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Nurses' use of 'wellness' supplements during the COVID-19 pandemic in the United States

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Abstract

Aim: Quantify disparities and identify correlates and predictors of 'wellness' supplement use among nurses during the first year of the pandemic.

Design: Longitudinal secondary analysis of Nurses' Health Studies 2 and 3 and Growing Up Today Study data.

Methods: Sample included 36,518 total participants, 12,044 of which were nurses, who completed surveys during the first year of the COVID-19 pandemic (April 2020 to April 2021). Analyses were conducted in March 2023. Modified Poisson models were used to estimate disparities in 'wellness' supplement use between nurses and non-healthcare workers and, among nurses only, to quantify associations with workplace-related predictors (occupational discrimination, PPE access, workplace setting) and psychosocial predictors (depression/anxiety, county-level COVID-19 mortality). Models included race/ethnicity, gender identity, age and cohort as covariates.

Results: Nurses were significantly more likely to use all types of supplements than non-healthcare workers. Lacking personal protective equipment and experiencing occupational discrimination were significantly associated with new immune supplement use. Depression increased the risk of using weight loss, energy and immune supplements.

Conclusion: Nurses' disproportionate use of 'wellness' supplements during the COVID-19 pandemic may be related to workplace and psychosocial stressors. Given well-documented risks of harm from the use of 'wellness' supplements, the use of these products by nurses is of concern.

Impact: 'Wellness' supplements promoting weight loss, increased energy, boosted immunity and cleansing of organs are omnipresent in today's health-focused culture,

though their use has been associated with harm. This is of added concern among nurses given their risk of COVID-19 infection at work. Our study highlighted the risk factors associated with use of these products (lacking PPE and experiencing occupational discrimination). Findings support prior research suggesting a need for greater public health policy and education around the use of 'wellness' supplements.

Reporting Method: STROBE guidelines were followed throughout manuscript.

Patient or Public Contribution: No patient or public contribution was involved.

KEYWORDS

COVID-19 pandemic, inequalities in health, occupational health, workforce issues

1 | INTRODUCTION

Widespread anxiety about health has increased during the COVID-19 pandemic, with US adults showing an increased interest in weight gain and loss (Herbert et al., 2021), immunity (Jungmann & Witthöft, 2020) and cleansing or detoxing the body (Baker, 2022) since the pandemic's onset. The 'wellness' supplement market is a multi-billion dollar industry that offers commodity solutions to consumers' anxieties, selling a variety of products which claim to result in weight loss, increased energy, 'boosted' immunity and 'cleansing' of organs and body tissues. Since the onset of the COVID-19 pandemic, 'wellness' supplement sales have markedly risen, with some manufacturers noting increases of as much as 415% in the months immediately post-pandemic onset (Adams et al., 2020). 'Wellness' supplements are available in many different formulations, such as pills or tablets, powders, serums and liquids or 'shots'.

Given their widespread availability via national retailers (such as GNC and The Vitamin Shoppe), department stores (such as Walmart, Target and grocery chains) and Internet-based retailers (such as Ritual and Athletic Greens), 'wellness' supplements may appear benign to consumers. However, in the United States, supplements remain underregulated, understudied and have been repeatedly found to be adulterated with potentially dangerous ingredients such as steroids or stimulants (CDC, 2018) or even unapproved pharmaceutical ingredients (Center for Drug Evaluation and Research, 2022; FDA Commissioner, 2021). Not only have these products been found largely ineffective (Chen et al., 2019; Crawford et al., 2020), they may actually harm health in some cases. Research has linked 'wellness' supplements to poisoning (Zell-Kanter et al., 2015), increased lung cancer risk (Tanvetyanon & Bepler, 2008), cardiovascular problems (Michos et al., 2021) and serious liver injury (Hoofnagle et al., 2021).

As described by Neuman's systems model, individuals (including nurses) are subject to stressors from a number of sources, including intrapersonal, interpersonal and extrapersonal (Neuman & Fawcett, 2011). These stressors can then affect the person's central well-being, unless protective 'lines of defence' are in place, which prevent the stress from harming the central well-being. Understanding this model, it is logical that nurses may turn to supplements as 'lines of defence' with the false belief that they will prevent and treat COVID-19 infection, as well as 'boost' their overall health (Rachul et al., 2020). Being among the highest risk professionals for exposure to and contraction of COVID-19 (Lu, 2020), nurses may feel especially compelled to seek protection.

The pressure on nurses to use supplements may be enhanced by other occupational stressors. It is well established that nursing is a stressful and pressure-filled profession, with higher rates of burnout and post-traumatic stress disorder than many other healthcare professions (Galanis et al., 2021; Mealer et al., 2009). During the COVID-19 pandemic, nurses experienced heightened stress above typical levels experienced for the profession. Factors contributing to stress include changing relationships with the public and their patients and barriers to access to personal protective equipment (PPE) (Robinson & Stinson, 2021). Nurses also report inequities and lack of adequate support related to their roles on health teams, with less access to resources (like PPE) or respect despite also being expected to perform duties that carry higher risk of exposure (such as providing most direct patient care) (Guttormson et al., 2022). Thus, nurses may feel that their usual 'lines of defence' have been removed, and seek alternate defences or coping mechanisms.

Nurses and healthcare workers are also directly targeted by supplement manufacturers. In April 2020, Nestlé's Persona supplement company offered a 3-month supply of 'personalized supplements' to 1000 healthcare workers as a way to 'thank' them for their service, claiming that the supplements would 'protect those who protect us' (Nestle Health Science, 2021). Other supplement manufacturers have similarly targeted nurses, with over 20 offering discounts on their products specifically for nurses (ID.Me., 2022).

Nurses' occupational stressors and vulnerability to deceptive marketing places them in a precarious position to seek out potentially harmful 'wellness' supplements and calls into question whether they are more likely to use them than non-healthcare professionals. Currently, there is a lack of longitudinal research about the use of supplements in many populations, nurses included. Several large US national cohorts of nurses exist that administer measures of supplement use and thus could be leveraged for investigation into patterns of use. Therefore, the purpose of this study was to explore nurses' use of 'wellness' supplements compared to non-healthcare workers

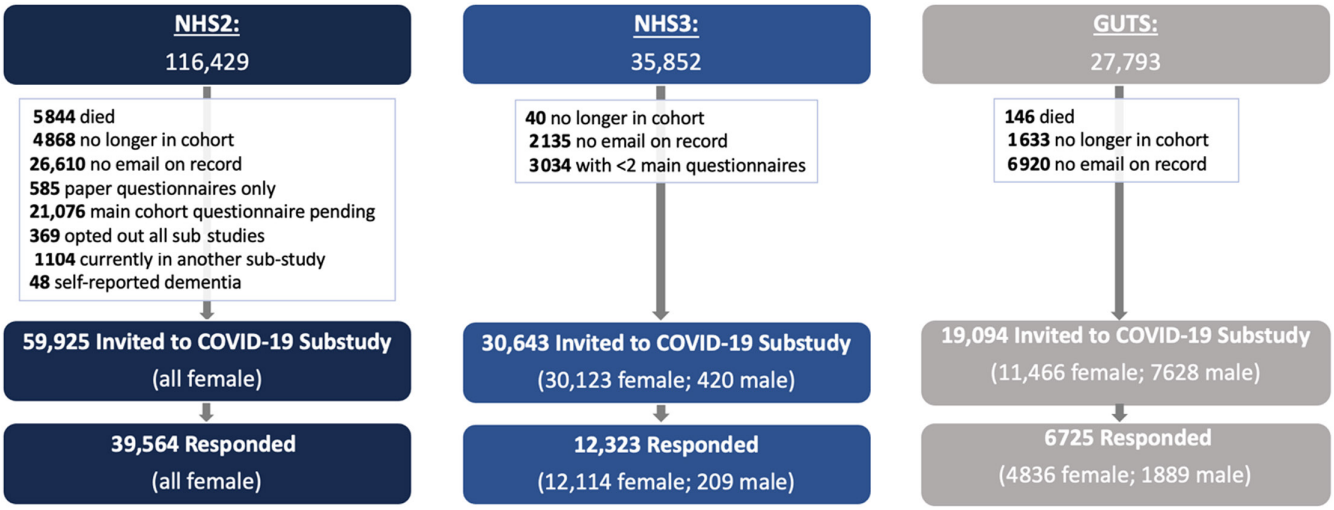

FIGURE 1 Enrolment in the COVID-19 substudy by cohort.

and to describe relationships between nurses' experiences during the first year of the COVID-19 pandemic and their use of 'wellness' supplements.

1.1 | Aims and purpose

This study had three primary aims: (1) to quantify disparities in both prevalent and new-onset 'wellness' supplement use (i.e. weight loss, cleanse/detox, immunity and energy supplements) between nurses and non-healthcare workers during the first year of the COVID-19 pandemic (April 2020 to April 2021), (2) to evaluate the extent to which workplace-related stressors are associated with 'wellness' supplement use among nurses and (3) to evaluate the extent to which psychosocial stressors are associated with 'wellness' supplement use among nurses.

2 | METHODS

2.1 | Design

The present study was a secondary data analysis of longitudinal data from the COVID-19 substudy, a national cohort study embedded within the Nurses' Health Study 2 (NHS2), Nurses' Health Study 3 (NHS3) and the Growing Up Today Study (GUTS). The COVID-19 substudy was developed to assess the impacts of the COVID-19 pandemic and observe trends in the incidence and prevalence of COVID-19. Additional goals of the substudy were to assess and understand the mental health status, behavioural changes and health behaviours of participants living through the pandemic, and to estimate trends in the availability and use of personal protective equipment (PPE) among active healthcare workers. Figure S1 outlines the study timeline and variables assessed at each study wave. Surveys and consent were completed by participants remotely.

2.2 | Population

The COVID-19 substudy includes participants from three ongoing national cohorts: NHS2, NHS3 and GUTS. NHS2 and NHS3 are the second and third generations of a national cohort study that was developed in 1976 to investigate population-level lifestyle risk factors in a US-based cohort of nurses (Belanger et al., 1978). NHS2 enrolled registered nurses with 4-year college degrees who identified as 'female', and NHS3 enrolled licensed practical/vocational nurses and registered nurses of all genders. GUTS is a third cohort comprised of children of women originally enrolled in the NHS2 cohort. The COVID-19 substudy is a derivative of these three cohorts, and includes members from each.

2.3 | Sample and setting

The COVID-19 substudy began in April 2020 and continued until April 2021. The substudy enrolled 58,612 participants with widely varying ages (range: 26–74 years), geographic locations across the United States, occupations and races/ethnicities. Substudy enrolment is detailed further in Figure 1. The sample of the present study was restricted to the 36,750 substudy participants who (1) lived within the United States throughout the study period, (2) completed the occupational role item (administered at the fourth follow-up survey in October 2020), (3) provided data on covariates (including adjustment variables for our models and the auxiliary variables for attrition weights: age, gender, race/ethnicity, geographic region, employment, mental health status and COVID-19 infections) and (4) responded to items that asked about supplement use at least once during the study period.

To investigate predictors of 'wellness' supplement use specifically among nurses, the study sample was stratified into 'nurse' and 'non-healthcare worker' samples. Those who reported a current occupational role of associates-level nurse (ADN), bachelors-level

nurse (BSN), registered nurse (RN), licensed practical nurse (LPN), nurse practitioner (NP) or certified nurse midwife (CNM) were coded as nurses. Among the remaining participants, other healthcare workers, such as physicians, emergency medical technicians and certified nurse assistants, were excluded from the analyses. The remaining participants were coded as non-healthcare workers. Analyses to address Aim 1 were conducted with the full analytic sample, comparing nurses to non-healthcare workers. Analyses to address Aims 2 and 3 were restricted to the subsample of nurses in order to explore nursing-specific extrapersonal stressors, as described by Neuman's systems model.

2.4 | Measures

2.4.1 | Predictors

Workplace-related predictors

Occupational discrimination. Occupational discrimination is defined as the experience of unfavourable treatment based on a person's occupation and was assessed using the Everyday Discrimination Scale (EDS) (Williams et al., 1997). Although discrimination was assessed mid-study (administered on 3 July 2020), participants were instructed to respond to the questions as they pertained to their 'day-to-day life', and thus, we used the EDS as a proxy measure for lifetime experience of discrimination. Therefore, discriminiation was treated as time invariant. Those who reported any levels of discrimination were asked to identify the attributions of discrimination; those who selected 'occupation' were coded as experiencing occupational discrimination, and those who did not select 'occupation' or reported no discrimination in the measure were coded as not experiencing occupational discrimination.

PPE access. Access to PPE was assessed among active healthcare workers at each wave via several items that asked about respondents' use of specific pieces of PPE and the frequency with which they were able to access them. The coding of this variable was based on previous work by Rich-Edwards et al. (2021). First, participants indicated whether they used PPE (gloves, protective gowns, face shield/goggles, N95 masks, surgical masks, powered air purifying respirator [PAPR]) since 1 March 2020 by selecting 'always', 'sometimes', 'never' or 'not applicable (I didn't need this for my job)'. Then, participants were asked whether they were able to consistently access this type of PPE, and selected one of the following options: 'I haven't always needed this'; 'there weren't enough of this'; 'I never needed this'; or 'I needed one, but it was not available'. A participant was considered 'lacking PPE' if they reported using an item either sometimes or never, and reported that it was not available. Responses were then coded and analysed in two categories ('always/sometimes lack PPE' or 'never lack PPE').

Workplace setting. The workplace setting variable describes the type of unit or position that participants who were active healthcare workers were employed in. At each survey wave, participants were asked about the setting in which they were employed in the last 30 days, and selected one or more of the following options:

- Hospital—Emergency room (ER), operating room (OR) or intensive care unit (ICU)
- Hospital—Dedicated COVID-19 unit
- Hospital—Other inpatient setting
- Hospital—Other outpatient setting
- Temporary COVID-19 facility
- Healthcare clinic outside a hospital
- Nursing home or group care facility
- Visiting nurse or home health provider
- School clinic
- Emergency medical service (emergency medical technician [EMT], paramedic)
- Other healthcare facility
- Employed in healthcare, but working from home or other remote work arrangement in the past 30 days.
- Employed in healthcare, but not in direct patient care in the past 30 days,
- Not employed in healthcare

For analyses, settings were categorized by the degree of COVID-19 risk associated with the setting informed by Nguyen et al. (2020), ranging from (1) a dedicated COVID-19 unit; (2) a hospital emergency room, operating room or non-COVID intensive care unit; (3) a nursing home or group care setting; (4) another in-person setting; or (5) a virtual position or one with no direct patient contact. Respondents who indicated working in multiple settings were coded in the highest risk classification that they selected (i.e. a participant who selected both 'hospital—other inpatient setting' and 'school clinic' was coded in risk classification 2). Specific categorization of each workplace setting is detailed in Table S1.

Psychosocial predictors

Depression and anxiety. Depressive symptoms were assessed at each wave using the Patient Health Questionnaire-2 (PHQ-2) (Kroenke et al., 2003), which captures the frequency of depressed mood and anhedonia over the past week. Anxiety symptoms were assessed at each wave using the Generalized Anxiety Disorder Scale-2 (GAD-2) (Kroenke et al., 2007), which captures the frequency of nervousness/restlessness and uncontrollable worry over the past week. For both the PHQ-2 and GAD-2, we used the validated cut-off score of 3 to identify participants exhibiting clinically meaningful levels of symptoms and analysed these predictors as binary variables (Kroenke et al., 2003, 2007).

County-level COVID-19 mortality rate. County-level COVID-19 mortality data, which is publicly available and updated daily through the COVID-19 Data Repository by the Center for Systems Science and Engineering at Johns Hopkins University (Dong et al., 2020), was used to derive a measure of county-level

COVID-19 burden. Similar methods to those developed by Rich-Edwards et al. (2021) were used to code county-level COVID-19 mortality rates as follows: Mortality data from the 13 days after survey competition was used to estimate the county-level burden of COVID-19 at the time of survey completion. This was based on the median duration of fatal COVID-19 hospitalization stays, which is 13 days (Lewnard et al., 2020), and on the assumption that a high level of mortality at the time of survey collection would have suggested high levels of occupational stress for nurses about 13 days prior (e.g. a high level of COVID-19-related mortality on 14 May 2020 would suggest that healthcare workers likely experienced greater occupational stress due to increased patient loads around 1 May 2020). We categorized COVID-19 mortality data into binary high versus low groups using quartiles. Specifically, counties in the top quartile of the mortality rate distribution at a given wave were coded as high COVID-19 mortality rate counties, and those in the lower three quartiles were coded as low COVID-19 mortality rate counties.

2.4.2 | Outcomes

Self-reported current use of 'wellness' supplements (i.e. 'cleanse/detox', 'weight loss', 'energy boosting' and 'immune boosting' supplements) was assessed in five study waves (April 2020, June 2020, October 2020, January 2021 and April 2021). At baseline, participants also reported whether they had started using supplements pre- or post-pandemic onset. We coded the use of each type of supplement in two time-varying ways: prevalent use, which was defined as using supplements at a given study wave regardless of when use was initiated, and new-onset use, which was defined as new use at a given study wave when no use was reported prior (including pre-pandemic use). In models examining new-onset use, participants were censored from the analysis after their first report of the outcome.

2.4.3 | Covariates

Multivariable models included race/ethnicity (categorical: non-Hispanic Black/African American, Hispanic/Latine, non-Hispanic White, other/unlisted), gender identity (categorical: cisgender women, cisgender men, transgender/gender diverse), age (continuous) and cohort as adjustment variables, given their associations with both our predictors of interest and 'wellness' supplement use.

2.5 | Statistical analyses

Analyses occurred in March 2023. After describing the study sample with respect to all key variables, we fit three sets of modified Poisson models to estimate risk ratios (RRs) and 95% confidence intervals (CIs) for prevalent and new-onset use of each type of 'wellness' supplement, first with the full sample and then restricted to subset of nurses. The first set of models quantified the average magnitude of disparities in 'wellness' supplement use across the study period in the full sample by including an indicator for nursing status as the primary predictor variable. The second set of models, restricted only to nurses, examined longitudinal associations between each workplace-related predictor (i.e. occupational discrimination, PPE access and workplace setting) and 'wellness' supplement use. Finally, the third set of models, similarly restricted to nurses, examined longitudinal associations between each psychosocial predictor (i.e. depressive symptoms, anxiety symptoms and county-level COVID-19 mortality rate) and 'wellness' supplement use. Of note, occupational discrimination was assessed at a single time point (July 2020) and was thus treated as a time-invariant exposure; all other predictors were treated as time-varying and were lagged one wave prior to outcome assessment. All models adjusted for the aforementioned covariates and were fit using generalized estimating equations (GEEs) with an exchangeable working correlation matrix to account for repeated measures. To account for attrition across the study period, we applied inverse probability weights as described by Austin et al. (2023) using the aforementioned covariates as well as employment, mental health status, and COVID-19 infections to predict loss-to-follow-up and/or item non-response at each wave.

2.6 | Ethical considerations

This study was conducted as part of a larger analysis of 'wellness' supplement use in the United States during the COVID-19 pandemic, and was approved by the Boston Children's Hospital Institutional Review Board in May 2021 (Approval number: IRB-A00039612-2). Data from NHS2, NHS3, GUTS and the COVID-19 substudy are managed by the Channing Network of Division Medicine at Brigham and Women's Hospital and are stored on a secure server that only researchers who are granted a data use agreement can access.

2.7 | Validity and rigor

STROBE guidelines were followed throughout the design of the study and the development of this article, and the STROBE checklist is included in Table S2. The data utilized in this study are from an ongoing national prospective cohort study, which originated in 1976 and remains well renowned as a large sample epidemiological study (Colditz et al., 2016). To maintain fidelity and rigor, access to COVID-19 substudy data requires oversight by a committee of investigators. The committee reviewed and approved the study proposal, methodology, results and the code used to run statistical analyses for rigor and validity. Further information about accessing NHS and GUTS data can be found at https://nurseshealthstudy.org/researchers and https://gutsweb.org/collaborate-with-guts/, respectively.

3 | RESULTS

3.1 | Sample characteristics

Study sample baseline characteristics can be found in Table 1. Participants' mean age was 60.5 years. Because NHS2 was restricted to those who identified as 'female' at enrolment and this cohort comprises most of the COVID-19 substudy, our sample was almost entirely cisgender women (99.5%, $n = 36{,}340$). Nurse and non-healthcare worker groups were similar in their age, gender identity, race/ethnicity and geographic region distributions.

At the time of survey completion, 32.9% of participants were nurses, while the remaining 67.1% of participants were non-healthcare workers. Only 7.8% of nurses reported working on a dedicated COVID-19 unit, while 15.7% of nurses reported working in an ER, OR or ICU setting. Occupational discrimination was markedly higher among nurses, with 34.7% of nurses reporting that they experienced occupational discrimination, compared to 6.5% of non-healthcare workers. PPE access was assessed among healthcare workers only, and therefore in this sample, only among nurses. Of the nurse participants, 16.9% reported 'always or sometimes' lacking PPE.

Prevalent use of all types of 'wellness' supplements was slightly higher among nurses than non-healthcare workers, with immune supplements being the most commonly used in both groups (25.0% of nurses and 20.1% of non-healthcare workers) (Table 2). Initiation of 'wellness' supplement use post-pandemic (described as 'new-onset') was also higher among nurses than non-nurses, with 9.4% of nurses reporting new use compared to 5.6% of non-nurses at baseline.

3.2 | Disparities in use between nurses and non-healthcare workers

Nurses reported significantly higher prevalent use of weight loss (RR 1.50, 95% CI 1.35–1.66), cleanse/detox (RR 1.37, 95% CI 1.24–1.50), energy (RR 1.57, 95% CI 1.44–1.70) and immune supplements (RR 1.17, 95% CI 1.12–1.21) compared to non-healthcare workers across the study period (Table 3). Nurses also reported significantly higher new-onset use across all four types of supplements than non-healthcare workers (weight loss: RR 1.34, 95% CI 1.17–1.54; cleanse/detox: RR 1.35, 95% CI 1.18–1.53; energy: RR 1.38, 95% CI 1.22–1.56; immune: RR 1.17, 95% CI 1.11–1.24).

3.3 | Longitudinal predictors of supplement use among nurses

3.3.1 | Prevalent use

Workplace-related predictors

Having experienced occupational discrimination (vs. not) was associated with a greater risk of prevalent use of weight loss (RR 1.25, 95% CI 1.08–1.46) and immune (RR 1.12, 95% CI 1.05–1.18) supplements across the study period among nurses. Nurses who lacked PPE experienced a greater risk of prevalent immune supplement use only (RR 1.08, 95% CI 1.02–1.14) compared to nurses with adequate PPE access (Table 4). In general, working in a unit with any COVID-19 risk was associated with greater supplement use relative to working virtually or without patient contact. This increased risk was largest among those working in a dedicated COVID-19 unit, who experienced greater relative risk of using cleanse/detox (RR 1.26, 95% CI 1.00–1.57), energy (RR 1.55, 95% CI 1.28–1.81) and immune (RR 1.68, 95% CI 1.41–2.00) supplements compared to nurses who worked without patient contact.

Psychosocial predictors

Anxiety and depression were both associated with small increases in risk of prevalent supplement use (Table 4). Nurses with, compared to those without, anxiety symptoms at a given study wave were slightly more likely to report use of immune supplements at the subsequent wave (RR 1.06, 95% CI 1.02–1.09), while nurses with, compared to those without, depressive symptoms at a given study wave were more likely to report use energy supplements at the subsequent wave (RR 1.15, 95% CI 1.04–1.26). Living in a high-mortality rate county was also associated with a slightly elevated risk of prevalent immune supplement use at the subsequent wave, compared to living in a low-mortality rate county (RR 1.08, 95% CI 1.04–1.12).

3.3.2 | New-onset use

Workplace-related predictors

Nurses who experienced occupational discrimination were more likely to report new-onset use of immune supplements than those who did not (RR 1.13, 95% CI 1.03–1.23; Table 4). The same was true of those who reported lacking PPE compared to participants with PPE access (RR 1.30, 95% CI 1.14–1.48). Working in a dedicated COVID-19 unit showed a significant increase in the risk of new-onset use of both energy (RR 1.79, 95% CI 1.25–2.57) and immune (RR 1.68, 95% CI 1.41–2.00) supplements at the following study wave, relative to having no patient contact. Similar associations were noted among those who worked in an ER, OR, or non-COVID ICU setting (energy: RR 1.78, 95% CI 1.31–2.42; immune: RR 1.22, 95% CI 1.05–1.42).

Psychosocial predictors

Depression and anxiety at a given study wave were associated with a greater risk of multiple types of new-onset supplement use at the following study wave (Table 4). Those who indicated depressive symptoms were more likely to begin using weight loss (RR 1.43, 95% CI 1.13–1.82), energy (RR 1.43, 95% CI 1.17–1.75) and immune (RR 1.17, 95% CI 1.05–1.31) supplements than participants without depression. Those who indicated anxiety symptoms were more likely to begin using both energy (RR 1.28, 95% CI 1.07–1.52) and immune (RR 1.20, 95% CI 1.09–1.31) supplements relative to participants

TABLE 1 Distribution of sociodemographic characteristics, psychosocial, occupational and spatial stressors among participants in the US-based COVID-19 pandemic substudy at baseline (April/May 2020).

Characteristic	Overall ($N = 36,518$)	Analytic sample nurses ($N = 12,044$)	Non-healthcare workers ($N = 24,474$)
Age in years, *M* (*SD*)	60.5 (11.1)	53.2 (12.0)	64.1 (8.6)
Cohort, *n* (%)			
Nurses' Health Study 2	29,170 (79.9)	6910 (57.4)	22,260 (91.0)
Nurses' Health Study 3	6788 (18.6)	4933 (41.0)	1855 (7.6)
Growing Up Today Study	560 (1.5)	201 (1.7)	359 (1.5)
Gender identity, *n* (%)			
Cisgender women	36,340 (99.5)	11,951 (99.2)	24,389 (99.7)
Cisgender men	169 (0.5)	89 (0.7)	80 (0.3)
Transgender/gender diverse	9 (0.0)	4 (0.0)	5 (0.0)
Race/ethnicity, *n* (%)			
Asian	409 (1.1)	141 (1.2)	268 (1.1)
Black/African American	361 (1.0)	123 (1.0)	238 (1.0)
Hispanic/Latine	607 (1.7)	295 (2.4)	312 (1.3)
Non-Hispanic White	34,376 (94.1)	11,208 (93.1)	23,168 (94.7)
Other/unlisted	765 (2.1)	277 (2.3)	488 (2.0)
Geographic region, *n* (%)			
Midwest	10,891 (29.8)	3671 (30.5)	7220 (29.5)
Northeast	9894 (27.1)	3471 (28.8)	6423 (26.2)
South	8673 (23.7)	2620 (21.8)	6053 (24.7)
West	7060 (19.3)	2282 (18.9)	4778 (19.5)
Current occupational role, *n* (%)			
ADN/BSN/RN	9419 (25.8)	9419 (78.2)	0 (0.0)
LPN	60 (0.2)	60 (0.5)	0 (0.0)
NP/CNM	2565 (7.0)	2565 (21.3)	0 (0.0)
Non-healthcare worker	24,474 (67.0)	0 (0.0)	24,474 (100.0)
Workplace setting,[a,b] *n* (%)			
COVID-19 unit	N/A	932 (7.8)	N/A
Hospital: ER, OR or ICU	N/A	1875 (15.7)	N/A
Nursing home/group care	N/A	500 (4.2)	N/A
Other in-person setting	N/A	6779 (56.7)	N/A
Virtual/no direct patient contact	N/A	1862 (15.6)	N/A
Missing	N/A	96	N/A
Occupational discrimination, *n* (%)[b]			
Yes	4931 (15.3)	3487 (34.7)	1444 (6.5)
No	27,206 (84.7)	6565 (65.3)	20,641 (93.5)
Missing	4381	1992	2389
PPE access,[c] *n* (%)			
Always/sometimes lack PPE	N/A	1666 (16.9)	N/A
Never lack PPE	N/A	8203 (83.1)	N/A
Missing	N/A	2175	N/A
County-level COVID-19 mortality rate,[d] *n* (%)			
Living in a high-mortality rate county	8500 (23.5)	3061 (25.7)	5439 (22.4)
Living in a low-mortality rate county	27,652 (76.5)	8861 (74.3)	18,791 (77.6)
Missing	366	122	244

Note: M = mean, SD = standard deviation, PPE = personal protective equipment. Percentages are column percentages excluding those with missingness (where applicable) and may not sum to 100 due to rounding.

[a]Assessed only among employed participants.

[b]Assessed only at Month 3 (July 2020).

[c]Assessed only among healthcare workers.

[d]Operationalized as the average mortality rate over the two weeks following survey completion.

TABLE 2 Distribution of prevalent and new-onset 'wellness' supplement use among participants in the US-based COVID-19 substudy.

	Overall (*N* = 36,518)	Analytic sample nurses (*N* = 12,044)	Non-healthcare workers (*N* = 24,474)
Prevalent 'wellness' supplement use, *n* (%)[a]			
Weight loss supplements	858 (2.3)	365 (3.0)	493 (2.0)
Cleanse/detox supplements	1106 (3.0)	434 (3.6)	672 (2.7)
Energy supplements	1263 (3.5)	582 (4.8)	681 (2.8)
Immune supplements	7936 (21.7)	3007 (25.0)	4929 (20.1)
Incident 'wellness' supplement use, *n* (%)[b]			
Weight loss supplements	103 (0.4)	44 (0.5)	59 (0.3)
Cleanse/detox supplements	119 (0.4)	54 (0.6)	65 (0.3)
Energy supplements	113 (0.4)	55 (0.6)	58 (0.3)
Immune supplements	1996 (6.8)	881 (9.4)	1115 (5.6)

Note: M = mean, SD = standard deviation. Percentages are column percentages excluding those with missingness (where applicable) and may not sum to 100 due to rounding.

[a]"Prevalent use" indicates participants who reported supplement use at any point during the study period (including before baseline data collection).

[b]"Incident use" indicates participants who reported new supplement use that began after baseline data collection.

TABLE 3 Relative risk of 'wellness' supplement prevalent and new-onset use between nurses and non-healthcare workers.

	'Wellness' supplement type			
	Weight loss RR (95% CI)	Cleanse/detox RR (95% CI)	Energy RR (95% CI)	Immune RR (95% CI)
Prevalent supplement use[a]				
Nurses	1.50 (1.35, 1.66)	1.37 (1.24, 1.50)	1.57 (1.44, 1.70)	1.17 (1.12, 1.21)
Non-healthcare workers	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
Incident supplement use[b]				
Nurses	1.34 (1.17, 1.54)	1.35 (1.18, 1.53)	1.38 (1.22, 1.56)	1.17 (1.11, 1.24)
Non-healthcare workers	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)

Note: RR = relative risk, CI = confidence interval. Estimates are derived from modified Poisson generalized estimating equation models that are adjusted for age, cohort, gender identity, race/ethnicity, and geographic region and weighted to account for loss-to-follow-up.

[a]"Prevalent use" indicates participants who reported supplement use at any point during the study period (including before baseline data collection).

[b]"Incident use" indicates participants who reported new supplement use that began after baseline data collection.

who did not. Living in a county with a high COVID-19 mortality rate was again associated with the risk of new-onset immune supplement use (RR 1.20, 95% CI 1.09–1.31).

4 | DISCUSSION

The COVID-19 pandemic created new dimensions of stressors and threats to central well-being, especially for healthcare workers. Nurses, in particular, faced high risk of exposure, due to close patient contact, and considerable stress due to demanding workloads and the mental and cognitive burden of caregiving in their work and personal lives. The underregulated 'wellness' supplement industry thus had a window to serve as a 'line of defence', leaving nurses especially susceptible to unproven, or even false, claims.

We found that nurses were significantly more likely than non-healthcare workers to use 'wellness' supplements, both as prevalent pre-pandemic use and new-onset use, across all supplement types. This disparity is supported by Neuman's systems model, suggesting that nurses may be experiencing several occupation-related stressors that lead them to seek out 'lines of defence' (i.e. supplement use), and thus are at increased risk for 'wellness' supplement use. As Neuman's system model further describes, this indicates that there is a need for secondary and tertiary prevention of these stressors to reduce their risk of harm related to use of these products.

Of the entire sample, immune supplements were by far the most commonly used type of supplement, with over one-fifth of the total sample reporting use of immune supplements at baseline. Baseline data were collected at the beginning of the COVID-19 pandemic, during a period of high infection and mortality rates, fear and

TABLE 4 Longitudinal predictors of 'wellness' supplement use among nurses in the COVID-19 pandemic substudy (April 2020–April 2021) ($N = 12{,}031$).

	'Wellness' supplement type			
	Weight loss RR (95% CI)	Cleanse/detox RR (95% CI)	Energy RR (95% CI)	Immune RR (95% CI)
Prevalent supplement use				
Lagged depressive symptoms	1.10 (0.96, 1.25)	1.04 (0.91, 1.18)	1.15 (1.04, 1.26)	1.03 (0.98, 1.07)
Lagged anxiety symptoms	1.01 (0.90, 1.13)	1.05 (0.95, 1.17)	1.05 (0.97, 1.14)	1.06 (1.02, 1.09)
Occupational discrimination	1.25 (1.08, 1.46)	1.11 (0.96, 1.29)	1.10 (0.97, 1.24)	1.12 (1.05, 1.18)
PPE[a] access				
Always/sometimes lack PPE	1.05 (0.88, 1.25)	1.06 (0.89, 1.26)	1.06 (0.93, 1.21)	1.08 (1.02, 1.14)
Never lack PPE	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
County-level COVID-19 mortality rate[b]				
Living in a high-mortality rate county	1.10 (0.98, 1.24)	1.00 (0.90, 1.12)	1.07 (0.97, 1.18)	1.08 (1.04, 1.12)
Living in a low-mortality rate county	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
Workplace setting				
COVID-19 unit	1.09 (0.86, 1.39)	1.26 (1.00, 1.57)	1.52 (1.28, 1.81)	1.68 (1.41, 2.00)
Hospital: ER, OR or ICU	1.09 (0.90, 1.32)	1.08 (0.89, 1.31)	1.58 (1.35, 1.85)	1.22 (1.05, 1.42)
Nursing home/group care	1.35 (1.02, 1.77)	1.09 (0.81, 1.47)	1.45 (1.14, 1.84)	1.14 (0.91, 1.41)
Other in-person setting	1.14 (0.98, 1.31)	1.15 (0.99, 1.33)	1.26 (1.11, 1.44)	1.06 (0.93, 1.20)
Virtual/no direct patient contact	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
New-onset supplement use				
Lagged depressive symptoms	1.43 (1.13, 1.82)	1.05 (0.81, 1.36)	1.43 (1.17, 1.75)	1.17 (1.05, 1.31)
Lagged anxiety symptoms	1.19 (0.97, 1.46)	1.09 (0.88, 1.34)	1.28 (1.07, 1.52)	1.20 (1.09, 1.31)
Occupational discrimination	1.24 (1.02, 1.51)	1.12 (0.92, 1.37)	1.20 (1.01, 1.42)	1.13 (1.03, 1.23)
PPE access				
Always/sometimes lack PPE	0.98 (0.69, 1.39)	0.80 (0.55, 1.17)	0.99 (0.74, 1.33)	1.30 (1.14, 1.48)
Never lack PPE	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
County-level COVID-19 mortality rate[a]				
Living in a high-mortality rate county	1.15 (0.92, 1.44)	1.12 (0.90, 1.38)	1.04 (0.86, 1.26)	1.20 (1.09, 1.31)
Living in a low-mortality rate county	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
Workplace setting				
COVID-19 unit	1.11 (0.73, 1.70)	1.11 (0.70, 1.75)	1.79 (1.25, 2.57)	1.68 (1.41, 2.00)
Hospital: ER, OR or ICU	0.90 (0.64, 1.29)	1.11 (0.77, 1.60)	1.78 (1.31, 2.42)	1.22 (1.05, 1.42)
Nursing home/group care	1.19 (0.74, 1.91)	1.65 (1.05, 2.59)	1.62 (1.05, 2.50)	1.14 (0.91, 1.41)
Other in-person setting	1.00 (0.75, 1.33)	1.19 (0.88, 1.61)	1.16 (0.89, 1.57)	1.06 (0.93, 1.20)
Virtual/no direct patient contact	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)

Note: RR = relative risk, CI = confidence interval. Estimates are derived from modified Poisson generalized estimating equation models that are adjusted for age, cohort, gender identity, race/ethnicity, and geographic region and weighted to account for loss-to-follow-up.

[a]PPE = Personal protective equipment.

[b]Operationalized as the average mortality rate over the two weeks following survey completion.

uncertainty about transmission of SARS-CoV-2 and intense risk and pressure on nurses as frontline workers and caregivers. This may have driven many to use immune supplements in an effort to 'boost' immunity, which has been reported as a key concern of the general public since pandemic onset (Jungmann & Witthöft, 2020). A larger percent of participants also reported new-onset use of immune supplements compared to other supplement types throughout the study period.

When examining predictors of 'wellness' supplement use among nurses, immune supplements had the greatest magnitude of association with both workplace-related and psychosocial predictors. Further, there is a striking association between nurses' access to PPE and their immune supplement use. While associations between lack of PPE access and immune supplement use were slight for prevalent pre-pandemic use, such associations were strong for new-onset use. Indeed, nurses who indicated that they had poor access to PPE were 1.30 times as likely to begin using immune supplements during the study period compared to those with sufficient PPE access. This increase in new-onset use during the first year of the pandemic suggests that, in response to institutional failure to provide nurses with safe working conditions including PPE (Rich-Edwards et al., 2021), some nurses were driven to underregulated and unproven supplements as a makeshift 'line of defence', as described by Neuman. Future studies should explore more deeply this proposed mechanism underlying nurses' immunity supplement use.

Energy supplement use was also more commonly reported among nurses compared to non-healthcare workers. Among nurses, working in any patient-facing role was associated with an increased risk of prevalent pre-pandemic use of energy supplements compared to a non-patient-facing role. Incident energy supplement use was associated with working in a dedicated COVID-19 unit or working in an ER, OR or non-COVID ICU setting, but not other in-person settings, as compared with virtual/no-patient-contact settings. One possible explanation for this difference is that during earlier waves of data collection, the burden of COVID-19 was broadly distributed across all areas of healthcare, and thus, nurses sought increased energy via supplements. However, as the pandemic continued, and COVID-19 patients were more often isolated in dedicated units and emergency rooms, the physical and emotional fatigue of nurses in other settings may have decreased, while nurses providing care to COVID-19 patients continued to experience high energy demands. Such a disparity in emotional and physical demands across healthcare settings has been documented in the literature previously (Lohela-Karlsson & Condén Mellgren, 2022).

Our study is the first that we are aware of to gather prospective data on 'wellness' supplement use during the pandemic in a large sample of nurses. With a total sample of 36,750 and a nurse-specific sample of 12,031, we were able to estimate associations among a number of predictors while including several relevant covariates. Our large, national cohort was also distributed across geographic regions, potentially capturing differing experiences of COVID-19 waves and responses.

Our study was not without limitations. First, the use of self-report surveys confers some risk of response bias (i.e. the stress of the pandemic could heighten perceptions of risk, positively biasing estimates or could result in negatively biased estimates due to poor recall). Second, our study population included predominantly cisgender women. This is reflective of the US nursing workforce where 91% of RNs and 92% of LPNs are women (Smiley et al., 2021), but this may limit the generalizability of our findings. Third, the supplement regulation and availability that has been discussed is unique to the United States, which limits international generalizability of these findings, though calls for greater regulation have been echoed in European countries as well as the United States (Coppens, 2018). Finally, our study population was predominantly non-Hispanic white respondents (94.1% of total sample, 93.1% of nursing sample), which is not representative of the national nursing workforce (Smiley et al., 2021) and may not represent the disparities in discrimination experienced by nurses from racial and ethnic minority populations (Hennein et al., 2021; Snyder & Schwartz, 2019).

Overall, these study findings highlight important predictors of 'wellness' supplement use among nurses, and disparities between nurses and the non-healthcare worker population. Findings suggest a need for prevention of 'wellness' supplement use, as nurses are a vital part of the healthcare workforce and should prioritize their own health. 'Wellness' supplements potentially harm health, or as our findings may suggest, could indicate deficiencies in safe or healthy work conditions, such as lack of PPE or overburdened staff. With this foundation, future studies should focus on the specific motivators that drive nurses to use 'wellness' supplements. Once these motivators are better understood, researchers may design public health interventions that aim to reduce the use of 'wellness' supplements among nurses. Goals of these interventions could include broadening access to PPE, reducing occupational discrimination against nurses, and providing education to nurses about the potential risks of 'wellness' supplements. As seen by the supplement industry's deliberate targeting of nurses during the COVID-19 pandemic, further findings may also help in developing policy or regulatory approaches to protect nurses and consumers from deceptive marketing or dangerous products.

The use of 'wellness' supplements is of imminent public health concern, and especially so among nurses. Our study aimed to understand predictors of 'wellness' supplement use among nurses throughout the COVID-19 pandemic. Notable findings included the widespread use of deceptively marketed 'immune-boosting' supplements and significant disparities in use between nurses and non-healthcare workers. Understanding factors that increase the risk of 'wellness' supplement use will help to inform future investigations and public health interventions to reduce unsafe use, consumption, or marketing of supplements and to improve the working conditions and risk factors for nurses that may lead to supplement use.

AUTHOR CONTRIBUTIONS

ST, AB, GF, DJ, SBA, AR, DJ, JR-E, JR, JH: Made substantial contributions to conception and design, or acquisition of data or analysis and interpretation of data; **ST, AB, GF**: Involved in drafting the manuscript or revising it critically for important intellectual content; **ST, AB, GF, DJ, SBA, AR, DJ, JR-E, JR, JH**: Given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content; **ST, AB, GF, DJ, SBA, AR, DJ, JR-E, JR, JH**: Agreed to be accountable for all aspects of the work in ensuring that

questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest with this work to report.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Channing Division of Network Medicine. Restrictions apply to the availability of these data, which were used with approval for this study. Data are available at https://gutsweb.org/collaborate-with-guts/ and https://nurseshealthstudy.org/researchers from NHS/GUTS leadership.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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