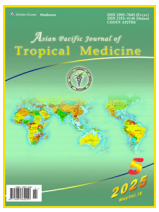

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Determinants of COVID-19 vaccine booster hesitancy among outpatients completing the primary scheme in Turkey

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ABSTRACT

Objective: To examine the change in COVID-19 booster vaccine hesitancy according to descriptive characteristics, characteristics related to COVID-19, health literacy (HL) skills related to booster dose.

Methods: The inclusion criterion was the completion of the primary scheme as two doses of COVID-19 vaccine. The study was conducted in January 2022 by applying face-to-face interview technique. Questions regarding HL were used to question the ability of individuals to access, understand, interpret and use information regarding the COVID-19 booster dose in their decisions.

Results: A total of 1210 people were included in this study with an mean age of (41.3±16.6) years, and 51.4% were women. In multivariate analysis, hesitation increased in the "moderately concerned" (a*OR* 2.65, 95% *CI* 1.09-6.45), "slightly concerned" (a*OR* 3.01, 95% *CI* 1.26-7.19) , "not concerned at all" (a*OR* 5.69, 95% *CI* 2.27-14.28) groups compared to the group "extremely concerned" about COVID-19 transmission. Those with Sinovac-CoronaVac as their most recent vaccine had increased hesitation compared to those with Pfizer-BioNTech (a*OR* 3.68, 95% *CI* 2.05-6.61). The effect of HL skills including "accessing", "understanding", and "appraising" information on hesitation was not statistically significant (P>0.05). HL skill of "applying" was assessed with ability of information to help decision making. Whether the information is helpful for decision-making, the risk of hesitancy increased for those who stated that it "sometimes helps" (a*OR* 2.55; 95% *CI* 1.31-4.99) and "never helps" (a*OR* 11.62; 95% *CI* 3.03-44.58) compared to those who stated that it "always helps".

Conclusions: The increased propability of hesitation in those less concerned about COVID-19 transmission shows the importance of appropriately guiding individuals' concern levels with a health communication strategy based on risk communication. The fact that the only HL skill with a significant effect in the multivariate model was "applying", shows the critical role of this skill in influencing behavioral changes.

KEYWORDS: COVID-19; Vaccine hesitancy; Booster hesitancy; Health literacy; Risk communication

1. Introduction

COVID-19 vaccines have been essential in preventing severe illness and death and have also helped safeguard health systems during the pandemic[1]. On the other hand, vaccine hesitancy was a problem that should be a struggle amid pandemic management[2]. Vaccine

Summary

Question: What are the factors including different health literacy skills related with COVID-19 vaccine booster hesitancy?

Findings: The COVID-19 booster vaccine hesitancy was 9% (109/1210) for all study participants. The hesitation increased in those with "moderately" or milder concerns of COVID-19 contagion, those whose last implemented COVID-19 vaccine was Sinovac-CoronaVac and those who reported that the information provided "sometimes" and "never" helped decision-making.

Meaning: Promotion of health literacy skill could be helpful in combating COVID-19 booster vaccine hesitancy.

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hesitancy is defined as a delay in acceptance or refusal of vaccination despite the availability of vaccination services[3]. It is complex and context specific, varying across time, place, vaccines, and socio-demographic variables[2,4]. The Strategic Advisory Group of Experts on Immunization (SAGE) working group on vaccine hesitancy recommended that monitoring, diagnosing, and segmenting issues that significantly contribute to vaccine hesitancy need to be the initial step[4].

Following vaccination, a person's serum antibody levels gradually drop. Furthermore, as SARS-CoV-2 evolves over time, more contagious variants are becoming more prevalent[5]. COVID-19 booster dose was suggested by the World Health Organization (WHO), because it decreases hospitalization and deaths[6]. Vaccine hesitancy remains a problem for the booster dose as well. It has been suggested that factors driving vaccine booster hesitancy may differ from hesitancy toward the initial COVID-19 vaccine[7]. Factors that were found related to COVID-19 booster vaccine hesitancy are side effects experienced after previous doses, concerns about adverse reactions, thinking that a booster dose is unnecessary, level of knowledge regarding COVID-19, opinion about the efficacy of the COVID-19 vaccine[5,7-10]. However, the majority of studies on this subject include people who have never been vaccinated, or those who have just received one dose of vaccine. Studies on the factors affecting COVID-19 booster vaccine hesitancy, especially among two dose vaccinated individuals, are limited[5,8].

Health literacy (HL) covers the skills of accessing/understanding/evaluating/applying health information to make decisions[11]. Insufficient HL was also an important public health issue in the worldwide including developed countries before the pandemic[12]. Pandemic conditions forced people to acquire and apply health information. The COVID-19 infodemic has brought attention to the underappreciated worldwide public health issue of insufficient HL among a population[13].

There are studies that have found insufficient HL is a risk factor for COVID-19 vaccine hesitancy[17]. Fewer studies investigated HL's relationship with COVID-19 booster hesitancy[7,15]. It is highlighted the need for effective communication strategies to increase vaccination uptake[4,7]. There are several intervention studies regarding COVID-19 vaccine uptake; however, it has been stated that there is a research gap in low and middle-income countries regarding studies investigating interventions[16]. Determination of the characteristics of relationships between HL skills and COVID-19 booster vaccine hesitancy in Turkey can be useful for communication intervention studies regarding vaccine acceptance in general that will be implemented, especially in developing countries.

In Turkey, COVID-19 booster dose vaccination was implemented on a schedule prioritizing risk groups and started on 30 June 2021 for people over 50 years of age and healthcare workers[17]. On 11 November 2021, everyone over the age of 18 was covered by the third dose of vaccination[18]. The Omicron variant was reported for the first time in Turkey on 10 December 2021[19]. Data for this study were collected in January 2022, approximately 6 months after booster vaccination was first introduced, approximately 2 months after booster vaccination was extended to the entire population over 18 years of age, and approximately 1 month after the emergence of the Omicron variant in the country. We believe that this calendar helps us to collect up-to-date data for our study.

This study aims to investigate the changes in COVID-19 booster dose hesitancy according to some factors, including descriptive characteristics, some characteristics regarding COVID-19, and HL skills regarding information on the booster COVID-19 vaccine, which include accessing, understanding, appraising, and applying.

2. Methods

2.1. Sampling

The population of this study is people over the age of 18 years who applied for any reason to different tertiary health care outpatient units except for emergency services in the Gazi University Hospital in Ankara, the capital city of Turkey, on 24-28 January 2022.

We have used Open Epi for the calculation of sample size, and the total number of applications for outpatient clinics was used as the study population. Other parameters used in sampling are excepted prevalence as 50%, margin of error as 3%, design effect as 1%, confidence interval 95%, and substitution rate as 25%. Finally, we achieved an expected sample size of 1 280. The inclusion criterion for this study are those who complete the primary scheme as two doses of COVID-19 vaccine and over 18 years. Those excluded from the study are those who were not included in the data set due to inconsistent answers during data analysis. Participants were selected from the people who applied to the outpatients with the convenience sampling method.

2.2. Implementation

This is a study whose epidemiological type is descriptive. Face-to-face interviews were used to obtain the data in 24-28 January 2022. We finally included 1 210 people in this study. Although the number of participants was below the expected sample size of 1280 including substitution rate, it was above the required sample size of 1 024 (Figure 1).

Written administrative approval for the study was obtained from the chief physician of Gazi University Medical Faculty Hospital.

2.3. Data

One of the question groups was related to descriptive characteristics such as age, sex, education status, household income, and chronic disease. Other of the question groups were some characteristics regarding COVID-19, such as concern about COVID-19 contagion, having had a COVID-19, the last COVID-19 vaccine that was implemented, having experienced at least one side effect after COVID-19 vaccination, hearing the Omicron variant.

The last question group was related to HL. We didn't prefer using any HL scale. Because we wanted to query HL skills specifically related to the COVID-19 booster dose, not HL skills in general. Four separate questions were used to investigate different HL skills. These questions were prepared based on the four components of Sorensen's HL matrix, each corresponding to a different HL skill[20]. Likert-type questions with five options are related to accessing, understanding, appraising, and applying health information related to COVID-19 booster dose. There were questions about how often they could access information about the booster dose of COVID-19 vaccine, how often they could understand this information, and how often they could appraise it. The skill related to applying was assessed with a question asking how often the information helps in decision-making.

The situation of those who will not receive the 3rd dose of vaccine and those who are undecided about this issue is considered vaccine hesitancy[3].

2.4. Statistical analysis

We have used the *Chi*-square test in the bivariate analysis. We have created a logistic regression model of factors related to COVID-19 booster dose hesitancy.

The type 1 error level was set at 0.05. Age and sex were included in the multivariate model since they were the variables recommended to be included in the model at the beginning[24]. For other variables, the logistic regression model used variables with a *P*-value less than 0.25 in the bivariate analysis. We used “backward” as a variable selection method while creating the regression model. SPSS version 22.0 was used for statistical analysis.

Variables included by the logistic regression model are age groups (ref: 18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65 years), sex (ref: female), educational levels (ref: postgraduate education), household income levels (ref: income is quite less than my expenses), category of concern of COVID-19 contagion (ref: extremely), have had a COVID-19 (ref: no), last COVID-19 vaccine implemented (ref: Pfizer BioNTech), heard about the Omicron variant (ref: yes), and HL skills questions (ref: always). Among the people who answered "never" to the question about accessing information related to booster dose, no one indicated hesitations about the vaccine. Therefore, the variable associated with this question was not included in the logistic regression model.

2.5. Ethical approval

The Gazi University Ethics Committee approved the study with Research Code No: 2022–270 at the 20th January 2022. Since the study was conducted using a face-to-face interview method, participants were verbally informed about the study and their verbal permissions were obtained before the interview. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

3. Results

A total of 1 210 people were included in this study with an mean age of (41.3±16.6) years, and 51.4% were women (Figure 1). Booster dose hesitancy rate was 9% (109/1 210) for all study participants. The reasons for not getting a booster dose vaccine were “thinking that one or two doses were sufficient” (46.8%, 51/109), “thinking that the side effects were too many” (29.4%, 32/109), “thinking that natural immunity was sufficient” (16.5%, 18/109), “presence of comorbidities” (9.2%, 10/109), “thinking that the pandemic was over” (7.3%, 8/109), “not wanting to get a vaccine because it was not compulsory” (6.4%, 7/109), and “not wanting to get vaccines from different companies” (2.8%, 3/109).

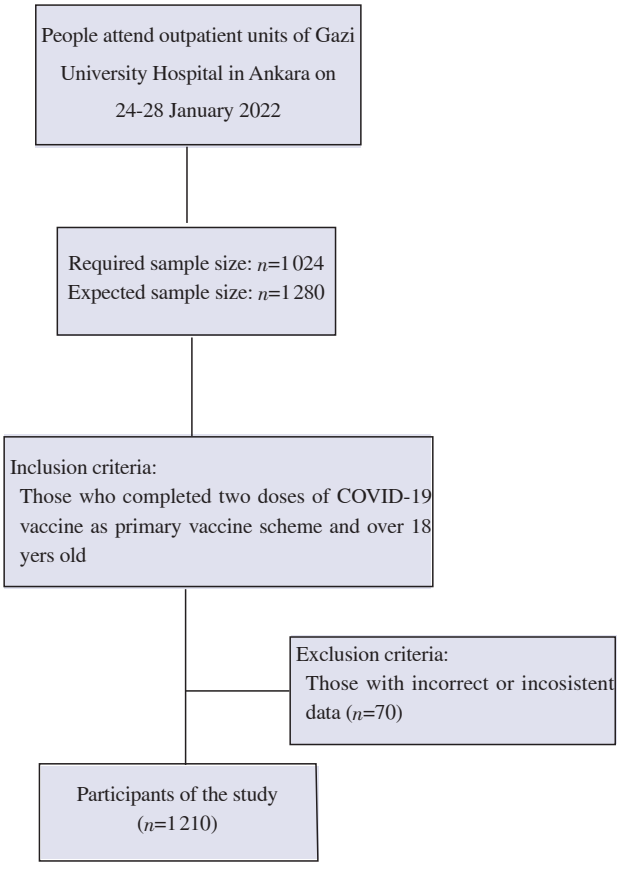

Figure 1. Study flowchart.

Table 1. Changing of hesitancy of booster dose according to descriptive characteristics and some characteristics regarding COVID-19 [*n* (%)].

Category	Total	Hesitancy of booster dose*	*P*#
Age, years			0.063
18-24	225 (18.6)	15 (6.7)	
25-34	269 (22.2)	27 (10.0)	
35-44	209 (17.3)	23 (11.0)	
45-54	227 (18.8)	28 (12.3)	
55-64	173 (14.3)	12 (6.9)	
≥65	107 (8.8)	4 (3.7)	
Sex			0.551
Female	622 (51.4)	59 (9.5)	
Male	588 (48.6)	50 (8.5)	
Educational level			0.005
Did not graduate from any school	29 (2.4)	5 (17.2)	
Primary school	140 (11.6)	23 (16.4)	
Secondary school	77 (6.4)	7 (9.1)	
High school	321 (26.5)	30 (9.3)	
University	492 (40.7)	37 (7.5)	
Postgraduate education	151 (12.5)	7 (4.6)	
Household income level			0.044
Income is quite less than my expenses	57 (4.7)	7 (12.3)	
Income is a little less than my expenses	258 (21.3)	33 (12.8)	
Income is equal to my expenses	548 (45.3)	44 (8.0)	
Income is a little more than my expenses	271 (22.4)	16 (5.9)	
Income is quite more than my expenses	76 (6.3)	9 (11.8)	
Have a chronic disease			0.289
Yes	445 (36.8)	35 (7.9)	
No	765 (63.2)	74 (9.7)	
Concern of COVID-19 contagion			<0.001
Not at all	105 (8.7)	21 (20.0)	
Slightly	194 (16.0)	27 (13.9)	
Moderately	196 (16.2)	22 (11.2)	
Quite a bit	444 (36.7)	25 (5.6)	
Extremely	271 (22.4)	14 (5.2)	
Prior COVID-19			0.126
Yes	335 (27.7)	37 (11.0)	
No	875 (72.3)	72 (8.2)	
Last COVID-19 vaccine implemented			<0.001
Sinovac-CoronaVac	141 (11.7)	29 (20.6)	
Pfizer BioNTech	1 069 (88.3)	80 (7.5)	
Have experienced at least one side effect after vaccination			0.791
Yes	835 (69.0)	74 (8.9)	
No	375 (31.0)	35 (9.3)	
Heard about the Omicron variant			0.003
Yes	1 116 (92.2)	92 (8.2)	
No	94 (7.8)	17 (18.1)	

*: Percentages represent the proprotions of participants of the total population at the the same row; #: *P* values indicate differences among participants belong to the same category with diferent hesitancy rates.

3.1. Factors regarding COVID-19 vaccine booster hesitancy

Changing the hesitancy of booster dose according to descriptive characteristics and some features associated with COVID-19 is shown in Table 1. The highest hesitancy of booster dose was seen in those who didn't graduate from any school (17.2%) (5/29), those whose household income is quite less than expenses (12.3%) (7/57), those whose category of concern of COVID-19 contagion is "not at all" (20.0%) (21/105). Booster dose hesitancy is also high in those whose last vaccine implemented is Sinovac-CoronaVac (20.6%) (29/141), and in those who have not heard about the Omicron variant (18.1%) (17/94). There is a statistically significant difference between groups of variables mentioned in previous sentences in terms of COVID-19 booster hesitancy ($P<0.05$) (Table 1).

3.2. Relationship of health literacy skills and COVID–19 vaccine booster hesitancy

Changing hesitancy of booster dose according to skills regarding HL is shown in Table 2. The hesitation was highest in the group that can sometimes access informational resources about getting a booster dose vaccination (11.9%, 19/159). Vaccine hesitancy was higher among those who stated that they could never understand the information (25.0%, 2/8), those who reported that they could never appraise the information provided (23.1%, 3/13), and those who reported that the provided information never helped decision-making (30.8%, 4/13).

Table 3 shows the factors associated with hesitancy of booster dose in the bivariate and multivariate analysis. In the bivariate analysis, hesitancy of booster was higher in the 45-54 age group (*OR* 1.97, 95% *CI* 1.02-3.79), those who primary school graduated (*OR* 4.04, 95% *CI* 1.67-9.75), those who did not graduate from any school (*OR* 4.28, 95% *CI* 1.25-14.60), and those haven't heard about omicron variant (*OR* 2.45, 95% *CI* 1.39-4.33). The effect of these variables in the multivariate model was not statistically significant. In both the bivariate and multivariate models, the hesitation risk was higher in those with "moderately" or milder concerns of COVID-19 contagion. In the multivariate model, the risk was almost 5.7 times higher for those with "not at all" COVID-19 contagion concern than those with "extreme" (*OR* 5.69, 95% *CI* 2.27-14.27). In the bivariate and multivariate analysis, the risk of hesitation was higher in those whose last implemented COVID-19 vaccine was Sinovac-CoronaVac in the multivariate model (*OR* 3.67, 95% *CI* 2.04-6.61). Those who report never being able to appraise the information provided were at high risk of hesitation in bivariate analysis (*OR* 4.61, 95% *CI* 1.17-18.16). But the effect of this variable in the multivariate model was not statistically significant. Those who reported that the information provided "sometimes" and "never" helped decision-making had a higher risk of hesitation in the bivariate and multivariate model in the multivariate model for those who reported "never" (*OR* 11.61, 95% *CI* 3.02-44.58).

Table 2. Changing of hesitancy of booster dose according to skills regarding health literacy [*n* (%)].

Category	Total	Hesitancy of booster dose*	*P*#
Can you access informational resources about getting a booster dose vaccination?			0.088
Always	505 (47.0)	37 (7.3)	
Often	387 (36.0)	20 (5.2)	
Sometimes	159 (14.8)	19 (11.9)	
Rarely	21 (2.0)	2 (9.5)	
Never	3 (0.3)	0 (0.0)	
Can you understand the information provided about getting a booster dose vaccination?			0.069
Always	467 (43.4)	33 (7.1)	
Often	381 (35.4)	22 (5.8)	
Sometimes	178 (16.6)	15 (8.4)	
Rarely	41 (3.8)	6 (14.6)	
Never	8 (0.7)	2 (25.0)	
Can you appraise the information provided about getting a booster dose vaccination?			0.102
Always	311 (28.9)	19 (6.1)	
Often	386 (35.9)	25 (6.5)	
Sometimes	295 (27.4)	23 (7.8)	
Rarely	70 (6.5)	8 (11.4)	
Never	13 (1.2)	3 (23.1)	
Does the information provided help you decide about getting a booster dose vaccination?			<0.001
Always	409 (38.0)	18 (4.4)	
Often	412 (38.3)	29 (7.0)	
Sometimes	193 (18.0)	23 (11.9)	
Rarely	48 (4.5)	4 (8.3)	
Never	13 (1.2)	4 (30.8)	

*: Percentages represent the proprotions of participants of the total population at the the same row, #: *P* values indicate differences among participants belong to the same category with diferent hesitancy rates.

Table 3. Factors associated with hesitancy of booster dose in the bivariate and multivariate analysis.

Characteristics	Crude *OR* (95% *CI*)	a*OR* (95% *CI*)
Age, years		
18–24	Ref	Ref
25–34	1.56 (0.80–3.01)	1.49 (0.70–3.20)
35–44	1.73 (0.87–3.41)	1.44 (0.64–3.18)
45–54	1.97 (1.02–3.79)	1.77 (0.81–3.88)
55–64	1.04 (0.48–2.29)	0.65 (0.23–1.83)
≥65	0.54 (0.17–1.67)	0.23 (0.04–1.20)
Sex		
Female	Ref	
Male	0.88 (0.59–1.31)	
Educational levels		
Postgraduate education	Ref	
University	1.67 (0.73–3.83)	
High school	2.12 (0.91–4.94)	
Secondary school	2.05 (0.69–6.09)	
Primary school	4.04 (1.67–9.75)	
Did not graduate from any school	4.28 (1.25–14.60)	
Household income level		
Income is quite less than my expenses	Ref	
Income is a little less than my expenses	1.04 (0.43–2.50)	
Income is equal to my expenses	0.62 (0.26–1.45)	
Income is a little more than my expenses	0.44 (0.17–1.14)	
Income is quite more than my expenses	0.95 (0.33–2.75)	
Category of concern of COVID-19 contagion		
Extremely	Ref	Ref
Quite a bit	1.09 (0.55–2.14)	1.40 (0.60–3.22)
Moderately	2.32 (1.15–4.66)	2.65 (1.09–6.45)
Slightly	2.96 (1.51–5.82)	3.01 (1.26–7.18)
Not at all	4.58 (2.23–9.42)	5.69 (2.27–14.27)
Have had a COVID-19		
No	Ref	
Yes	1.38 (0.91–2.10)	
Last COVID-19 vaccine implemented		
Pfizer BioNTech	Ref	Ref
Sinovac-CoronaVac	3.20 (2.00–5.10)	3.67 (2.04–6.61)
Heard about Omicron variant		
Yes	Ref	Ref
No	2.45 (1.39–4.33)	2.58 (0.98–6.80)
Accessing information about booster dose		
Always	Ref	
Often	0.68 (0.39–1.20)	
Sometimes	1.71 (0.95–3.08)	
Rarely	1.33 (0.29–5.93)	
Never	NA	
Understanding the information provided		
Always	Ref	
Often	0.80 (0.46–1.40)	
Sometimes	1.21 (0.641–2.28)	
Rarely	2.25 (0.88–5.74)	
Never	4.38 (0.85–22.57)	
Appraising information provided		
Always	Ref	
Often	1.06 (0.57–1.97)	
Sometimes	1.30 (0.69–2.43)	
Rarely	1.98 (0.83–4.73)	
Never	4.61 (1.17–18.16)	
Helping make a decision		
Always	Ref	Ref
Often	1.64 (0.89–3.01)	1.59 (0.85–2.99)
Sometimes	2.93 (1.54–5.58)	2.55 (1.30–4.99)
Rarely	1.97 (0.64–6.09)	1.40 (0.43–4.57)
Never	9.65 (2.71–34.34)	11.61 (3.02–44.58)

4. Discussion

Most essential waves of the COVID-19 pandemic have been left behind; however, the agent is still spreading and evolving. WHO recommends COVID-19 vaccination, including booster dose[6]. However, studies regarding the variables influencing COVID-19 vaccine booster hesitancy in people vaccinated with two doses are relatively limited[9]. It is stated that strategies for vaccine promotion should be tailored[22]. Therefore, we need to know specific factors related to booster hesitancy for developing health promotion programs aiming to increase the uptake of vaccination.

We found that the COVID-19 vaccine booster booster hesitancy rate is only 9% (109/210). This rate may have been low because the study was conducted on people who received two vaccine doses. Another reason for the low rate may be that the study was conducted in patients who applied to the 3rd level outpatient health service. According to the latest data released by the Ministry of Health for Turkey, the booster dose vaccination rate is 41.8%, and the 2nd dose vaccination rate is 85.7%[6]. Studies including people who had received two doses found that booster hesitancy varies over a wide range; it is 2.1% in Japan[8], 29% in Poland[5], and 30.5% in Singapore[23]. One of the critical points is that because people's attitudes toward vaccination changed throughout the pandemic, where and when the data was taken may impact the findings on the prevalence of vaccine hesitancy[22]. This factor limits effective comparison hesitancy rates of COVID-19 booster dose.

We found that the most frequently reported reasons for booster hesitancy are “thinking that one or two doses were sufficient” (46.8%) (51/109), and “thinking that the side effects were too many” (29.4%) (32/109). Concerning or experiences regarding side effects (49.2% in Poland and 57.7% in Japan), opinion with booster dose is unnecessary (39.5% in Poland and 25% in Japan) are the most declared reasons for booster hesitancy, according to studies that including two doses vaccinated person similar to our work[6, 9]. The fact that the side effect remains a reason for hesitation in people vaccinated with two doses suggests that the reasons for hesitation that apply to the previous doses may still apply to the booster dose. The belief that the first two doses were sufficient is a cause for hesitation suggests that new reasons for hesitation may arise with the booster dose. The third dose hesitation becomes more complex due to existing and newly added factors[10].

4.1. COVID–19 vaccine booster hesitancy and descriptive characteristics

Regarding age group, we only found increasing risk for 45-54 years group in bivariate analysis; no significant effect of age was found in the multivariate model for hesitancy. Some studies found an increased risk of booster hesitancy for different age groups, such as under 50 years[5] and 18-44 years[24], in bivariate analysis, but no effect of age group was found in multivariate analysis. However, an example of a study found that younger age is a risk factor in the multivariate model[8]. Studies imply that younger age groups may be a risk factor. It was suggested that young people's high vaccine hesitancy is likely due to their lack of interest in immunization or sickness, and their attitude is more subjective to others'[22].

We haven’t found statistically significant differences by sex for booster hesitancy. Similar to our study, no difference was found in terms of gender in most studies[8,15,23-25]. Although some studies found the risk higher in women[26] or men[5,7], they only determined the relationship for bivariate analysis.

We have found increased risk for at least two educated groups in bivariate analysis. But, education is not considered a risk factor in the multivariate analysis. Cross-sectional studies implemented in the USA and China have found that booster hesitancy is high in lower educational levels in the bivariate comparison[7,9]. On the other hand, some studies have found opposite results indicating that higher educational groups have an increased risk for booster hesitancy in the bivariate[15,26] or multivariate analysis[23]. There were also studies that found that education doesn't have a significant effect[5,24]. These results show that the relationship between determining factors and vaccine hesitancy may vary depending on society. The fact that the relationship between vaccination and education level can be positive or negative shows the complex nature of the problem of vaccine hesitancy. In addition to easier access to information for higher education groups, their greater exposure to the infodemic may also play a role in the emergence of this complex relationship.

The two groups with the highest vaccine booster hesitancy are the two lowest-income groups. We found a difference between income groups only in bivariate analysis, and there appears to be a roughly U-shaped relationship between income groups and hesitancy. Some studies have found that lower-income groups have an increased risk for hesitancy in the bivariate analysis[9,15]. These results show that vaccine hesitancy can also be a health inequalities issue.

4.2. COVID–19 booster hesitancy and some characteristics regarding COVID–19

We observed a 20.6% hesitation in those who received their last vaccine from Sinovac-CoronaVac and a 7.5% hesitation in those who received their last vaccine from Pfizer BioNTech. Those whose last implemented vaccine is Sinovac-CoronaVac have a higher level for hesitancy in the multivariate model (*OR* 3.67, 95% *CI* 2.04-6.61). Sinovac-CoronaVac has been used in vaccination campaigns in various countries in Asia, South America, Central America, and Eastern Europe[17]. Sinovac-CoronaVac was the first vaccine to receive emergency use approval in Turkey, and vaccination was initiated by prioritizing risk groups with buy vaccine. This indicates

that the population at risk for booster hesitation in Turkey may be large and vulnerable.

In a study in Poland, similar to our study, including people who received two doses of vaccine, the lowest booster COVID-19 hesitancy was found in those whose last vaccine was AstraZeneca (17.7%), and the highest hesitancy rate was found in those whose last vaccine was Janssen Johnson & Johnson (73.3%). For Pfizer BioNTech, this is 27.3%[5]. A study conducted in China found that the risk of hesitancy was slightly higher in those whose last vaccine was Sinovac-CoronaVac[10]. In studies involving the whole population, as expected, booster hesitation was found to be higher in those who had never been vaccinated[7,9]. Since booster hesitation may vary depending on the status of first and second-dose vaccines and the most recently used vaccine, these parameters should be considered in studies aiming to increase the booster dose.

Bivariate and multivariate models show that the risk of booster hesitation is higher in groups with a moderate or lower COVID-19 contagion concern category. Other studies have also found lower COVID-19 threat perception[23], or lower perceived susceptibility related to COVID-19 booster hesitancy in the multivariate analysis[9]. The COVID-19 hesitancy studies, which were not booster dose-specific, also found that hesitancy increased as perceived risk for contagion decreased[25,27]. Informing the society of a negative outcome and the probability that the outcomes will occur is one of the main functions of risk communication[28]. Results suggest that within the framework of a health communication strategy based on a risk communication approach, mass communication activities aimed at guiding the threat perception of individuals may be more effective. In our study, the fact that experiencing side effects in the statistical analysis was not effective on vaccine hesitancy and that there are samples that found the same result in studies with the same setup as us can be seen as an advantage[8]. However, according to our results and some non-dose specific studies, the side effect is among the most frequently indicated reason for hesitancy[29,30]. It may be useful to inform those who are booster hesitant about vaccination by questioning their side effect history regarding previous doses.

Omicron, announced by World Health Organization on November 26th 2021, and other variants are potentials for changings in the trajectory of the COVID-19 pandemic[6]. Hesitancy is 2.45 times higher in those who haven't heard Omicron variant in the bivariate analysis, but it has no effect on the model in multivariate analysis. Increased hesitancy risk for those who have not heard variants can be important, because variants can cause changes in the severity of disease, and the efficiency of vaccines.

4.3. COVID-19 vaccine booster hesitancy and health literacy skills

Before the COVID-19 pandemic, studies were needed to investigate the relationship between HL and vaccine hesitancy by determining the level of HL with different measurement methods[34]. With the pandemic, especially as new COVID-19 variants continue to emerge, the need for further research on the relationship between HL and vaccine booster hesitancy continues[32].

A study that used HL scale that was developed by considering the Sorensen model shows that inadequate and problematic health literacy was 30.9% and 38%, respectively in Turkey[33]. According to the last European Health Literacy Survey, including 17 countries problematic HL is 33%, and inadequate HL is 13%[37]. Unfortunately, in Turkey HL is more challenging than in developed countries. This means that the situation may be more fragile for Turkey and other countries where limited HL is high, for risky health behaviors, including vaccine hesitancy, that are affected by HL.

For HL skills regarding understanding and appraising, the frequency of booster hesitancy generally increases as one moves from the group reporting that "the information is always helpful" to the group reporting that "it is never helpful". However, in the bivariate analysis, no significant difference was found for these variables. The multivariate model shows, regarding whether information related to booster dose helps decision making, the risk of booster hesitancy increases for those who indicate that "it sometimes helps" and for those who indicate that "it never helps" compared to those who state that "it always helps".

To the best of our knowledge, we have not found any study that is exactly similar to ours, which includes only persons with two doses vaccinated and investigates the relationship between COVID-19 booster hesitancy and different HL skills. However, there are studies regarding COVID-19 hesitancy including unvaccinated, one or two doses of a vaccinated person. Different studies conducted in India and USA show that in bivariate analysis, the mean scores for functional literacy, communicative literacy, critical literacy components, and total vaccine literacy were lower in the booster hesitant group. However, in the multivariate model, the effect of HL is not statistically significant[7,15,24].

The effect of HL was also detected in COVID-19 vaccine hesitancy studies that did not focus on booster doses. In some studies that did not measure any dimension of HL, the effect of HL was found in the bivariate[35] or multivariate model[22,36]. Another studies that did not focus on booster doses and that using COVID-19 vaccine literacy scale found that low levels of interactive-critical COVID-19 vaccine literacy is risk factor for hesitation[25,37,38].

Only the question regarding applying HL has an effect on the multivariate model in our study. According to the Nutbeam model, categories of HL skills are functional, interactive, and critical HL. In this model, critical HL refers to cognitive skills, which can be applied to critically analyze information and use this to exert control over situations[11]. In a similar way, one of the dimensions of Sorensen model is related applying of health information[20]. Our results show

that specifically regarding booster COVID-19 vaccine hesitancy, it becomes clear that efforts to improve HL should include the capacity to help people make decisions. A study explored the change from intention to final decision regarding the COVID-19 vaccine have found that a significant percentage of the study population changed their mind between intention and final decision[36]. It is highlighted that major challenging is that how person can integrate information with behavior, and this point, the need for critical health literacy have emerged[39]. Our results support approaches suggesting that HL can be accepted as social vaccine to understanding and applying information regarding COVID-19[40].

One of the important point is that the relationship between HL and vaccine hesitation has a complex structure. People with lower critical HL might be less concerned about the effectiveness and side effects of the vaccines[41]. Furthermore, it may be that when vaccine distrusters have higher HL, they are more likely to choose information that matches their beliefs[42]. The complicated nature of the relationship between vaccine hesitancy and its determining factors should not be overlooked when creating solutions to the problem.

4.4. Limitations

The fact that the vaccine literacy scale was not used can be considered as a limitation of this study. On the other hand, we think that the fact that the questions related to HL were designed to evaluate different HL skills based on the Sorensen matrix and the information about the booster dose in line with the purpose of the study limited this negative effect.

A limitation of this study is that the data obtained are based on self-report. Both HL skills are assessed subjectively, and vaccination histories are not based on records.

Another important limitation of this study is that it is not representative of the general population as the participants were only from outpatient clinics of a university hospital. Furthermore, one of the structural limitation of this study is that the causality relationship cannot be clearly revealed since it is a cross-sectional study.

In conclusion, those who are less concerned about COVID-19 transmission are at increased risk of booster dose hesitation. This result reveals the importance of appropriately directing individuals' perceptions about the health threats they face within the risk communication framework.

The risk of hesitation is increased in those whose last vaccine was Sinovac-CoronaVac. This vaccine is the first vaccine to be approved for emergency use in Turkey's vaccination program, which started by prioritizing risk groups. The fact that hesitancy to receive a booster dose was higher among those who received this vaccine last time may be a clue that susceptible groups may be more prevalent and vulnerable in Turkey. On the other hand, it should be remembered that previous vaccination history, including vaccine type, may be among the influential factors for hesitation to booster vaccinations. This example shows that the factors associated with booster vaccine hesitancy may be more complex than those associated with hesitancy to first dose vaccines.

The increase in booster dose hesitation among those who reported that accessed health information was less frequently helpful in deciding to vaccinate, indicates the importance of the function of the applying component of HL skills. In studies examining the relationship between HL and health behaviors, evaluating the effects of different HL skills separately may help to illuminate the complex network of relationships better.

Health information resources must have accurate and understandable content correlated with people's HL skills. Our study shows that, beyond this, it will be important that materials used to combat vaccine hesitancy have the necessary capacity to guide people to apply appropriate health behaviors. When properly designed, initiatives to improve HL can also function as a new adjuvant for vaccines.

Conflict of interest statement

We declare that we have no conflict of interest.

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Ethical approval

The Gazi University Ethics Committee approved the study with Research Code No: 2022–270.

Authors' contributions

Conceptualization; Hakan Tüzün, Mehmet A. Özçelik; Literature searches and data extraction: Hakan Tüzün, Cansu Özbaş, Mehmet A. Özçelik; Analysis: Hakan Tüzün, Mehmet A. Özçelik; Writing and Review: Hakan Tüzün, Mehmet A. Özçelik, Cansu Özbaş; Editing: Hakan Tüzün, Mustafa N. İlhan; Supervision: Hakan Tüzün, Cansu Özbaş, Mustafa N. İlhan. All authors reviewed the manuscript and confirmed the approval of the submitted manuscript.

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