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Original article

Adherence to COVID-19 nutritional guidelines and their impact on the clinical outcomes of hospitalized COVID-19 patients

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SUMMARY

Background & aims: Coronavirus disease 2019 (COVID-19) patients are at high risk of malnutrition, and their doctors are part of a multidisciplinary team, including nutritionists. However, adherence to nutritional guidelines may be difficult in the context of capacity constraints during the COVID-19 pandemic. The aim of this study was to investigate barriers to doctors' adherence to nutritional guidelines and the impacts of guideline adherence on the outcomes of hospitalized COVID-19 patients.
Methods: A multinational electronic survey involving 51 doctors was conducted between November 2020 and January 2021 from 17 COVID-19-designated hospitals in countries with high (Indonesia) and low (Vietnam) numbers of confirmed COVID-19 cases.
Results: In general, doctors reported concerns related to nutritional practices in patients with Covid-19 which included feeling stress when performing medical nutritional therapy (65%), lacking self-efficacy or confidence in performing nutritional care (49%), lacking clear nutritional guidelines (45%), and experiencing budget limitations (33%). A regression analysis adjusted for age, country, and the number of hospitalized COVID-19 cases revealed that guideline knowledge (β: −1.01 (−1.78, −0.23); p = 0.012) and awareness of guidelines (β: −1.37 (−2.66, −0.09); p = 0.037) were negatively correlated with the length of stay of critically ill COVID-19 patients, but non-significant after adjusting for specialization of the doctor. When stratified according to country, a significant relationship between guideline adherence and length of stay of critically ill patients was only found in Vietnam [guideline adherence: β: −0.55 (−1.08, −0.03); p = 0.038; guideline knowledge: β: −1.01 (−1.9, −0.13); p = 0.027] after adjusting for age, specialty, and number of hospitalized COVID-19 cases. In Indonesia, the significant relationship between

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guideline adherence and mortality of COVID-19 patients remained strong (β: −14 (−27, −1); p = 0.033) after adjusting for age, specialty, and number of hospitalized COVID-19 cases

Conclusions: Inadequate nutritional knowledge is a key barrier to guideline adherence, and this was international and may be related to doctors' specialties and the COVID-19 pandemic. Adherence to nutritional guidelines may represent a prognostic factor for survival in COVID-19 patients.

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1. Introduction

The current worldwide pandemic of coronavirus disease 2019 (COVID-19) has been the greatest global challenge since World War II. As of the end of January 2021, more than 100 million cases had been confirmed globally. The spectrum of COVID-19 is highly variable, and symptoms range from asymptomatic, mild with nonspecific symptoms (e.g., a fever, cough, sore throat, and headaches), to moderate to severe and critical pneumonia with acute respiratory distress syndrome requiring admission to the intensive care unit (ICU) [1].

While the COVID-19 pandemic may lead to increased risks of malnutrition [2] and higher mortality rates [3], patients with malnutrition are also at risk of developing more severe forms of the disease. According to a recent study by Ehwerhemuepha and colleagues, children older than five and adults aged 18–78 years with previous diagnoses of malnutrition were found to have higher odds of severe COVID-19 than those with no history of malnutrition in the same age groups [4]. Malnutrition may also prolong hospital stays, which may lead to a poor quality of life and additional morbidity [5]. Doctors are part of a multidisciplinary team that provides nutritional support and takes overall responsibility for the clinical outcomes of hospitalized COVID-19 patients [6]. Since there are limited effective antiviral drugs, safe cost-effective nutritional support is a helpful way to strengthen patients' immune systems and fight off the coronavirus [1,7–9]. However, medical students often do not receive adequate nutritional education, and a lack of nutritional knowledge among clinicians is recognized as a global phenomenon [10–14]. A systematic review analyzing 24 studies concluded that nutrition is insufficiently incorporated into medical education, and limited nutritional education affects medical students' knowledge, skills, and confidence in providing high-quality, effective nutritional care [10]. As one-third of COVID-19 patients experience >5% weight loss during their hospital stay [2], failure to convert nutritional knowledge into practice may result in increased morbidity and mortality in hospitalized COVID-19 patients [15].

Several barriers to and potential challenges in providing nutritional therapy during the COVID-19 pandemic have been recognized [16,17]. However, little is known about barriers that affect doctors' implementation of and adherence to COVID-19 nutritional guidelines and whether adherence to guidelines affects the health outcomes of COVID-19 patients. It is also unknown whether the pandemic has affected doctors' attitudes toward adherence to nutritional guidelines. For example, Indonesia is recorded as the currently the most affected country by the COVID-19 pandemic worldwide, and it has the fifth highest observed case-fatality ratio (3.0% per 100 confirmed cases) [18,19]. On the other hand, with only 1651 confirmed coronavirus cases and 35 deaths, Vietnam is ranked as one of the world's best-performing countries in its response to the pandemic. Hence, the broad aim of this study was to investigate barriers to doctors' adherence to nutritional guidelines in hospitalized COVID-19 patients in Asian countries with high (Indonesia) and low (Vietnam) numbers of confirmed COVID-19 cases. Specific aims were [1] to understand the practical challenges and concerns in providing medical nutritional therapy and [2] the prognostic potential of adherence to nutritional guidelines (guideline knowledge, attitudes, and environmental factors) on the clinical outcomes (indicated by the length of stay and mortality) of hospitalized COVID-19 patients.

2. Materials and methods

2.1. Study participants

This study was a multinational online survey designed to understand barriers to doctors' adherence to guidelines of medical nutritional therapy for hospitalized COVID-19 patients in Asian countries with high (Indonesia) and low (Vietnam) numbers of confirmed COVID-19 cases and case-fatality rates. Invitation emails were sent directly to the administrative leaders of ICUs and pulmonary and infectious departments of COVID-19-designated hospitals in Indonesia (n = 35 hospitals) and Vietnam (n = 19 hospitals). The administrative leaders were chosen and contacted by the research contributors (HSN, DFI) through social media groups of the Indonesia Medical Association and Vietnam Physician Association networks. In total, 24 doctors from 14 hospitals in Indonesia and 27 doctors from 6 hospitals in Vietnam completed the online questionnaire. The hospital response rate was 31.4/% (Indonesia: 31.4% and Vietnam: 31.6%), and the overall participant response rate was 17% (Indonesia: 10% and Vietnam: 23%). Out of 14 participating hospitals in Indonesia, 12 were located in Jakarta and Java Island, which had substantial higher COVID-19 cases compared to other regions in Indonesia. In addition, 7 participating hospitals were designated hospitals for COVID-19 by the Indonesia Ministry of Health. All of 11 participating hospitals in Vietnam were designated hospitals for COVID-19 by the Vietnam Ministry of Health. Out of six participating hospitals, 4 are central hospitals according to Ministry of Health administrative structure's classification and 2 are the field hospitals according to which were set up for only COVID-19 patients. Details about hospitals according to administrative structure were provided in the Supplementary Table 3.

Data were collected using Google Forms (Google, Menlo Park, CA, USA) between November 2020 and January 2021. All responses were collected anonymously with no identifiable information collected (e.g., name or contact address). Participants were informed of the purpose of the online survey, and consent to participate was assumed if they completed the online survey. Each participant was allowed to complete the online survey only once. Participants were included if they had experience performing nutritional care for hospitalized COVID-19 patients, and they completed the online surveys. The exclusion criteria were doctors who did not have experience in treating or performing nutritional therapy on hospitalized COVID-19 patients and those who did not complete the online survey questionnaires. This study was approved by the Research Ethics Committee of Alma Alta University, Indonesia (KE/AA/XI/10323/EC/2020).

2.2. Survey questionnaire

The questionnaire was developed based on the framework of "barriers to physician adherence to practice guidelines in relation to behavior change", which was proposed by Cabana et al. [20]. The questionnaire consisted of three domains with a total of 36 questions: knowledge (12 questions), attitudes (22 questions), and environmental factors (two questions). Depending on the participant's answer, each question was awarded 1 or 0 points, with a maximum of 36 points total. For example, one point was awarded to participants if they knew "ESPEN guidelines on clinical nutrition in intensive care units" [21] or "Nutrition Therapy in Patients with COVID-19 Disease Requiring ICU Care" [9]. A higher total adherence score of knowledge, attitudes, and environmental factors represents better adherence to COVID-19 nutritional guidelines by doctors when treating hospitalized COVID-19 patients.

The "knowledge section" (12 questions in total) included awareness of the guidelines (four questions) and familiarity with clinical nutritional practices of the guidelines (eight questions). The four guidelines were published between February 2019 and July 2020: Coronavirus Disease 2019 (COVID-19) Treatment Guidelines (1), ESPEN guidelines on clinical nutritional care in intensive care units (ICUs) [21], ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection [7], and Nutrition Therapy in Patients with COVID-19 Disease Requiring ICU Care (reviewed and approved by the Society of Critical Care Medicine and the American Society for Parenteral and Enteral Nutrition (ASPEN)) [9]. Familiarity with COVID-19 nutritional guidelines consisted of multiple-choice questions to test the doctor's knowledge on key issues of medical nutritional therapy for hospitalized COVID-19 patients. Examples of questions were "what is the optimal timing of enteral nutrition delivery for COVID-19 patients in the ICU?" and "What are the factors/diseases that lead to protein malnutrition (sarcopenia) in COVID-19 patients?"

The "attitudes section" (18 questions in total) consisted of four parts: agreement on the roles of nutritional therapy (eight questions), self-efficacy (five questions), motivation (eight questions), and outcome expectancy (one question) in performing medical nutritional therapy in hospitalized COVID-19 patients. Examples of the statements/questions included "the nutritional assessment and the early nutritional care management of COVID-19 patients must be integrated into the overall therapeutic strategy", "do you lack self-efficacy or confidence in performing nutrition therapy for hospitalized COVID-19 patients?", and "medical nutrition therapy will not lead to the desired treatment outcome". Respondents answered with "agree" or "disagree". The motivation section investigated doctors' motivations to provide medical nutritional therapy and their behaviors regarding nutritional management. Motivation questions included "do you feel stress when treating COVID-19 patients?", "do you monitor COVID-19 patients' body weight change?", "do you monitor COVID-19 patients' food intake?", and "do you prescribe supplements for hospitalized COVID-19 patients?" Environmental factors investigated "concerns of budget control and patient or patient's family requests to prescribe nutritional supplements".

2.3. Primary outcomes

The primary outcomes were length of stay and mortality in hospitalized COVID-19 patients. The length of stay of hospitalized COVID-19 patients was defined as the time from the first COVID-19 case admitted to the hospital to the end of survey at the end of January 2021. The average length of stay of COVID-19 patients (mildly/moderately, severely, and critically ill) was obtained from each hospital. COVID-19 mortality, as total cases or as the case-fatality rate (the number of deaths divided by the number of confirmed cases) in each hospital, was derived from the Indonesia National Disaster Management Agency (https://covid19.bnpb.go.id/) and Administration of Medical Service, Ministry of Health Vietnam (https://ncov.moh.gov.vn).

2.4. Data analysis

Statistical analyses were conducted using SPSS version 19 (IBM, Armonk, NY, USA). Continuous data are presented as the mean and standard deviation (SD), and categorical data are presented as the number (n) and percentage (%). Differences between groups were analyzed by an unpaired t-test or one-way analysis of variance (ANOVA). Chi-squared or Fisher's exact test was employed to compare proportions. Regression coefficients (β) adjusted for age, sex, country, and total number of confirmed COVID-19 cases and 95% confidence intervals (CIs) were determined to investigate the predictive effect of adherence to guidelines on the length of hospital stay and mortality of hospitalized COVID-19 patients. $p < 0.05$ was considered statistically significant.

3. Results

3.1. Participant characteristics and concerns related to nutritional therapy

Table 1 shows the baseline characteristics of the study participants. In total, 51 medical doctors (Indonesia: 47% and Vietnam: 50%) with experience treating COVID-19 patients were recruited from 17 COVID-19-designated hospitals located in Indonesia ($n = 11$) and Vietnam ($n = 6$). Compared to Vietnamese doctors, Indonesian doctors were older, were less likely to specialize in ICU care, had more nutritional credits from medical school, and had more experience in treating COVID-19 patients (all $p < 0.05$). Concerns related to nutritional practice of hospitalized COVID-19 patients included feeling stress when performing medical nutritional therapy (65%), lacking self-efficacy or self-confidence in performing nutritional therapy (49%), lacking clear nutritional guidelines (45%), and experiencing budget limitations (33%) (Table 1).

3.2. Barriers to doctors' adherence to nutritional guidelines for COVID-19

We next evaluated barriers to doctors' adherence to COVID-19 nutritional guidelines according to country and specialty ($n = 51$). Table 2 shows that Vietnamese doctors had significantly higher guideline knowledge scores (Vietnam: 7.5 ± 2.1 vs. Indonesia: 5.7 ± 2.1; $p = 0.004$) but lower outcome expectancy in medical nutritional therapy of hospitalized COVID-19 patients ($p = 0.001$) than Indonesian doctors and, to a lesser extent, total guideline adherence scores (Vietnam: 23.2 ± 3.6 vs. Indonesia: 21.2 ± 4.1; $p = 0.072$). When stratified by specialization, doctors who specialized in ICU care exhibited the highest scores of guideline adherence and guideline knowledge but lower outcome expectancies in medical nutritional therapy of COVID-19 patients (all $p < 0.05$).

3.3. Adherence to guidelines and clinical outcomes in hospitalized COVID-19 patients

We next investigated the relationships of adherence to COVID-19 nutritional guidelines with the length of stay and COVID-19 mortality. Table 3 shows that after adjusting for age, country, and number of hospitalized COVID-19 cases, guideline knowledge

Table 1
Baseline characteristics of the medical doctors ($N = 51$).

Characteristic	Total ($N = 51$)	Country		p-value[a]
		Indonesia ($N = 24$)	Vietnam ($N = 27$)	
Hospital characteristics				
Number of participating doctors (n, %)	51	24	27	NA
Number of included hospitals	17	11	6	NA
Number of hospitalized Covid-19 patients	23,015	22,737	278	NA
Mortality rate (n, ratio)	1411 (0.06)	1406 (0.06)	5 (0.02)	NA
Average length of stay (LOS)	24.2 ± 1.6	22.6 ± 8.6	27 ± 9.6	0.181
Moderate illness LOS	16.4 ± 3.2	16.6 ± 3.5	15.3 ± 1.5	0.550
Severe illness LOS	23.9 ± 3.7	23.4 ± 4.2	24.5 ± 3.4	0.684
Critical illness LOS	35.5 ± 5.4	34.8 ± 6	36 ± 5.7	0.754
Participant characteristics				
Age (years)	33.5 ± 7.2	36.1 ± 8.8	31.0 ± 4.2	0.007
Female (n, %)	25 (49%)	12 (50%)	13 (48%)	0.559
Practice experience (years)	5.4 ± 3.7	5.2 ± 4.1	5.5 ± 3.2	0.766
Specialization (n, %)				<0.001
ICU	15 (29.5%)	2 (8.3%)	13 (48.1%)	
Infectious/pulmonary diseases	21 (41.2%)	8 (33.3%)	13 (48.1%)	
Others	15 (29.5%)	14 (58.3%)	1 (3.7%)	
Number of Covid-19 patients treated	60.4 ± 145.5	103.5 ± 197.7	22.4 ± 54.2	0.047
Severity of Covid-19 cases treated (n, %)				0.969
Mild and moderate illness	27 (51.9%)	13 (52.9%)	14 (54.2%)	
Severe illness	7 (13.7%)	3 (13.7%)	4 (14.8%)	
Critical illness	17 (33%)	8 (33%)	9 (33%)	
Nutrition credits received in medical school	2.2 ± 2.0	2.5 ± 1.8	2.0 ± 2.0	0.047
Concerns related to nutritional therapy (reported as yes; n, %)				
Feel stress when treating hospitalized Covid-19 patients	33 (64.7%)	12 (50.0%)	21 (77.8%)	0.046
Lack clear nutritional guidelines	23 (45.1%)	10 (41.7%)	13 (48.1%)	0.428
Lack self-efficacy or self-confidence	25 (49.0%)	10 (41.7%)	15 (55.6%)	0.239
Lack motivation	6 (11.8%)	1 (4.2%)	5 (18.5%)	0.124
Nutrition therapy will not lead to desired treatment outcomes	9 (17.6%)	0 (0%)	9 (55.6%)	<0.001
Patient or patient's family request	40 (78%)	21 (87.5%)	19 (70%)	0.126
Budget limitations	19 (37.3%)	6 (25.0%)	13 (48.1%)	0.148

Continuous variables are presented as the mean ± standard deviation (SD). Categorical variables are presented as numbers (percentages).
[a] The p-value was determined using an unpaired Student's t-test for continuous variables or Chi-squared test for categorical variables. Abbreviations: ICU, intensive care unit.

Table 2
Doctors' adherence to COVID-19 nutritional guidelines according to country and specialization ($N = 51$).

Variables	Total	Nationality			Specialization			
		Indonesia ($N = 24$)	Vietnam ($N = 27$)	p-value[a]	ICU ($n = 15$)	Pulmonary/infectious ($n = 21$)	Others ($n = 15$)	p-value[b]
Total adherence score (maximum 36 points)	22.2 ± 4.8	21.2 ± 4.1	23.2 ± 3.6	0.072	24.6 ± 2	21.3 ± 3.7[a]	21.2 ± 4.9[a]	0.019
Guideline knowledge (maximum 12 points)	6.6 ± 2.3	5.7 ± 2.1	7.5 ± 2.1	0.004	8.4 ± 1.4	5.9 ± 2.0[a]	5.9 ± 2.5[a]	0.001
Awareness (maximum 4 points)	2.0 ± 1.4	1.5 ± 1.3	2.4 ± 1.3	0.017	2.9 ± 1	1.5 ± 1.3[a]	1.7 ± 1.4[a]	0.004
Familiarity (maximum 8 points)	4.6 ± 1.3	4.8 ± 1.4	5.6 ± 1.6	0.052	5.5 ± 0.8	4.4 ± 1.2[a]	4.2 ± 1.5[a]	0.011
Attitudes (maximum 22 points)	15.6 ± 2.5	13.4 ± 2.0	15.7 ± 2.1	0.822	16.2 ± 1.2	15.4 ± 2.9	15.3 ± 3	0.586
Agreement on the role of nutritional therapy (maximum 8 points)	7.8 ± 0.6	7.9 ± 0.3	7.6 ± 0.8	0.099	7.7 ± 0.8	7.7 ± 0.6	7.9 ± 0.4	0.754
Self-efficacy in performing nutritional therapy (maximum 5 points)	2.1 ± 1.5	2.0 ± 1.7	2.2 ± 1.4	0.686	2.5 ± 1.4	2 ± 1.7	1.9 ± 1.5	0.608
Motivation in performing nutritional therapy (maximum 8 scores)	4.9 ± 1.3	4.6 ± 1.5	5.2 ± 1.1	0.112	5.5 ± 1	4.8 ± 1.2	4.5 ± 1.7	0.136
Outcome expectancy of nutritional therapy (1 point)	0.8 ± 0.4	1.0 ± 0.0	0.7 ± 0.5	0.001	0.5 ± 0.5	0.9 ± 0.3[a]	1.0 ± 0[a]	0.001
Environmental factors (maximum 2 points)	0.4 ± 0.7	0.6 ± 0.8	0.3 ± 0.5	0.094	0.6 ± 0.9	0.4 ± 0.7	0.3 ± 0.6	0.465
Patient or patient's family request	0.2 ± 0.4	0.3 ± 0.5	0.4 ± 0.7	0.673	0.3 ± 0.5	0.2 ± 0.4	0.1 ± 0.4	0.401
Budget limitations	0.2 ± 0.4	0.4 ± 0.7	0.4 ± 0.7	0.245	0.3 ± 0.5	0.2 ± 0.4	0.1 ± 0.4	0.654

All variables are expressed as the mean ± standard deviation.
[a] $p < 0.05$ vs. ICU. Abbreviation: ICU, intensive care unit.
[a] The p-value was determined using an unpaired Student's t-test for continuous variables between Indonesian and Vietnamese doctors.
[b] The p-value was determined using one-way ANOVA among the ICU, pulmonary/infectious, and other groups.

(β: −1.01 (−1.78, −0.23); $p = 0.012$) and awareness of guidelines (β: −1.37 (−2.66, −0.09); $p = 0.037$) were negatively correlated with the length of stay in critically ill COVID-19 patients, but this association became nonsignificant after further adjustment for specialty (Table 3, model 2). Regarding COVID-19 mortality, guideline adherence (β: −13 (−24, −2); $p = 0.027$), in particular guideline knowledge (β: −25 (−45, −6); p = 0.012) and awareness of guidelines (β: −44 (−72, −15); $p = 0.005$), independently predicted COVID-19 mortality (Table 3, model 1), and this relationship was less affected by the specialty of the doctors (Table 3, model 2). When stratified according to country, a significant relationship between guideline adherence and length of stay of critically ill

Table 3
Adjusted multivariate regression coefficients (β) and 95% confidence intervals (95% CIs) for length of stay and mortality of hospitalized COVID-19 patients treated by the study doctors ($N = 51$).

Variables	Length of stay						Mortality	*p*-value
	Mild and moderate illness	*p*-value	Severe illness	*p* value	Critical illness	*p*-value		
Model 1: Adjusted for age, country, and number of hospitalized Covid-19 patients								
Total adherence score	0.06 (−0.12, 0.25)	0.483	0 (−0.28, 0.28)	0.993	−0.35 (−0.81, 0.1)	0.125	−13 (−24, −2)	0.027
Knowledge (total score)	0.24 (−0.1, 0.57)	0.157	−0.08 (−0.58, 0.42)	0.775	−1.01 (−1.78, −0.23)	0.012	−25 (−45, −6)	0.012
Guideline awareness	0.14 (−0.42, 0.71)	0.609	−0.15 (−0.97, 0.67)	0.705	−1.37 (−2.66, −0.09)	0.037	−44 (−72, −15)	0.005
Guideline familiarity	0.48 (−0.05, 1.01)	0.074	−0.05 (−0.82, 0.72)	0.906	−1.18 (−2.45, 0.08)	0.066	−25 (−64, 14)	0.194
Attitudes (total score)	−0.01 (−0.29, 0.26)	0.912	0.05 (−0.35, 0.45)	0.814	−0.1 (−0.79, 0.59)	0.778	−9 (−26, 8)	0.279
Agreement	0.01 (−1.07, 1.09)	0.986	−0.82 (−2.37, 0.74)	0.293	−0.19 (−2.95, 2.58)	0.892	0 (−32, 32)	0.106
Self-efficacy or confidence	0.10 (−0.34, 0.54)	0.650	0.39 (−0.23, 1.01)	0.206	0.51 (−0.57, 1.59)	0.344	−22 (−49, 5)	0.810
Motivation	−0.22 (−0.79, 0.35)	0.437	−0.27 (−1.02, 0.49)	0.476	−1.1 (−2.32, 0.12)	0.075	−4 (−38, 30)	0.987
Outcome expectancy	−0.02 (−2.20, 2.16)	0.986	0.67 (−1.84, 3.19)	0.624	1.21 (−2.97, 5.38)	0.56	−2 (−242, 238)	0.227
Environment factors	−0.50 (−1.63, 0.64)	0.381	−0.48 (−1.74, 0.78)	0.455	−1.03 (−3.12, 1.07)	0.325	−41 (−109, 27)	0.382
Patient or patient's family request	−1.35 (−3.33, 0.63)	0.174	−1.27 (−3.52, 0.99)	0.261	−2.33 (−5.97, 1.31)	0.201	−55 (−184, 74)	0.188
Budget limitations	−0.18 (−2.06, 1.71)	0.849	−0.32 (−2.69, 2.05)	0.786	−0.95 (−4.91, 3.01)	0.628	−78 (−199, 42)	0.316
Model 2: Adjusted for age, country, specialization, and number of hospitalized Covid-19 patients								
Total adherence score	−0.14 (−0.43, 0.15)	0.303	−0.26 (−0.99, 0.48)	0.457	−0.26 (−0.99, 0.48)	0.457	−11 (−22, 0.1)	0.053
Knowledge (total score)	−0.39 (−0.97, 0.19)	0.165	−0.6 (−1.85, 0.65)	0.308	−0.68 (−1.46, 0.1)	0.084	−21 (−41, −2)	0.035
Guideline awareness	−0.56 (−1.63, 0.51)	0.274	−0.85 (−3.28, 1.57)	0.451	−0.84 (−2.11, 0.42)	0.184	−44 (−74, −13)	0.007
Guideline familiarity	−0.33 (−1, 0.34)	0.293	−0.48 (−2.06, 1.1)	0.513	−0.78 (−1.97, 0.41)	0.192	−66 (−135, 3)	0.060
Attitudes (total score)	−0.08 (−0.63, 0.46)	0.741	0.15 (−1.37, 1.67)	0.828	0.15 (−1.37, 1.67)	0.828	−6 (−45, 33)	0.753
Agreement	−0.41 (−2.87, 2.06)	0.721	1.56 (−2.08, 5.19)	0.362	1.56 (−2.08, 5.19)	0.362	6 (−15, 28)	0.534
Self-efficacy or self-confidence	0.02 (−0.92, 0.97)	0.957	−0.59 (−2.97, 1.8)	0.597	−0.59 (−2.97, 1.8)	0.597	−2 (−65, 61)	0.950
Motivation	−0.03 (−1.22, 1.16)	0.961	−0.06 (−2.54, 2.42)	0.957	−0.1 (−2.54, 2.42)	0.957	−22 (−93, 48)	0.519
Outcome expectancy	−2.81 (−5.81, 0.2)	0.064	3.31 (−3.31, 9.93)	0.292	3.31 (−3.31, 9.93)	0.292	205 (−258, 667)	0.368
Environment factors	−0.68 (−2.14, 0.78)	0.322	−2.16 (−5.42, 1.11)	0.172	−2.16 (−5.42, 1.11)	0.172	−81 (−214, 51)	0.216
Patient or patient's family request	−0.81 (−3.47, 1.85)	0.513	−4.17 (−10.83, 2.48)	0.192	−4.17 (−10.83, 2.48)	0.192	−77 (−328, 175)	0.532
Budget limitations	−1.37 (−3.95, 1.22)	0.266	−4.04 (−10.22, 2.14)	0.176	−4.04 (−10.22, 2.14)	0.176	−199 (−436, 38)	0.095

patients was only found in Vietnam [guideline adherence: β: −0.55 (−1.08, −0.03); $p = 0.038$; guideline knowledge: β: −1.01 (−1.9, −0.13); $p = 0.027$] after adjusting for age, specialty, and number of hospitalized COVID-19 cases (Table 4). In Indonesia, the significant relationship between guideline adherence and mortality of COVID-19 patients remained strong (β: −14 (−27, −1); $p = 0.033$) after adjusting for age, specialty, and number of hospitalized COVID-19 cases (Table 4).

4. Discussion

Our study results indicated that adherence to guidelines, particularly guideline knowledge, was associated with the length of hospital stay in critically ill patients and their mortality due to COVID-19. These results agreed with recent studies showing that adherence to guidelines by practitioners improved the health outcomes and survival rates of cancer patients [22,23]. Despite continuous efforts to improve doctors' guideline adherence, guideline nonadherence is still a major concern across all medical fields [24]. Guideline nonadherence is often intentional and supported by valid reasons, such as applicability of guidelines, lack of agreement with guideline recommendations, contraindications, and patient preferences [25]. Our results indicated that the key barrier for doctors' guideline adherence was a lack of nutritional knowledge, not attitudes (e.g., feeling stress) or environmental factors (e.g., budget concerns). Almost half of participants (Vietnam: 48%, Indonesia: 42%) thought there was a lack of clear COVID-19 nutritional guidelines as well as a lack of self-efficacy/self-confidence in performing medical nutritional therapy (Vietnam: 56%, Indonesia: 42%). Hence, inadequate nutritional education and knowledge, together with a lack of agreement on guideline recommendations, are likely to explain doctors' guideline nonadherence for COVID-19 patients. The importance of adequate nutritional support cannot be underestimated, since supportive care appears as first-line treatment and COVID-19 patients may develop malnutrition during hospitalization [26,27]. Our study highlights the need for healthcare organizations to implement nutritional education curriculum initiatives that might improve doctors' adherence to nutritional guidelines and benefit the healthy outcomes of hospitalized COVID-19 patients.

The current study also found that Vietnamese doctors exhibited better guideline adherence than Indonesian doctors, which may be explained by differences in institutional structures of the healthcare systems and COVID-19 severity. Indonesia is one of the country's most highly affected by COVID-19, with a high case-fatality ratio (3.0% per 100 confirmed cases) [18,19]. This suggests that Indonesia is facing severe capacity constraints, and there is a continual need to enhance critical care capacity. In contrast, Vietnam has had only 1651 coronavirus cases and 35 deaths (data through December 31, 2020). It is tempting to assume that Indonesian doctors have been overwhelmed by the COVID-19 pandemic, making it difficult to adhere to nutritional guidelines in clinical practice [28]. Another potential factor contributing to regional differences in guideline adherence is the specialty of the doctors, which may be related to differences in the healthcare systems. Our study found that compared to other specialties (e.g., pulmonary/infectious disease), ICU doctors exhibited the best guideline adherence due in part to better nutritional knowledge. Since 86.6% of ICU doctors who participated in the current study were Vietnamese doctors, national differences in guideline adherence and guideline knowledge are likely to be influenced by a doctor's specialization. In Indonesia's healthcare system, doctors who care for critically ill patients specialized in pulmonary or infectious disease, not ICU care, and dietitians, not physicians, are in charge of nutritional support for ICU patients. In contrast, Vietnamese doctors are the ones in charge of nutritional therapy for ICU patients. Hence, the lack of nutrition knowledge among Indonesian participants can likely be explained by differences in the institutional structures of the healthcare systems. Nutritional support is an integral part of COVID-19 treatment, especially in those who are critically ill [29]. Managing nutritional

Table 4
Adjusted multivariate regression coefficients (β) and 95% confidence intervals (95% CIs) for length of stay in hospitalized COVID-19 patients stratified by country treated by the study doctors ($N = 51$).

Variable	Length of stay (mean days)[a]						Mortality	*p*-value
	Mild and moderate illness	*p*-value	Severe illness	*p*-value	Critical illness	*p*-value		
Indonesia								
Total adherence score	0.24 (−0.11, 0.6)	0.158	0.31 (−0.05, 0.68)	0.086	0.32 (−1.01, 1.66)	0.461	−14 (−27, −1)	0.033
Knowledge (total score)	0.43 (−0.27, 1.12)	0.201	0.65 (−0.44, 1.75)	0.21	0.21 (−1.86, 2.27)	0.82	−31 (−54, −9)	0.01
Guideline awareness	0.64 (−0.51, 1.8)	0.247	0.32 (−1.01, 1.66)	0.585	0.42 (−3.39, 4.22)	0.803	−55 (−89, −21)	0.004
Guideline familiarity	0.11 (−0.99, 1.21)	0.829	0.91 (−0.79, 2.61)	0.245	0.16 (−2.69, 3.01)	0.898	−36 (−85, 14)	0.144
Attitudes (total score)	0.17 (−0.22, 0.57)	0.355	0.21 (−0.32, 0.73)	0.401	0.43 (−0.25, 1.11)	0.19	−10 (−29, 10)	0.304
Agreement	0.61 (−3.63, 4.85)	0.76	0.13 (−0.46, 0.73)	0.456	1.31 (−7.61, 10.23)	0.175	−50 (−230, 130)	0.563
Self-efficacy or self-confidence	0.44 (−0.22, 1.09)	0.174	0.33 (−0.6, 1.26)	0.458	0.79 (−0.42, 2.00)	0.179	−24 (−56, 8)	0.13
Motivation	0.1 (−0.73, 0.94)	0.791	0.59 (−0.46, 1.64)	0.208	0.37 (−1.28, 2.03)	0.618	−6 (−47, 34)	0.739
Outcome expectancy	−0.67 (−3.72, 2.39)	0.653	NA		NA		−50 (−230, 130)	0.563
Environment factors	−1.81 (−4.23, 0.61)	0.132	−1.54 (−4.26, 1.18)	0.228	−2.35 (−5.67, 0.97)	0.128	−84 (−187, 19)	0.103
Patient or patient's family request	−1.05 (−3.63, 1.53)	0.404	−3.23 (−8.05, 1.59)	0.161	−3.72 (−11.41, 3.97)	0.297	−99 (−289, 92)	0.284
Budget limitations	−1.19 (−5.41, 3.04)	0.558	−2.78 (−8.21, 2.66)	0.246	−2.55 (−9.68, 4.59)	0.401	−138 (−307, 31)	0.102
Vietnam								
Total adherence score	−0.14 (−0.43, 0.15)	0.303	−0.26 (−0.99, 0.48)	0.457	−0.55 (−1.08, −0.03)	0.038	NA	
Knowledge (total score)	−0.39 (−0.97, 0.19)	0.165	−0.6 (−1.85, 0.65)	0.308	−1.01 (−1.9, −0.13)	0.027	NA	
Guideline awareness	−0.56 (−1.63, 0.51)	0.274	−0.85 (−3.28, 1.57)	0.451	−1.29 (−2.78, 0.2)	0.085	NA	
Guideline familiarity	−0.33 (−1.00, 0.34)	0.293	−0.48 (−2.06, 1.1)	0.513	−0.92 (−2.21, 0.37)	0.153	NA	
Attitudes (total score)	−0.08 (−0.63, 0.46)	0.741	0.15 (−1.37, 1.67)	0.828	0.02 (−1.19, 1.23)	0.974	NA	
Agreement	−0.41 (−2.87, 2.06)	0.721	1.56 (−2.08, 5.19)	0.362	2.49 (−0.58, 5.55)	0.105	NA	
Self-efficacy or self-confidence	0.02 (−0.92, 0.97)	0.957	−0.59 (−2.97, 1.8)	0.597	−0.12 (−1.94, 1.69)	0.885	NA	
Motivation	−0.03 (−1.22, 1.16)	0.961	−0.06 (−2.54, 2.42)	0.957	−1.16 (−2.77, 0.45)	0.149	NA	
Outcome expectancy	−2.81 (−5.81, 0.20)	0.064	3.31 (−3.31, 9.93)	0.292	−0.04 (−5.53, 5.46)	0.989	NA	
Environment factors	−0.68 (−2.14, 0.78)	0.322	−2.16 (−5.42, 1.11)	0.172	−1.53 (−3.97, 0.91)	0.200	NA	
Patient or patient's family request	−0.81 (−3.47, 1.85)	0.513	−4.17 (−10.83, 2.48)	0.192	−2.8 (−7.62, 2.02)	0.233	NA	
Budget limitations	−1.37 (−3.95, 1.22)	0.266	−4.04 (−10.22, 2.14)	0.176	−2.81 (−7.39, 1.78)	0.210	NA	

[a] Results were adjusted for age, specialization, and number of hospitalized COVID-19 patients.

support in critically ill patients requires specific knowledge and skills to prevent poor clinical outcomes [30]. This may explain our results indicating that doctors who specialized in ICU care had the highest scores of guideline adherence and guideline knowledge. However, we also found that ICU doctors had lower outcome expectations toward nutritional therapy for hospitalized COVID-19 patients. This is consistent with a study by Ami et al., which showed that there was a lack of outcome expectancy among ICU physicians regarding the initiation and management of nutrition in ICU patients, but not in the Covid-19 setting [31]. In addition, the current study found that 94% of ICU doctors reported “feeling stress when performing nutritional care for hospitalized COVID-19 patients”. With the ongoing pandemic, healthcare workers are burned out and suffering from psychological symptoms (e.g., depression, anxiety, and insomnia), which may affect their motivation to implement nutritional guidelines [32,33]. The COVID-19 pandemic has increased burnout symptoms in ICU professionals [34]. Higher burnout rates were also reported among Turkish ICU professionals, who were in the front line combating COVID-19 [35].

A lack of nutritional education in medical training has been underscored as a major obstacle for doctors performing nutritional care [36,37]. The current study found that Indonesian and Vietnamese doctors only received one or two nutrition credits in their medical curriculum. Another study revealed that doctors are less likely to include nutritional support in their care plans if they have inadequate nutritional knowledge or low confidence in nutritional therapy [38]. We found that nearly half (49%) of doctors we questioned felt a lack of self-efficacy/self-confidence in performing medical nutritional therapy for hospitalized COVID-19 patients despite agreeing (100%) on the role of nutritional support in COVID-19 patients. Our results are consistent with numerous studies reporting that doctors agreed on the importance of nutritional therapy but did not feel comfortable or adequately prepared to provide nutritional counseling to their patients [39–41]. For example, it was reported that nutritional counseling occurred in only one-fourth of all office visits to Australian physicians, although most of the physicians felt it was their responsibility to provide nutritional counseling [41]. Doctors' nutritional knowledge can be improved by incorporating more nutritional education during their medical training or implementing nutrition educational curriculum initiatives at the institution level (e.g., hospitals) [20].

The strength of this study includes its novelty, being the first to investigate barriers affecting doctors' nutritional guideline adherence in COVID-19 patients, and being a multinational survey of countries facing high and low numbers of COVID-19 cases. The present study also had several limitations. First, there was a relatively small sample size ($n = 51$) of only two countries in Southeast Asia. We recognized that our study with small sample size may not provide a complete picture of nutrition practice in Indonesia and Vietnam or other countries during Covid-19 outbreak. The low response rate in our study is, due in part, to the exclusion of doctors who never performed nutritional care for hospitalized Covid-19 patients and the high workload of doctors in the pandemic. The study was conducted at the second wave of the outbreak in Vietnam when the number of patients, symptomatic patients, and deaths was limited. Moreover, Indonesian hospitals are overwhelmed by COVID-19 that makes doctors refuse to do our survey. Second, limitations of online surveys have been noted and extensively discussed potential issues such as response bias and interpretation must be taken into account [15]. The major strengths of the online survey were its cost-effectiveness and the fact that it could be conducted in a short period of time with no regional restrictions; however, there are concerns with internet accessibility, a lack of controlled sampling, response rates, and ethical issues (e.g., consent, anonymity, confidentiality) [15]. Nonetheless, an online survey was likely the best solution to collect data in the context of social distancing and nationwide lockdowns during the COVID-19 pandemic. Considering the limitation of qualitative research and exploratory study during

pandemic, we couldn't assess the standard of care of treatment in the different clinical settings as well as which targets were used by the doctors when delivering nutritional care, hence it is not easy to give strength to the observed differences between groups. Moreover, our study provided insight into doctor's adherence to current Covid-19 nutritional guidelines, we acknowledged that this statement does not necessarily reflect implementation of nutritional care. Respondents may have interpreted the definitions of guidelines, protocols and clinical pathways differently. While we found statistically significant relationship between guideline adherence and clinical outcome, the nature and extent of these differences in practice and their influence on clinician adherence to guidelines remains uncertain. Considering the limitations of self-administered survey methods, enriched understanding of these issues could be obtained through qualitative research.

5. Conclusions

Our study revealed that inadequate nutritional guideline knowledge was a key barrier to guideline adherence among doctors. Guideline adherence may affect doctors' confidence in providing nutritional care and may predict clinical outcomes in hospitalized COVID-19 patients. Guideline nonadherence is an international phenomenon and may be related to institutional structures of healthcare systems, the severity of COVID-19, and a lack of agreement with guideline recommendations.

Ethical approval and consent to participate

This study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board (or Ethics Committee) of Alma Alta University, Indonesia (protocol code KE/AA/XI/10323/EC/2020).

Informed consent was obtained from all subjects involved in the study.

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Author contributions to the manuscript

D-K-N Ho and J-S Chang contributed to the conception and design of the research; A Faradina, E Nurwanti, Y-K Chang and H Hadi contributed to the design of the research; D-K-N Ho, H-S Nguyen, T-D Dang, and D-F Irnandi contributed to the acquisition and analysis of the data; B-S Wiratama, A-A Tinkov, A-V Skalny and J-S Chang contributed to the interpretation of the data; and D-K-N Ho and J-S Chang drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

Consent for publication

Not applicable.

Availability of supporting data

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

The authors declare that no competing interests exist.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2021.09.003.

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