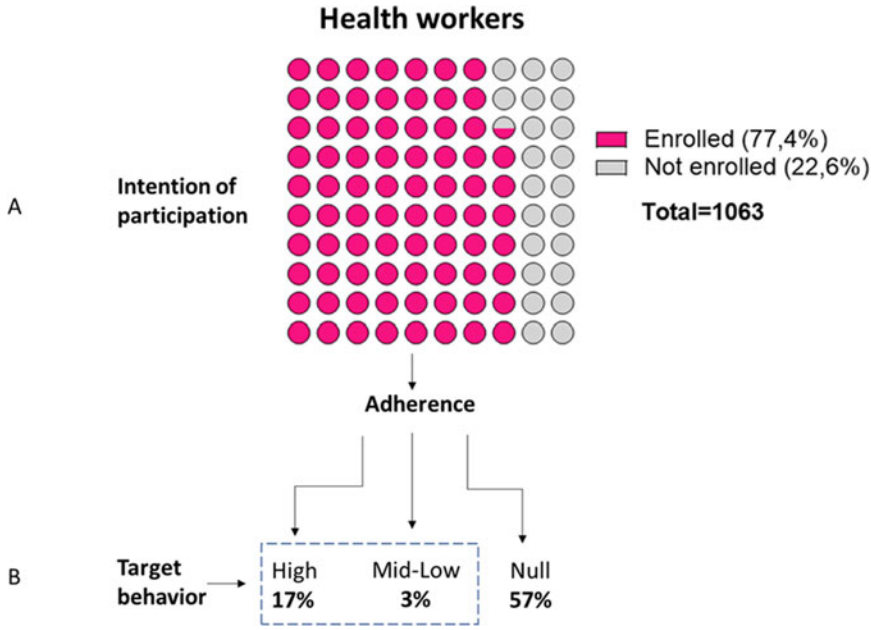

Figure 1. *Intention of participation and target behavior.* (a) Intention of participation was calculated based on the number of enrolled participants (823) included in this study in relation to the global health workers population. (b) Target behavior (adherence) was calculated based on the frequency of supplementation as high and mid-low (adherents) and null (non-adherents). Not enrolled workers were excluded for further analysis.

Table 1 Main demographic data from invited participants

Gender	*n*	Age range	Age mean	SD	% Adherence/gender
Male	131	20–60	35.3	9.54	18.46
Female	692	20–56	34.7	7.94	25.32

Note: Demographic data from all initially enrolled health workers are shown together with their adherence by gender to the supplementation strategy.

health workers, the level of adherence versus the potential risk of infection or exposure at the working area. Supplementary Table S1 shows the general role and profession from all the participants, and Table 2 summarizes the categories of roles, their working mode (full time at health center, remote and hybrid), their potential risk to COVID-19 and the adherence levels per category. We identified that full time workers performing at the health centers as the first line of reception or service to overall patients (high and medium risk), showed better levels of adherence (First line of attention, nurses, and medical coordinators) as compared to that observed in workers performing in hybrid (other medical staff) or remote (administrative staff) modality. These findings are in line with our observation that female workers were those more adherent to the supplementation strategy and that, in general, during

Table 2 Adherence by potential COVID-19 risk associated to role categories

Role category	Working mode	Potential risk	*n*	% Adherence
First line of attention, nurses, and medical coordinators				
Health assistants, nurses, medical doctors, general services	Health center[a]	High/medium	660	**30.00%**
Administrative				
Health analyst, data analyst, administrative managers.	Remote	Low	47	**21.28%**
Other medical staff				
Optometrists, nutritionists, dentists, psychologists, etc.	Hybrid	Medium/low	116	**5.17%**

Note: Each role or profession from the participants was categorized according to their functions and the potential risk to COVID-19 in line with guidelines from Occupational Safety and Health Administration, USA. In addition, potential risk was established according to the working mode: Full time at health center, hybrid (home and health center) and remote
[a]To reduce density of workers in the same area, some participants were enrolled in a hybrid rotation during weekdays between health centers and home remote working mode.

COVID-19 pandemics women adopted more preventive behaviors as they perceived more risk derived from it (Alsharawy *et al*., 2021).

Adherence to the nutritional supplementation strategy was associated to a reduced percentage of COVID-19-positive diagnosis among participants

Overall efficacy of nutritional supplements relies mainly on the accumulative effect of continuous supplementation (Heaney *et al*., 2003), that is the target behavior for this study (adherence). To understand the potential role of adherence to the supplementation strategy on COVID-19 prevention, we collected infection data for all enrolled participants and compared COVID-19 diagnosis (infection) between adherent and non-adherent participants. We only included data within the intervention timeframe, starting 15 days after the onset of intervention (August to October 2020). In general, we found that in adherent participants the percentage of clinical COVID-19-positive diagnosis was significantly lower (12.6%) as compared to that observed in non-adherent participants (18.9%) (Figure 2(a)). In line with this observation, we also identified that for all role categories (especially those more adherent), the number of diagnosed COVID-19-positive workers were lower in adherent participants as compared to that observed in non-adherent workers (Figure 3(b)).

The perceived risk of COVID-19 may contribute to the adoption of nutritional supplementation habits.

Besides providing a potential protection toward COVID-19, adoption of the target behavior (adherence) is an additional aim of this intervention to enhance the later onset of cooperative and caring habits within health workers. To identify whether adherence to our proposed nutritional supplementation plan could derive into later adoption of this behavior, 3 months after the end of our intervention, we randomly

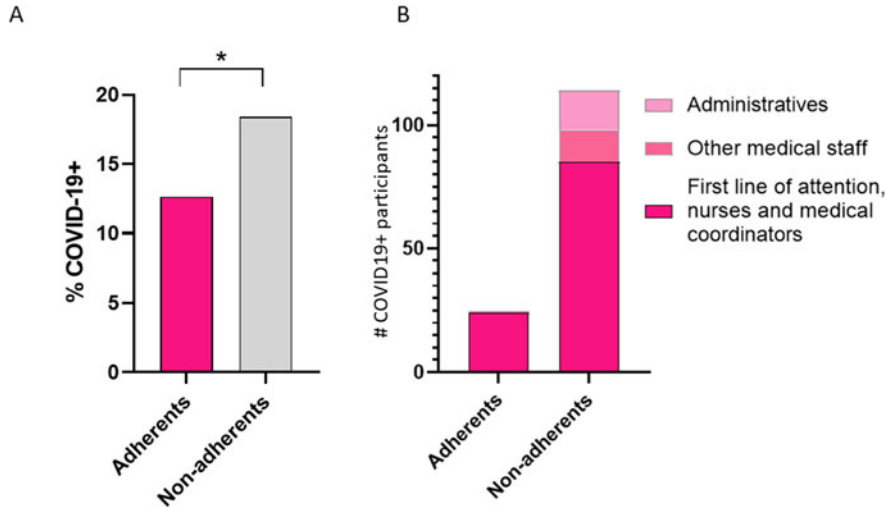

Figure 2. COVID-19 infection and adherence to nutritional supplementation. (a) Infection data from health workers were analyzed according to the adherence to vitamin D and C supplementation. The proportion of COVID-19-positive diagnostics within adherent participants ($n = 214$) is compared to that observed within non-adherent participants ($n = 609$). * $p = 0.0321$, χ^2 test with Yates' correction. (b) Comparative analysis of number of diagnosed COVID-19-positive workers by role category in adherent ($n = 26$) vs non-adherent (115) participants.

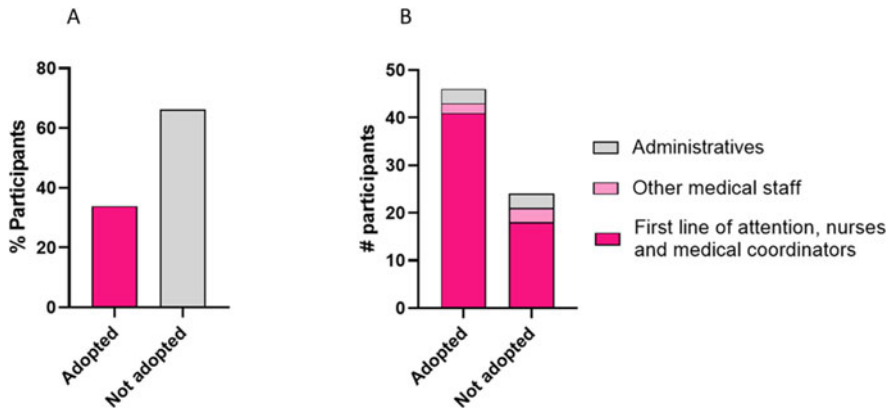

Figure 3. Temporal adoption of nutritional supplementation habit. Three months after the intervention, participants were contacted via phone call to indagate for their general health status and the potential adoption of supplementation habit. (a) Proportion of adherent participants ($n = 24$) reporting adoption compared to non-adopting participants ($n = 46$) (b) Comparative analysis of number of health workers by role category in adopting vs non-adopting participants.

contacted some of the participants ($n = 158$) via phone call as an *ex post* follow up to indagate for their overall health status, and supplementation behaviors. The following figure shows that within contacted high adherence participants, 35% of them continued attached to the nutritional supplementation, being the workers with more perceived risk of infection, those more likely to adopt the habit.

Discussion

Leading public policies and strategies to avoid early dissemination of COVID-19 and progression of disease was a critical aim for governments and public health systems worldwide, especially during the first waves and peaks of the pandemics. In absence of vaccines or any approved therapeutic protocols, social caring behaviors became major drivers to mitigate epidemiological effects of this global health crisis. For instance, besides social distancing and wearing facemask to avoid viral contact, other behavioral-based approaches such as nutritional supplementations were alternatively encouraged to improve general immune responses and reduce potential disease progression (Chien *et al*., 2004; Lordan *et al*., 2021; NIH, 2022). Here, we demonstrate that the behavioral EAST framework may be a suitable method to promote adherence to a nutritional supplementation plan with vitamins D and C, as a cooperative and altruistic strategy for individual and collective caring against COVID-19, within health workers.

In general, based on the target behavior of this study, we found two different behavioral subgroups within the participants: adherence (20%) and non-adherence (57%) to the nutritional supplementation strategy. We found that adherence was higher for female workers and likely affected by the perceived risk bias according to the potential exposure to suspected or confirmed COVID-19 patients in the working area. Importantly, adherence to nutritional supplementation was associated with a lower percentage of infection as compared to that observed within non-adherence participants. In addition, adoption of this behavior was detected 3 months after in some of the adherent participants (35%), suggesting that consistency to this supplementation strategy could derive in the onset of a caring nutritional habit.

Our findings are in line with data from other authors demonstrating that perceived risk of infection is higher in women and specially in health workers at the front lines and/or in direct contact with coronavirus and suspected/confirmed COVID-19-positive patients (Alsharawy *et al*., 2021; Cipolletta *et al*., 2022). Accordingly, the main proportion of adherent participants in this study included nurses, health assistants, general services and security agents in the first line of attention of users in our health centers, whereas workers performing in hybrid (alternate home vs health center) or remote modality were the less adherent participants. This observation highlights an opportunity to minimize the effects of this bias during this type of interventions to maximize the adherence and its derived results, not only at the working level but also at the personal and sociocultural context.

In line with the observation that the perceived risk bias was likely affecting the adoption of the target behavior, we found that the most adherent participants such as nurses and medical assistants were less susceptible to COVID-19 infection as compared to their counterparts within non-adherent participants. The sample size in this study and the proportion of adherent workers is small. However, important socio-epidemiological insights and implications for our organization derive from this observation. Indeed, this subset of health workers has been described in literature as the most susceptible to COVID-19, and as consequence, has been associated with high stress levels and anxiety for occupational risk, high occupational burden, and occurrence of work disability for infection (Health Workforce Department, 2021; Biber

et al., 2022). Thus, promoting strategies to minimize the effects of emerging diseases and their consequences on health workers is vital to mitigate the negative impact of pandemic events on the public health systems.

In addition, our observations on infection data are in line with recent evidence from clinical trials and experimental models showing that both vitamin D and C can be implemented as alternative strategies to mitigate diagnosis, progression of COVID-19 symptoms or mortality (Varikasuvu *et al.*, 2022). Although more global conclusive evidence on dosage and effectiveness is still required, both nutritional supplements are attractive and promising choices as preventive strategies against respiratory viruses, as their antiviral features derive from its antioxidant and anti-inflammatory properties (Gavrielatou *et al.*, 2022). Moreover, its antiviral activity has been suggested from their potential effect on the regulation of receptors that are used for viruses to entry into human cells (Arboleda and Urcuqui-Inchima, 2020; Getachew and Tizabi, 2021; Ivanov *et al.*, 2021). Hence, several studies on nutritional habits and lifestyle around vitamin's rich food and/or supplementation have been linked to less susceptibility to viral infections and balanced immune responses (Alkhatib, 2020; Thirumdas *et al.*, 2021).

The focus on behavioral frameworks to promote nutrition and lifestyle habits as preventive strategies to avoid infectious, and even non-infectious diseases, are raising special interest for public policy makers due to the increasing evidence in the field and the economic implications for public health systems. For instance, in regard of COVID-19, we were invited to support an initiative from London School of Economics and Political Science aimed to raise international awareness about vitamin D and the encouragement to consider widespread vitamin D supplementation, considering its little chance of harm but its potential as preventive strategy. The call was based on the evidence and opinion from more than 200 scientists worldwide concluding on the positive effect of this vitamin on infections and deaths (Vitamin D for all, 2021). Hence, the present work aims to contribute to this purpose.

Finally, during health crisis such as COVID-19, the solutions are often explored on high tech treatments or strategies. However, the records of biomedical sciences are plenty of overlooked basic nutritional physiology that could be used quickly to mitigate emergencies and epidemiological crisis (Bennett *et al.*, 2015; Zhou *et al.*, 2020; Smith and McClung, 2021; Wu *et al.*, 2022). As many countries in Latinoamerica, Colombia is characterized by a high prevalence of insufficiency and deficiency of vitamin D status (Vargas Uricoechea *et al.*, 2020). This has been previously highlighted as an opportunity to nutritionally mitigate other viral endemic diseases (Martínez-Moreno *et al.*, 2020). Studies and observations as the ones presented here shed light on the biological and behavioral relevance of this type of interventions, in which basic science is rapidly adapted (during pandemic emergency) to generate social impact on health and behavior. This opens new roads of opportunities for the strategic development of public policies to improve protection of general population and health workers during vulnerable events of emerging or re-emerging diseases derived from global climate change and future environmental challenges.

Supplementary material. To view supplementary material for this article can be found at https://doi.org/10.1017/bpp.2024.11.

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Competing interest. All authors participating in the development of this study, data analysis and elaboration of the manuscript declare no conflict of interest.

References

Ahmad, S. R. (2022), 'Vitamin C for COVID-19 treatment: have we got enough evidence?', *Frontiers in Nutrition*, **9**: 1090. https://doi.org/10.3389/FNUT.2022.892561/BIBTEX.

Ajzen, I. (1991), 'The theory of planned behavior', *Organizational Behavior and Human Decision Processes*, **50**(2): 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Alkhatib, A. (2020), 'Antiviral functional foods and exercise lifestyle prevention of coronavirus', *Nutrients*, **12**(9): 2633. https://doi.org/10.3390/NU12092633.

Alsharawy, A., R. Spoon, A. Smith and S. Ball (2021), 'Gender differences in fear and risk perception during the COVID-19 pandemic', *Frontiers in Psychology*, **12**: 3104. https://doi.org/10.3389/FPSYG.2021.689467/BIBTEX.

Amrein, K., M. Scherkl, M. Hoffmann, S. Neuwersch-Sommeregger, M. Köstenberger, A. Tmava Berisha, G. Martucci, S. Pilz and O. Malle (2020), 'Vitamin D deficiency 2.0: an update on the current status worldwide', *European Journal of Clinical Nutrition*, **74**(11): 1498–1513. https://doi.org/10.1038/s41430-020-0558-y.

Arboleda, J. F. and S. Urcuqui-Inchima (2020), 'Vitamin D supplementation: a potential approach for coronavirus/COVID-19 therapeutics?', *Frontiers in Immunology*, **11**: 1523. https://doi.org/10.3389/FIMMU.2020.01523.

Bennett, B. J., K. D. Hall, F. B. Hu, A. L. Mccartney and C. Roberto (2015), 'Nutrition and the science of disease prevention: a systems approach to support metabolic health', *Annals of the New York Academy of Sciences*, **1352**(1): 1. https://doi.org/10.1111/NYAS.12945.

Biber, J., B. Ranes, S. Lawrence, V. Malpani, T. T. Trinh, A. Cyders, S. English, C. L. Staub, K. L. McCausland, M. Kosinski, N. Baranwal, D. Berg and R. Pop (2022), 'Mental health impact on healthcare workers due to the COVID-19 pandemic: a U', *S. cross-sectional survey study. Journal of Patient-Reported Outcomes*, **6**(1): 63. https://doi.org/10.1186/S41687-022-00467-6.

Chien, C. T., W. T. Chang, H. W. Chen, T. D. Wang, S. Y. Liou, T. J. Chen, Y. L. Chang, Y. T. Lee and S. M. Hsu (2004), 'Ascorbate supplement reduces oxidative stress in dyslipidemic patients undergoing apheresis', *Arteriosclerosis, Thrombosis, and Vascular Biology*, **24**(6): 1111–1117. https://doi.org/10.1161/01.ATV.0000127620.12310.89.

Cialdini, R. B. and M. R. Trost (1998), 'Social Influence: Social Norms, Conformity and Compliance', in D. T. Gilbert, S. T. Fiske and G. Lindzey (eds), *The Handbook of Social Psychology*, 4th edn, New York: McGraw-Hill, 151–192.

Cipolletta, S., G. R. Andreghetti and G. Mioni (2022), 'Risk perception towards COVID-19: a systematic review and qualitative synthesis', *International Journal of Environmental Research and Public Health*, **19**(8): 4649. https://doi.org/10.3390/IJERPH19084649.

Colotta, F., B. Jansson and F. Bonelli (2017), 'Modulation of inflammatory and immune responses by vitamin D', *Journal of Autoimmunity*, **85**: 78–97. https://doi.org/10.1016/j.jaut.2017.07.007.

Cotterill, S., R. Powell, S. Rhodes, B. Brown, J. Roberts, M. Y. Tang and J. Wilkinson (2019), 'The impact of social norms interventions on clinical behaviour change among health workers: Protocol for a systematic review and meta-analysis', *Systematic Reviews*, **8**(1): 1–9. https://doi.org/10.1186/S13643-019-1077-6/TABLES/3.

DeLuca, H. F. (2004), 'Overview of general physiologic features and functions of vitamin D', *The American Journal of Clinical Nutrition*, **80**(6 Suppl): 1689–1696. https://doi.org/10.1093/ajcn/80.6.1689s.

Dempsey, R. C., J. McAlaney and B. M. Bewick (2018), 'A critical appraisal of the social norms approach as an interventional strategy for health-related behavior and attitude change', *Frontiers in Psychology*, **9**: 1–16. https://doi.org/10.3389/fpsyg.2018.02180.

Fleet, J. C. (2022), 'Vitamin D-mediated regulation of intestinal calcium absorption', *Nutrients*, **14**(16): 3351. https://doi.org/10.3390/nu14163351.

Gavrielatou, E., E. Xourgia, N. A. Xixi, A. G. Mantelou, E. Ischaki, A. Kanavou, D. Zervakis, C. Routsi, A. Kotanidou and I. I. Siempos (2022), 'Effect of Vitamin C on clinical outcomes of critically Ill patients with COVID-19: an observational study and subsequent meta-analysis', *Frontiers in Medicine*, **9**: 814587. https://doi.org/10.3389/FMED.2022.814587/FULL.

Getachew, B. and Y. Tizabi (2021), 'Vitamin D and COVID-19: role of ACE2, age, gender, and ethnicity', *Journal of Medical Virology*, **93**(9): 5285. https://doi.org/10.1002/JMV.27075.

Gibbons, J. B., E. C. Norton, J. S. McCullough, D. O. Meltzer, J. Lavigne, V. C. Fiedler and R. D. Gibbons (2022), 'Association between vitamin D supplementation and COVID-19 infection and mortality', *Scientific Reports*, **12**(1): 1–11. https://doi.org/10.1038/s41598-022-24053-4.

Grant, W. B., H. Lahore, S. L. Mcdonnell, C. A. Baggerly, C. B. French, J. L. Aliano and H. P. Bhattoa (2020), 'Evidence that Vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths', *Nutrients*, **12**(4): 988. https://doi.org/10.3390/nu12040988.

Health Workforce Department (2021), *The Impact of COVID-19 on Health and Care Workers: A Closer Look at Deaths*, Genéve: World Health Organization.

Heaney, R. P., K. M. Davies, T. C. Chen, M. F. Holick and M. Janet Barger-Lux (2003), 'Human serum 25-hydroxycholecalciferol response to extended oral dosing with cholecalciferol', *American Journal of Clinical Nutrition*, **77**(1): 204–210. https://doi.org/10.1093/ajcn/77.1.204.

Hogg, M. A. and S. A. Reid (2006), 'Social identity, self-categorization, and the communication of group norms', *Communication Theory*, **16**(1): 7–30. https://doi.org/10.1111/J.1468-2885.2006.00003.X.

Holford, P., A. C. Carr, T. H. Jovic, S. R. Ali, I. S. Whitaker, P. E. Marik and A. D. Smith (2020), 'Vitamin C —an adjunctive therapy for respiratory infection, epsis and COVID-19', *Nutrients*, **12**(12): 1–17. https://doi.org/10.3390/NU12123760.

Ivanov, V., A. Goc, S. Ivanova, A. Niedzwiecki and M. Rath (2021), 'Inhibition of ACE2 expression by ascorbic acid alone and its combinations with other natural compounds', *Infectious Diseases*, **14**: 117863372199460. https://doi.org/10.1177/1178633721994605.

Kypri, K., T. Vater, S. J. Bowe, J. B. Saunders, J. A. Cunningham, N. J. Horton and J. McCambridge (2014), 'Web-based alcohol screening and brief intervention for university students: a randomized trial', *Jama*, **311**(12): 1218–1224. https://doi.org/10.1001/jama.2014.2138.

Lamberg-Allardt, C. (2006), 'Vitamin D in foods and as supplements', *Progress in Biophysics and Molecular Biology*, **92**(1): 33–38. https://doi.org/10.1016/j.pbiomolbio.2006.02.017.

Lapinski, M. K., E. K. Maloney, M. Braz and H. C. Shulman (2013), 'Testing the effects of social norms and behavioral privacy on hand washing: a field experiment', *Human Communication Research*, **39**(1): 21–46. https://doi.org/10.1111/j.1468-2958.2012.01441.x.

Lordan, R., H. M. Rando and C. S. Greene (2021), 'Dietary supplements and nutraceuticals under investigation for COVID-19 prevention and treatment', *MSystems*, **6**(3): e00122. https://doi.org/10.1128/MSYSTEMS.00122-21/FORMAT/EPUB.

Malacova, E., P. Cheang, E. Dunlop, J. L. Sherriff, R. M. Lucas, R. M. Daly, C. A. Nowson and L. J. Black (2019), 'Prevalence and predictors of Vitamin D deficiency in a nationally representative sample of adults participating in the 2011-2013 Australian health survey', *British Journal of Nutrition*, **121**(8): 894–904. https://doi.org/10.1017/S0007114519000151.

Martens, P., C. Gysemans, A. Verstuyf and C. Mathieu (2020), 'Vitamin D's effect on immune function', *Nutrients*, **12**(5): 1248.

Martineau, A. R., D. A. Jolliffe, R. L. Hooper, L. Greenberg, J. F. Aloia, P. Bergman, G. Dubnov-Raz, S. Esposito, D. Ganmaa, A. A. Ginde, E. C. Goodall, C. C. Grant, C. J. Griffiths, W. Janssens, I. Laaksi, S. Manaseki-Holland, D. Mauger, D. R. Murdoch, R. Neale and C. A. Camargo (2017), 'Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data', *BMJ (Online)*, **356**: i6583. https://doi.org/10.1136/bmj.i6583.

Martínez-Moreno, J., J. C. Hernandez and S. Urcuqui-Inchima (2020), 'Effect of high doses of vitamin D supplementation on dengue virus replication, Toll-like receptor expression, and cytokine profiles on dendritic cells', *Molecular and Cellular Biochemistry*, **464**(1–2): 169–180. https://doi.org/10.1007/s11010-019-03658-w.

Neethu, R., M. Reddy, M. Janardhan Reddy, S. Batra, S. K. Srivastava and K. Syal (2022), 'Vitamin C and its therapeutic potential in the management of COVID19', *Clinical Nutrition ESPEN*, **50**: 8–14. https://doi.org/10.1016/J.CLNESP.2022.05.026.

NIH (2022), *Dietary Supplements in the Time of COVID-19 - Consumer*. https://ods.od.nih.gov/factsheets/DietarySupplementsInTheTimeOfCOVID19-Consumer/.

OSHA (2023), *COVID-19 - Control and Prevention - Healthcare Workers and Employers | Occupational Safety and Health Administration*. https://www.osha.gov/coronavirus/control-prevention/healthcare-workers.

Pludowski, P., M. F. Holick, W. B. Grant, J. Konstantynowicz, M. R. Mascarenhas, A. Haq, V. Povoroznyuk, N. Balatska, A. P. Barbosa, T. Karonova, E. Rudenka, W. Misiorowski, I. Zakharova, A. Rudenka, J. Łukaszkiewicz, E. Marcinowska-Suchowierska, N. Łaszcz, P. Abramowicz, H. P. Bhattoa and S. J. Wimalawansa (2018), 'Vitamin D supplementation guidelines', *The Journal of Steroid Biochemistry and Molecular Biology*, **175**: 125–135. https://doi.org/10.1016/J.JSBMB.2017.01.021.

Saponaro, F., A. Saba and R. Zucchi (2020), 'An update on vitamin d metabolism', *International Journal of Molecular Sciences*, **21**(18): 1–19. https://doi.org/10.3390/ijms21186573.

Service, O., M. Hallsworth, D. Halpern, F. Algate, R. Gallagher, S. Nguyen, S. Ruda, M. Sanders, with M. Pelenur, A. Gyani, H. Harper, J. Reinhard and E. Kirkman (2014), 'EAST Four simple ways to apply behavioural insights', *Behavioural Insights Team*, **4**: 29–37.

Shah, K., V. P. Varna, U. Sharma and D. Mavalankar (2022), 'Does vitamin D supplementation reduce COVID-19 severity?: a systematic review', *QJM: Monthly Journal of the Association of Physicians*, **115**(10): 665–672. https://doi.org/10.1093/QJMED/HCAC040.

Smith, T. J. and J. P. McClung (2021), 'Nutrition, immune function, and infectious disease', *Medical Journal (Fort Sam Houston, Tex.)*, Jan-Mar:(PB 8-21-01/02/03): 133–136.

Thirumdas, R., A. Kothakota, R. Pandiselvam, A. Bahrami and F. J. Barba (2021), 'Role of food nutrients and supplementation in fighting against viral infections and boosting immunity: a review', *Trends in Food Science & Technology*, **110**: 66. https://doi.org/10.1016/J.TIFS.2021.01.069.

Vargas Uricoechea, H., A. Mera Mamián, M. V. Pinzón Fernández and V. Agredo (2020), 'Vitamin D nutritional status in the adult population in Colombia – an analytical cross-sectional study', *Heliyon*, **6**(2): e03479. https://doi.org/10.1016/j.heliyon.2020.e03479.

Varikasuvu, S. R., B. Thangappazham, A. Vykunta, P. Duggina, M. Manne, H. Raj and S. Aloori (2022), 'COVID-19 and vitamin D (Co-VIVID study): a systematic review and meta-analysis of randomized controlled trials', *Expert Review of Anti-Infective Therapy*, **20**(6): 1. https://doi.org/10.1080/14787210.2022.2035217.

Vitamin D for all (2021), #VitaminDforAll: Over 200 Scientists and Doctors Call For Vitamin D To Combat COVID19. https://vitamindforall.org/letter.html.

Wimalawansa, S. J. (2022), Against Infections — Sepsis and COVID-19. 25.

Wu, Q., Z. J. Gao, X. Yu and P. Wang (2022), 'Dietary regulation in health and disease', *Signal Transduction and Targeted Therapy*, **7**(1): 1–29. https://doi.org/10.1038/s41392-022-01104-w.

Young, S. D. and N. J. Goldstein (2021), 'Applying social norms interventions to increase adherence to COVID-19 prevention and control guidelines', *Preventive Medicine*, **145**: 106424. https://doi.org/10.1016/J.YPMED.2021.106424.

Zhou, M., N. Zhang, M. Zhang and G. Ma (2020), 'Culture, eating behavior, and infectious disease control and prevention', *Journal of Ethnic Foods*, **7**(1): 40. https://doi.org/10.1186/S42779-020-00076-Y.

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