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Informed Yet Unvaccinated: Investigating COVID-19 Vaccine Hesitancy Among Syrian University Students Using the 5C Framework

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Abstract

Background: Vaccine hesitancy (VH) remains a pressing global health concern, particularly in low-resource settings, where vaccination remains the primary means of protection against infection. The urgency of this issue became evident during the COVID-19 pandemic. The present study aimed to elucidate the determinants of vaccine hesitancy among university students in medical and non-medical fields in Syria by utilizing the 5C framework (confidence, complacency, constraints, calculation, and collective responsibility). Methods: A structured interview-administered questionnaire collected responses from 4722 students at five universities in Syria. The questionnaire assessed sociodemographic factors, COVID-19 vaccination status, vaccination experience, sources of information, beliefs in vaccine-related conspiracies, attitudes toward vaccine policies and attributes, and the 5C psychological antecedents. Internal consistency and factor analysis of the Arabic 5C scale were performed to ensure construct validity. Statistical analyses included descriptive statistics, logistic regression, and multivariate multiple regression. Results: Our findings revealed that 64% of participants had not received the COVID-19 vaccine, with official sources (e.g., WHO, Ministry of Health) being the most trusted. The highest 5C score was for calculation (5.86, sd = 1.21), followed by confidence (5.29, sd = 1.26). Belief in vaccine conspiracies was common, particularly regarding profit motives and genetic modification. Only three of the 5C—complacency, calculation, and collective responsibility—significantly, predicted vaccination behavior, while all the 5C were influenced by contextual factors. Non-medical students showed significantly higher hesitancy (OR = 1.60, 95% CI [1.39–1.84, $p < 0.001$]) compared to their medical counterparts. Hesitant respondents displayed significantly, higher complacency, increased calculation, and reduced collective responsibility scores. Conspiracy beliefs eroded confidence and magnified perceived barriers, whereas trust in official sources and favorable views of the vaccine's attributes strengthened collective responsibility and acceptance. The regression models explained 2.8% to 11.2% of variance across the 5C, with collective responsibility showing the highest explanatory power (adjusted R^2 = 0.112). Conclusions: Despite high self-reported knowledge, significant

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VH persisted—a paradox that highlights the limits of information alone. Given the cross-sectional design and the modest explanatory power of the models, these recommendations are tentative. These findings highlight the need for trust-based interventions targeting populations in conflict-affected areas.

Keywords: COVID-19 vaccine hesitancy; 5C psychological model; conflict-affected settings; conspiracy beliefs; information sources; public health interventions

1. Introduction

Vaccination serves as one of the most vital and successful health approaches used to combat serious infectious diseases and stop their spread worldwide as a preventive measure [1]. However, the World Health Organization has acknowledged that one of the top ten significant global health obstacles undermining immunization efforts—especially in areas facing complex crises—is vaccine hesitancy (VH) [2]. Studies have confirmed the role of VH as an obstacle in the fight against the outbreaks of infectious diseases [3–6]. International attention to this problem has intensified after the COVID-19 pandemic in 2019, where people's reluctance to take the available vaccines resulted in a noticeable increase in fatality rates [7].

While VH is a global issue, it presents unique risks in conflict-affected settings like Syria, where systemic health failures intersect with social distrust [8]. Syria offers a particularly compelling case for studying people's reluctance toward vaccines, due to its dramatic change from a previously strong healthcare system to one facing unprecedented challenges [9–13]. Syria's healthcare situation has undergone a profound deterioration over the past decade and a half. Before 2011, the country's pharmaceutical industry was able to meet national needs [14]. This capacity has fallen sharply to less than 10%, severely affecting the availability and affordability of medicines. The war that started after the Syrian revolution and the destruction of most health sector facilities have made the country unable to deal with infectious diseases [14]. Moreover, the forced displacement of people and healthcare workers from major cities such as Aleppo, Hama, Deir ez-Zor, and Homs has caused a severe shortage of trained staff necessary for effective vaccination and health education programs [9,15,16].

During the COVID-19 pandemic in 2021 and the conflict in Syria, the governance of vaccination was fragmented. In government-controlled areas such as Damascus, Aleppo, Hama, Lattakia, and Homs, which also received internal migration from other governorates, the Ministry of Health coordinated campaigns with WHO and UNICEF [17,18]. In opposition-held areas, local health directorates, NGOs, and international partners played central roles. This fragmentation complicated trust in authorities, which varied regionally [17]. Consequently, this structural collapse means that even routine vaccination campaigns now face extraordinary logistical and personnel shortages.

The economic impact of the conflict and sanctions has been severe, as the country went through complete economic collapse for years. These economic pressures have forced the population below the poverty line, directly affecting access to healthcare and the ability to afford vaccines [19]. Above all these challenges, in February 2023 an earthquake affected the entire country, especially the already devastated and isolated northern regions (Aleppo, Idlib, AL Raqqa, Deir Al Zour, and others). This disaster further damaged the collapsed healthcare system and also killed over 50 healthcare providers, triggering a public health crisis [20–22]. These combined factors have led to a fragile health system that cannot bear the additional burden of VH, which remains the only available method to stop a disease if it

spreads throughout the country [23,24]. This was clearly highlighted by the United Nations in recent analyses emphasizing Syria's ongoing transition challenges and the critical need for strengthening the Syrian health sector [24].

Recent surveillance information reveals the consequences of these disruptions, with the reappearance of previously re-emerging infectious diseases and outbreaks, including acute watery diarrhea (AWD)/cholera, measles, and tuberculosis [25–28]. Additionally, between 2013 and 2024, Syria experienced a resurgence of polio after a long period without any reported cases [29–31]. Infant vaccination coverage in Syria has been substantially affected by the ongoing conflict. According to WHO and UNICEF estimates (2021 revision), coverage among children aged 12–23 months was around 91% for BCG, 91.7% for DTP1, 91% for DTP3, and 90.7% for HepB3. However, these national averages mask significant regional disparities, with war-affected areas experiencing considerably lower coverage due to disrupted health services, population displacement, and insecurity [32,33].

In 2021, the WHO-supported Early Warning, Alert, and Response System (EWARS) in Syria reported 158,912 consultations across the governorates for various infectious diseases. The most common morbidities were influenza-like illness (92,765 cases, 58.4%) and acute diarrhea (32,303 cases, 20.3%) [34]. Additional reported conditions included leishmaniasis (10,495 cases), severe acute respiratory infections (10,115 cases), and chickenpox (3597 cases). Furthermore, 77 suspected measles/rubella cases and 13 cases of acute flaccid paralysis were also reported, highlighting the re-emergence of vaccine-preventable diseases [34]. Despite having a network of more than 1200 health facilities in 14 governorates, the Syrian healthcare system continues to struggle to deliver services consistently. The COVID-19 pandemic has exposed these vulnerabilities more due to limited testing capacity and logistical challenges for vaccination. As the latest reported number for the COVID-19 vaccination rate in Syria was only 18.34% by March 2023 [35]. Such low coverage heightens the risk of variant emergence, threatening not only Syria but the wider Middle East and North Africa (MENA) region and other low- and middle-income countries (LMICs).

Social, religious, and cultural elements further complicate vaccine acceptance [4,36,37]. The spread of misinformation, social stigma, and beliefs—such as viewing disease as divine anger or vaccines as lethal—create additional barriers. Economic hardship compounds these attitudes by limiting access to basic preventive tools.

Considering these challenges, our 2021 survey—conducted during the most intense COVID-19 wave and before vaccines became available—assessed knowledge, attitudes, and practices among Syrians. Surprisingly, half of the 2860 well-educated respondents said they would decline a future COVID-19 vaccine [38]. While past investigations have mapped vaccine knowledge and attitudes in Syria, few have applied a validated psychological framework to reveal deeper drivers of hesitancy, particularly among educated groups. This unexpected level of VH among educated individuals showed a critical knowledge–behavior gap and underscores the need to identify the psychological antecedents of refusal.

To bridge this gap, our investigation focuses on university students from both medical and non-medical disciplines, future influential community voices. By exploring vaccine hesitancy in these educated groups, we seek to uncover the psychological, social, and contextual factors affecting VH even when information is accessible. Guided by the 5C model—confidence, complacency, constraints, calculation, and collective responsibility—we consider how prolonged economic hardship, a deteriorated healthcare system, and complex sociocultural norms uniquely shape each dimension in Syria [39]. As part of the 5C model's 'confidence' dimension, participants were specifically asked about their trust in vaccine safety, effectiveness, and whether the ministry makes decisions in the community's best interest to assess trust in health authorities during pandemics.

Findings from this work will equip health authorities and humanitarian organizations with culturally sensitive, peer-led, and trust-based strategies to enhance vaccine acceptance and strengthen public health recovery in Syria and other conflict-affected low- and middle-income countries.

2. Materials and Methods

2.1. Questionnaire

The standardized 52-item questionnaire consisted of three main sections to cover the purpose of the study and understand the reasons behind VH (available together with all other Supplementary Material on OSF: https://osf.io/ekmd8/, accessed on 16 September 2025). The first part covers the demographic data of the study participants, such as (age and gender, etc.). The second part covers information related to previous experiences with vaccines (e.g., COVID-19, polio, and tetanus, etc.) and questions to determine the impact of conspiracy mentality. The third part covers several sections, including (1) a section assessing the psychological factors influencing vaccination decisions, (2) a section studying the influence of the source of information on vaccination, (3) a section on the influence of the source or manufacturer of the vaccine, and (4) a section related to studying people's opinions about the compulsory travel document).

The section on assessing the psychological factors influencing the decision to vaccinate includes a translated version of a scale that covers the (5C): Confidence, trust in the effectiveness and safety of vaccines as well as trust in the procedures implemented by the governments and health authorities for vaccination [5], Complacency, which refers to not taking the disease seriously and therefore not vaccinating against it [39], Constraints, which relates to factors that may hinder the vaccination process, such as inability to afford the cost, availability of vaccines or geographical access to the place of vaccination [40], Calculation, which refers to the extent to which individuals seek information about the vaccine, which as a result of incorrect sources may lead to non-vaccination [41], Collective responsibility, which reflects the extent to which individuals are willing to protect others by vaccinating to reduce infection [41], adopted from Betsch et al. 2018 [39]. Each of the 5 C's was assessed with 3 questions. Responses were rated on a seven-point Likert-type scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Average scores were calculated for the items within each sub-scale, with higher scores indicating a stronger level of agreement with the corresponding psychological factor. The calculation of a total score does not reflect an absolute state of the sample's indecision towards vaccines but allows the 5C scale to be used to give an assessment of the psychological factors that influence the decision to vaccinate.

The remaining parts of the questionnaire include the sources of information used to find information about vaccines, whether official or unofficial. In addition to three questions about the extent to which the source of the vaccine or the manufacturer influences the decision to vaccinate, responses are measured on a seven-point Likert-type ascending scale, where 1 represents "No influence at all" and 7 "Strong influence".

Finally, the last part includes two questions regarding the extent to which Syrians accept the imposition of the mandatory travel document 24 h before the flight, which consists of a PCR test exclusively at centers approved by the Ministry of Health. Note that although the questionnaire included 51 items, only data related to 45 items were processed and presented in this study.

2.2. Study Design and Sampling

For data collection, interviews were conducted in five universities located in four different Syrian governorates: Damascus University, Aleppo University, Hama Univer-

sity, International University for Science and Technology (IUST), and Arab International University (AIU), as shown in Figure 1.

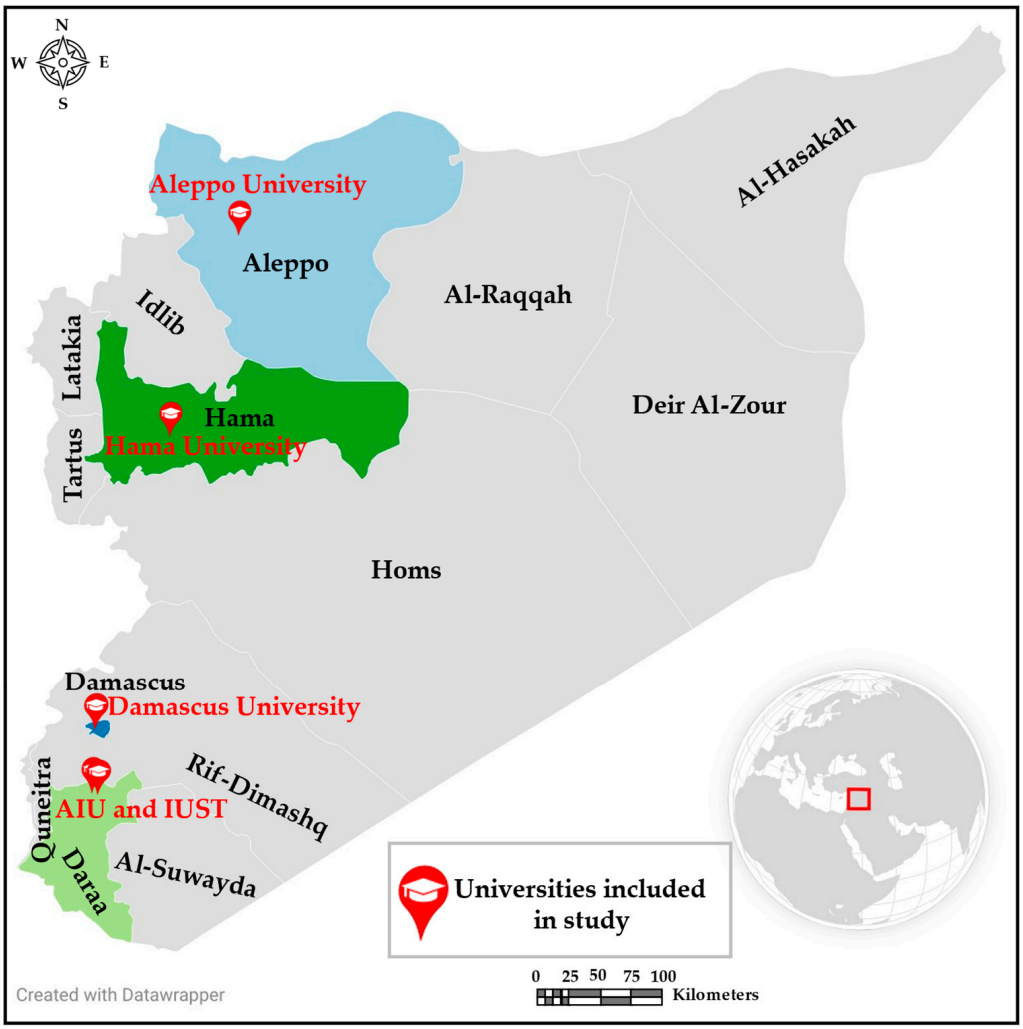

Figure 1. A map of Syria showing the different locations of data collection.

The random sampling technique was unable to be used due to limited mobility and access. Instead, the research team was instructed to use convenience sampling in specific safe locations to avoid unnecessary risks. On-site data was collected by the principal investigator and 50 trained volunteers daily (from 8:00 am to 4:00 pm) between 19 August 2022 and 30 October 2022, using the Kobo collect app. The questionnaire was originally developed in English and translated into Arabic by a sworn translator. Back-translation from Arabic to English was performed by an independent bilingual translator to ensure accuracy and cultural appropriateness. At each of the five locations, the faculties and departments were classified by their scientific specialties as either medical or non-medical. Faculties and departments were selected through a lottery. After selecting a college or department, the principal investigator and trained volunteers visited the site and distributed the questionnaire through convenient sampling in lecture halls and campuses to conduct interviews and fill out the forms one-on-one with a volunteer under the researcher's supervision.

Although pragmatic under security constraints, convenience sampling may over-represent students from relatively accessible urban campuses and under-represent those from rural or highly insecure areas. Consequently, the reported "constraints" results may be underestimated due to recruitment primarily from urban/safer campuses. Thus, caution should be exercised when interpreting the prevalence estimates and correlations reported

here when generalizing them to the entire Syrian university student population. Future studies using probabilistic designs or multistage cluster designs, when conditions permit, are necessary to validate and extend these findings to rural and university campuses in devastated areas.

2.3. Ethical Considerations

The study was approved by the Committee of Human Research, Publications, and Ethics by 18 July 2022, Committee of the Faculty of Pharmacy, Arab International University (AIU), with reference number 2022-PSR-17/O.

2.4. Data Preparation

For details on variable creation and data preparation procedures, please refer to the section "Data preparation—creating new variables" in the Supplementary File on OSF (https://osf.io/ekmd8/, accessed on 16 September 2025). This section outlines how composite variables such as the 5C psychological antecedents, conspiracy mentality scores, information sources, and vaccine-related variables were constructed and processed prior to analysis.

2.5. Statistical Analysis

The raw data was transferred to Microsoft Excel version 16.78.3 (2019), where it was validated qualitatively, checked, and cleaned. After that, all statistical analyses were performed using R (version 4.4.1, R Core Team, 2024) in RStudio (RStudio Team, 2024) at the Department for Economics and Sociology of Sports, Faculty of Economics and Empirical Human Sciences, Saarland University, Germany. University students were interviewed in person using a questionnaire-based structured interview. n = 5060 students participated. Participants were excluded from the analysis when they answered (1) "prefer not to say" for gender (n = 36), (2) "don't know" for the question if they got the COVID-19 vaccine (n = 296), and (3) if their age was > 45 years (n = 6). A total of n = 4722 observations are included in the study.

After establishing the psychometric properties of the translated 5C questionnaire (see Supplementary File), a logistic regression was used to investigate the effect of sociodemographic variables (gender: male/female) and study program (medical/non-medical) as well as the 5C on COVID-19 vaccination behavior. Assumptions were checked using typical procedures. Odds ratios with their 95% confidence intervals (CIs) and Nagelkerke's pseudo-R^2 were computed to quantify explained variance (more accurately as improvement from null model to fitted model) [42].

In a second step, the influence of further variables on the multivariate construct of VH measured using the 5C was investigated using multivariate multiple regression. Included independent variables are gender (male/female), study program (medical/non-medical), information status about previous vaccines, conspiracy mentality, official as well as unofficial sources of information, vaccine attributes, and vaccine passport. For variables that show an overall significant effect on the 5C, univariate analyses were performed to investigate the strength and direction of the effect. Regression coefficients (beta), *CIs*, and p-values are reported. Adjusted R^2 values give an indication of explained variance. Assumptions were checked following standard procedures.

The significance level was set to $p < 0.05$ for all analyses. The full report of all analyses performed can be found in the Supplementary Files on OSF (https://osf.io/ekmd8/, accessed on 16 September 2025).

3. Results

3.1. Descriptive Statistics

3.1.1. Sociodemographic Indicators

The median age of the participants was 21.9 years, with an interquartile range (IQR) of 20.85–30.75 years. The gender distribution showed a higher proportion of males (59.2%) compared to females (40.8%). Geographically, most participants were from the capital, Damascus, with fewer respondents from other governorates. In terms of academic background, the study participants were predominantly from non-medical-related study disciplines compared to medical-related disciplines. The overall characteristics of the study are summarized in Figure 2.

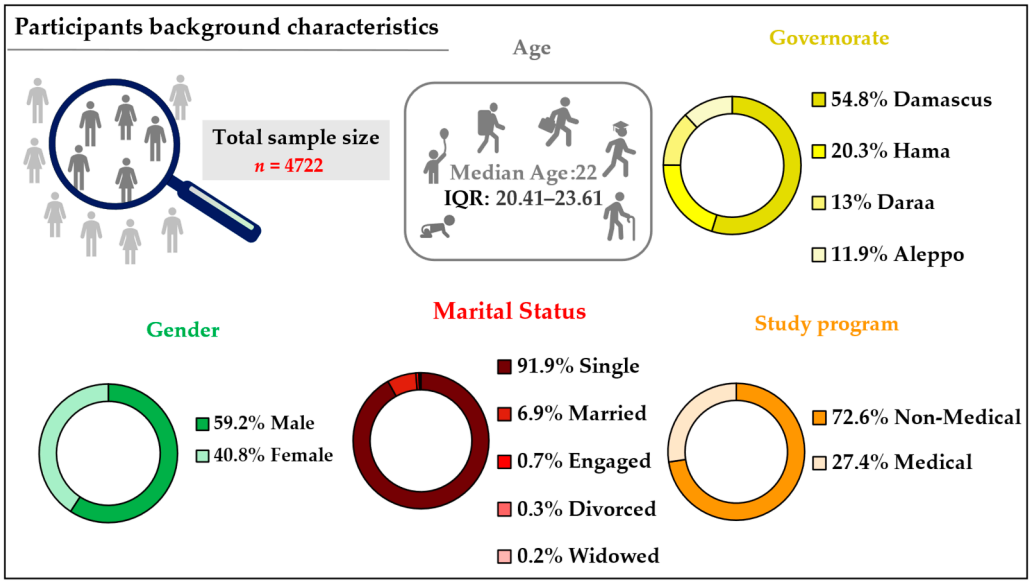

Figure 2. Sociodemographic of participants.

3.1.2. Factors Influencing Vaccination

Vaccination experience was assessed by asking the respondents about their COVID-19 vaccination status, considered as the reference of vaccination behavior, and other vaccine-preventable diseases. The overall vaccination experience (EXP) was high, with a mean score of 0.78 (sd = 0.11). Examination of COVID-19 vaccination status among the total participants (n = 4722) revealed that 64% (n = 3022) had not received the COVID-19 vaccine. Among those who refused vaccination, the majority were fully informed, accounting for 70% (n = 2114), and 30% were partially informed. Detailed results of vaccination experience are presented in Figure 3.

When asked which sources influenced their willingness to be vaccinated, participants indicated that official sources were the most influential. Governmental institutions and international health agencies (e.g., WHO, USAID, CDC, and UNICEF, etc.) were among the leading sources. Scientific literature on vaccines (such as articles, books, and journals, etc.) also played a moderate role. Conversely, respondents also valued social media, family and friends, and media outlets, though social influencers were less impactful. The summarized results for each information source are represented in Figure 4.

Given the widespread conspiracy theories about vaccines—especially COVID-19 vaccines—respondents were asked to share their opinions on these beliefs. Most of them believe that COVID-19 vaccines do not work and are made for profit. While one-third, approximately, believe vaccines influence their genetic material. The conspiracy mentality results are represented in Figure 5.

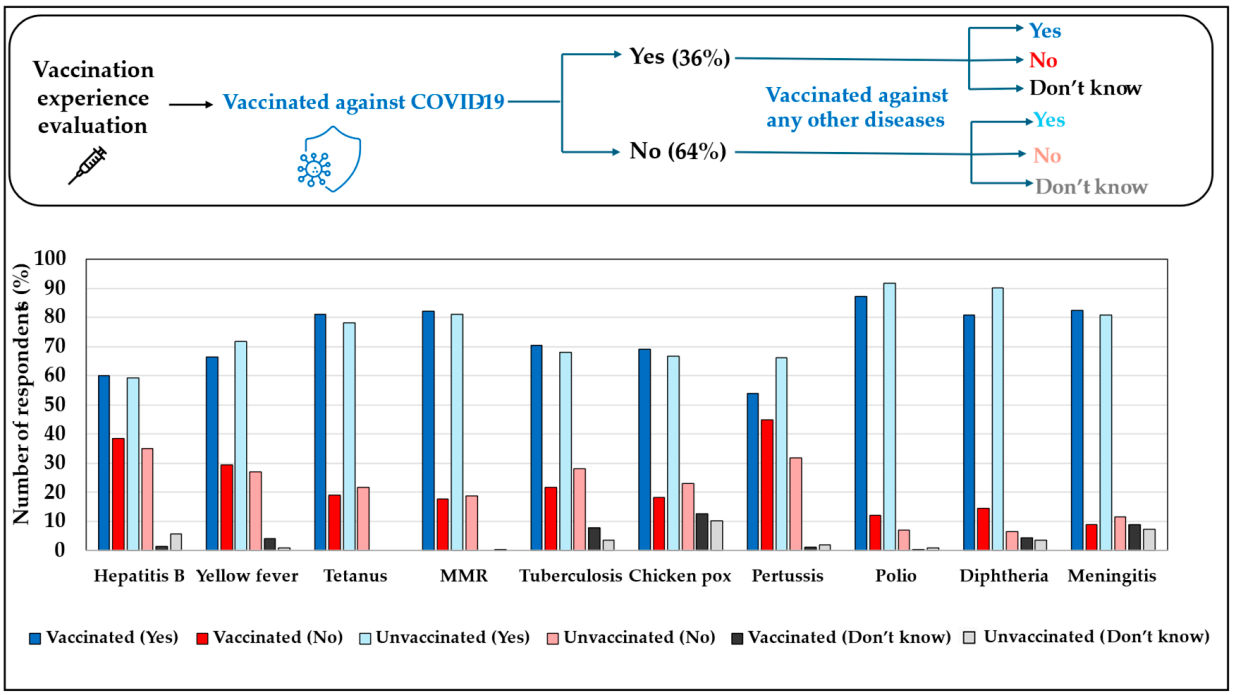

Figure 3. Distribution of participants' responses based on previous vaccination experience. "Vaccinated" refers to individuals who received the COVID-19 vaccine, while "Unvaccinated" refers to those who did not. "Yes" indicates participants who had received vaccines for other vaccine-preventable diseases, while "No" means they had not, and "Don't know" refers to participants who were unsure or could not recall their vaccination history.

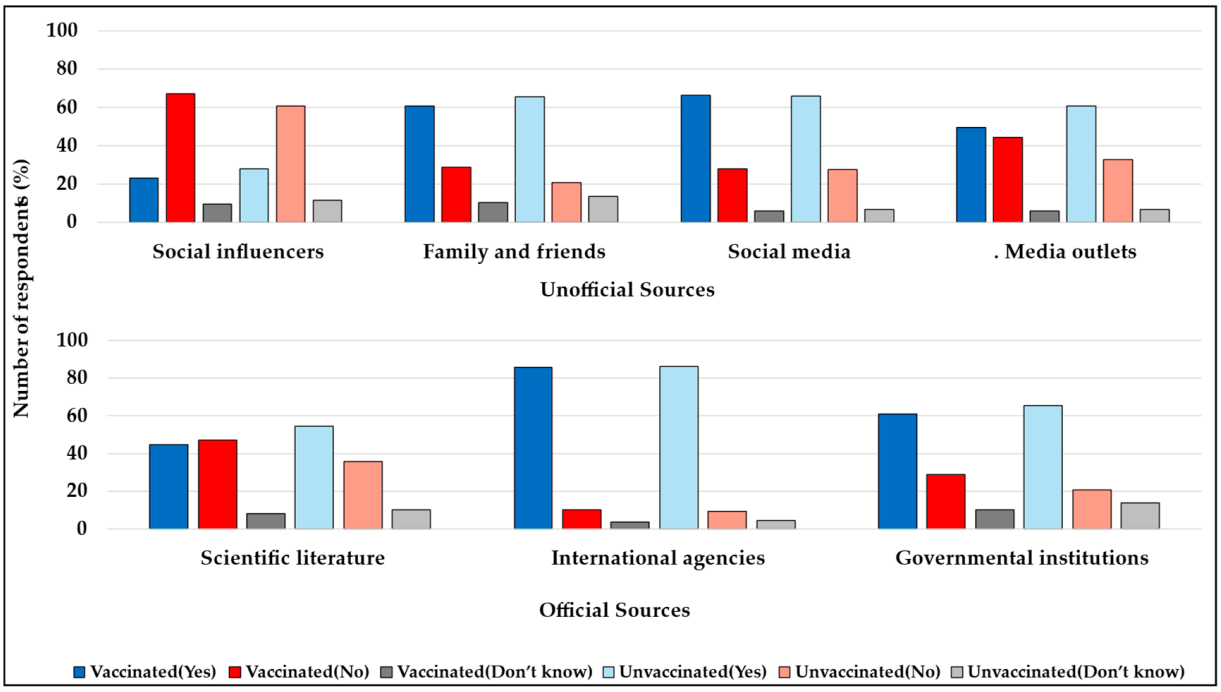

Figure 4. Information source preferences among study respondents. "Vaccinated" indicates individuals who received the COVID-19 vaccine, while "Unvaccinated" denotes those who did not. Additionally, "Yes" indicates that the information source was preferred, "No" indicates t it was not, and "Don't know" refers to participants who were unsure about their preference.

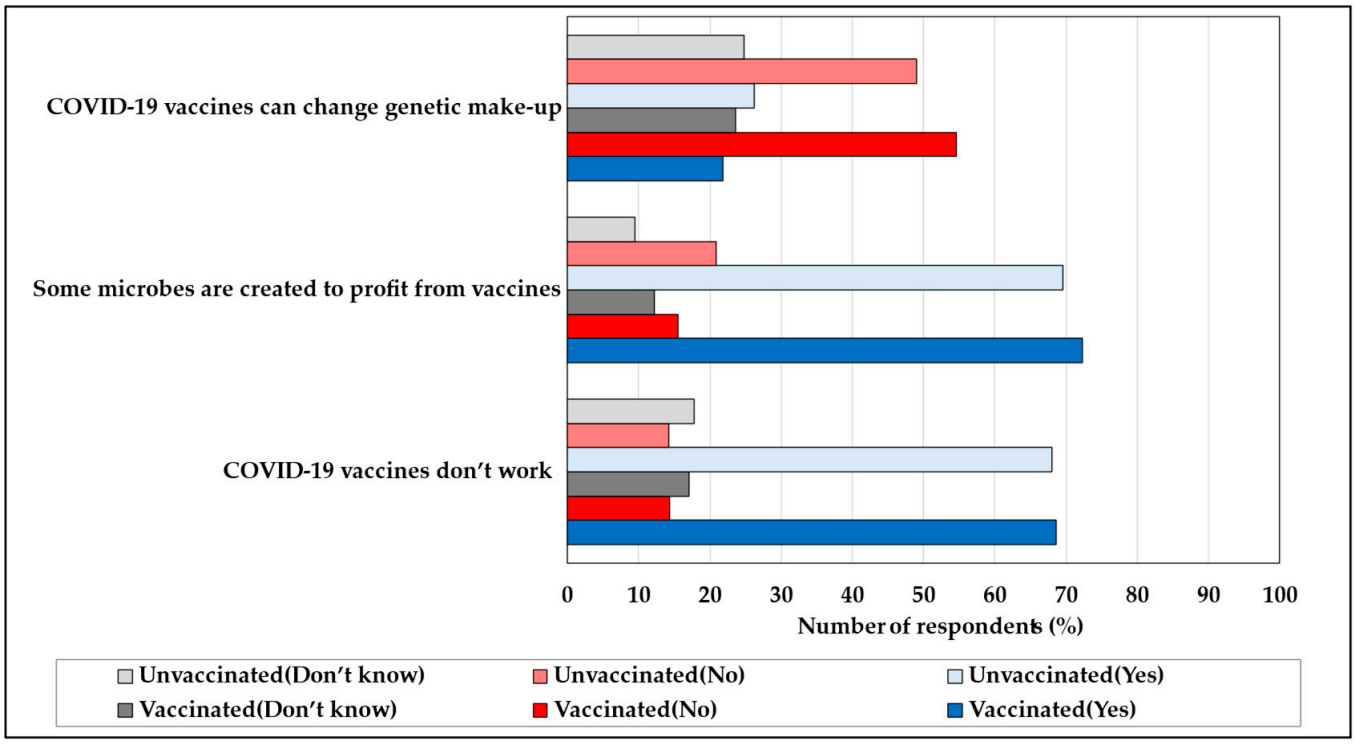

Figure 5. Prevalence of conspiracy mentality beliefs among study participants. "Vaccinated" denotes those who received the COVID-19 vaccine, while "Unvaccinated" refers to those who did not. Additionally, "Yes" participants who supported conspiracy mentality beliefs, 'No' indicates those who did not, and 'Don't know' refers to those who were unsure.

To understand whether vaccine attributes have an effect, respondents were asked about their importance. The mean score was 0.64 (sd = 0.23) across all participants. The results for vaccine attributes are represented in Table 1.

Table 1. Vaccine attributes of study respondents.

Characteristic	Overall (*n* = 4722)	Unvaccinated (*n* = 3022)	Vaccinated (*n* = 1700)
Vaccine Attributes (Overall Score) [1]	0.64 (0.23)	0.64 (0.23)	0.64 (0.23)
Manufacturer/Country of Origin [2]	5 (4, 6)	5 (4, 6)	5 (4, 6)
Brand Name [2]	5 (3, 6)	5 (3, 6)	4 (3, 6)
Availability of Popular Brand [2]	5 (3, 6)	5 (3, 6)	5 (3, 6)

[1] Mean (SD); [2] Median (Q1, Q3); "Vaccinated" denotes those who received the COVID-19 vaccine, while "Unvaccinated" refers to those who did not.

As vaccine passports were mandatory in Syria during the COVID-19 pandemic and served as a travel document to cross country borders, the study also assessed respondents' opinion on vaccine passports. The results showed a mean score of 0.57 (sd = 0.42), indicating moderate overall support among respondents. However, opinions were evenly divided (50–50) on limiting mobility of unvaccinated individuals as a strategy to increase vaccination rates. Interestingly, unvaccinated participants showed slightly higher support for both policies compared to vaccinated individuals, as represented in Table 2.

Table 2. Vaccination policy.

Characteristic		Overall (n = 4722)	Unvaccinated (n = 3022)	Vaccinated (n = 1700)
Mandatory Vaccination [1]	Score	0.57 (0.42)	0.58 (0.42)	0.54 (0.42)
Do you agree that limiting the mobility of people who are not vaccinated is an effective way to increase the vaccination rates? [2]	Yes	50.0	51.2	47.9
	No	50.0	48.8	52.1
Do you agree with vaccines being a permissible factor to travel or visit public place of interest? [2]	Yes	63.2	65.3	59.6
	No	36.8	34.7	40.4

[1] Presented as Mean (SD); While [2] presented as (%); "Vaccinated" denotes those who received the COVID-19 vaccine, while "Unvaccinated" refers to those who did not.

3.1.3. Distribution and Mean Scores of the Psychological Antecedents of Vaccination (5C)

The results, interpreted on a seven-point Likert-type scale from 1 (strongly disagree) to 7 (strongly agree), are presented as mean scores and standard deviations. The highest score was found for calculation, followed by confidence, collective responsibility, and complacency while constraints were the lowest. The results are represented in Table 3.

Table 3. 5C of the Syrian students.

5C	Mean	SD
Confidence	5.29	1.26
Complacency	4.90	1.44
Constraints	3.68	1.49
Calculation	5.86	1.21
Collective responsibility	4.98	1.20
Overall collective mean score	4.94	0.59

3.2. Inferential Statistics

3.2.1. Evaluation of VH

A logistic regression model revealed significant predictors of COVID-19 vaccination behavior among university students. Study program emerged as the strongest predictor, as non-medical students were 1.6 times more likely (OR = 1.60, 95% CI [1.39–1.84], $p < 0.001$) to be unvaccinated compared to students from medical backgrounds. Among the 5C, only three components (complacency, calculation, and collective responsibility) showed a significant association with vaccination behavior, while confidence and constraints were not significant predictors. Higher complacency was associated with increased odds of being unvaccinated (OR = 1.11, 95% CI [1.06–1.16], $p < 0.001$), as was higher calculation—indicating that extensive deliberation about vaccination benefits and risks was linked to VH (OR = 1.06, 95% CI [1.01–1.12], $p = 0.022$). Conversely, higher collective responsibility was associated with decreased odds of being unvaccinated (OR = 0.90, 95% CI [0.86–0.96], $p < 0.001$). Confidence, perceived constraints, and gender showed no significant effect on vaccination behavior. Overall, the model explained a modest but meaningful portion of variance in vaccination behavior (Nagelkerke pseudo-R^2 = 0.023). The results of logistic regression are represented in Figure 6.

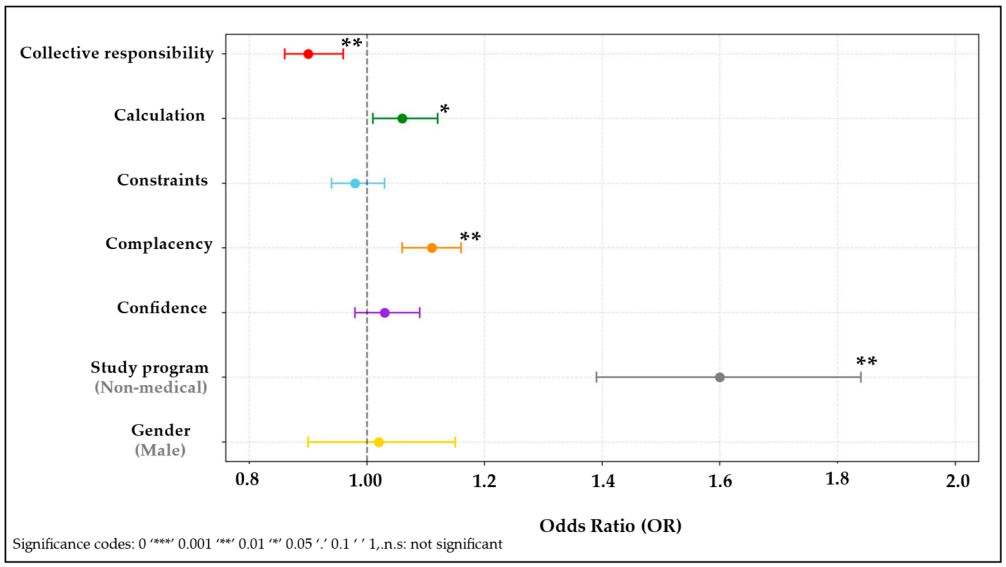

Figure 6. Predictors of COVID-19 vaccination behavior among Syrian university students. Logistic regression model, demonstrating the correlation of socio-demographic and psychological factors (5C) on vaccination behavior. This model explains vaccination behavior from key predictor variables by (R^2 = 0.023).

3.2.2. Multivariate Multiple Regression Model to Investigate Which Factors Influence the 5C

After examining the effects of 5C on vaccination behavior, a multivariate multiple regression model was conducted to go deeper into the 5C and understand what affects each of them and reflects on VH. All independent variables showed an overall significant effect on the 5C, allowing us to investigate their influence on the individual 5C in univariate models, separately from their effects on vaccination behavior.

First, for confidence significant positive predictors were official information sources (β = 0.28, 95% CI [0.14–0.42], p = 0.001), vaccine attributes (β = 0.78, 95% CI [0.62– 0.94], $p < 0.001$), and vaccine passports (β = 0.33, 95% CI [0.24–0.41], $p < 0.001$), while conspiracy beliefs showed a negative association ($\beta = -0.29$, 95% CI [−0.43–−0.16], $p < 0.001$).

Second, complacency was positively influenced by official sources (β = 0.50, 95% CI [0.33–0.66], $p < 0.001$) but negatively associated with conspiracy beliefs ($\beta = -0.33$, 95% CI [−0.48–−0.17], $p < 0.001$), unofficial sources ($\beta = -0.51$, 95% CI [−0.67–−0.35], $p < 0.001$), and studying a non-medical program ($\beta = -0.35$, 95% CI [−0.45–−0.26], $p < 0.001$).

Third, constraints that negatively affect vaccination decisions were positively associated with studying a non-medical program (β = 0.38, 95% CI [0.28–0.48], $p < 0.001$), information status about one's own vaccinations (β = 0.13, 95% CI [0.04–0.23], p = 0.005), conspiracy beliefs (β = 0.55, 95% CI [0.39–0.71], $p < 0.001$), and unofficial sources (β = 0.42, 95% CI [0.26–0.59], $p < 0.001$). Conversely, constraints were negatively associated with the use of official sources of information ($\beta = -0.66$, 95% CI [−0.83–0.50], $p < 0.001$) and vaccine passport support ($\beta = -0.42$, 95% CI [−0.53–−0.32], $p < 0.001$). These associations indicate factors affecting the perception of constraints rather than directly predicting vaccination behavior.

Fourth, calculation was increased by being fully informed (β = 0.20, 95% CI [0.13–0.28], $p < 0.001$]) and vaccine attributes (β = 0.43, 95% CI [0.28–0.59], $p < 0.001$), but decreased by unofficial sources ($\beta = -0.74$, 95% CI [−0.87–−0.61], $p < 0.001$) and vaccine passport support ($\beta = -0.23$, 95% CI [−0.31–−0.15], $p < 0.001$).

Finaly, collective responsibility was associated positively with official sources (β = 0.87, 95% CI [0.74–1.0], $p < 0.001$), vaccine attributes (β = 0.86, 95% CI [0.71–1.0],

$p < 0.001$) and vaccination passport support ($\beta = 0.23$, 95% CI [95% CI [0.15– 0.31], $p < 0.001$), but negatively by studying in a non-medical program ($\beta = -0.15$, 95% CI 95% CI [−0.22–−0.07], $p < 0.001$), being fully informed ($\beta = -0.29$, 95% CI [−0.36–−0.22], $p = 0.001$), and the use of unofficial sources of information ($\beta = -0.18$, 95% CI [−0.31–−0.06], $p = 0.004$). The adjusted R^2 values for the 5 regression models indicate the proportion of variance in each 5C explained by the included predictors, reflecting how well these factors account for differences in the 5C components, independently of vaccination behavior. Calculation and collective responsibility reported the highest adjusted R^2 values and lower for the rest. The results are comprehensively presented in Figure 7.

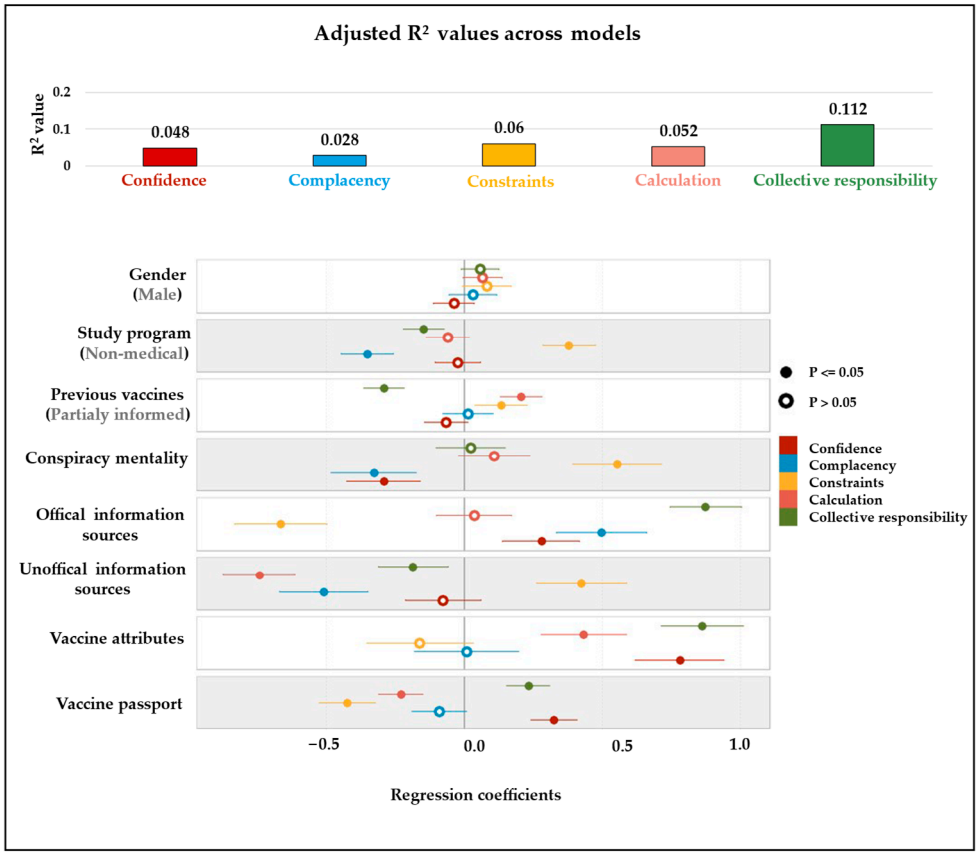

Figure 7. Multivariate regression models examining the association between social determinants of vaccination and 5C psychological constructs. Models demonstrate the variance explained by predictor variables in confidence, complacency, constraints, calculation, and collective responsibility, respectively.

4. Discussion

This study aims to assess the psychological, social, and contextual factors influencing COVID-19 vaccine hesitancy among Syrian university students in war-affected areas. Among the study respondents ($n = 4722$), 64% refused the COVID-19 vaccines. 70% of them were fully informed about their vaccination status. This gap indicates that possession of information about vaccines does not automatically translate into uptake.

In exploring where students look for guidance, we found that study participants predominantly relied on international health agencies as their primary sources of information, indicating a strong preference for official sources. Many students sought guidance from family and friends, 73% ($n = 3017$). This high proportion indicates a preference for personally close sources of unofficial information. The participants used governmental agencies and social media more than media outlets (TV and radio) and social influencers, as shown in Figure 4. Suggesting that official and informal narratives are both present and

may obscure otherwise authoritative messages [43]. Previous work supports this tension: Yue et al. demonstrated that trust in the WHO promotes vaccine confidence, while parallel informal channels can simultaneously foster hesitancy [43]. A 2022 Syrian web-based study also documented significant use of social media for health information but—unlike our cohort—reported no significant associations between online information searching and vaccination status, indicating how the influence of the same channel can differ by sample and context [44].

Interpreting the psychological antecedents through the 5C framework allows for a more complex interpretation. The overall mean score of 4.94 (sd = 0.59) represents moderate hesitation; however, the internal pattern is different. Calculation had the highest mean, underscoring intense risk–benefit deliberation, while complacency also increased the odds of refusing vaccination. Conversely, constraints had the lowest score and were non-significant in multivariable models, suggesting that physical access or even costs were not the main barriers. Confidence and collective responsibility occupied the mid-range, pointing to baseline trust in vaccine safety and a willingness to protect others, yet not at a level that would ensure uptake. This pattern aligns only partly with other vaccine hesitancy studies. For example, both European and Chinese studies report the same case—high calculation and complacency but protective collective responsibility—whereas a 13-country Arab study including Syria barriers were low confidence and high constraints [45–47].

A consolidated comparison with Ghana, where the same 5C-based survey instrument was administered, underscores contextual variability [48]. In the Ghana cohort of 3486 students, fully adjusted models explained 11% to 34% of the variance in vaccination intention and behavior—well above the ≈10% captured in Syria [48,49]. Four 5C dimensions—confidence, constraints, calculation, and collective responsibility—remained significant in Ghana, whereas complacency lost significance after adjustment; by contrast, all 5C retained explanatory weight in Syria [48]. Among Syrian students, the strongest effect on vaccination behavior was study program, followed by small effects of complacency, calculation, and collective responsibility, whereas confidence, constraints, and gender had no effect. Sociodemographic patterns also diverged: reluctance in Syria clustered among non-medical students, while the Ghana analysis highlighted gender, study program, and ethnicity. Yet both settings converged on one critical point: conspiracy beliefs and heavy reliance on unofficial information consistently magnified hesitancy, underscoring a universal challenge of misinformation that transcends national and cultural contexts [48].

More recently, a study conducted in Ukraine—yet another context of conflict—using the same 5C survey among university students revealed additional insights where collective responsibility was the strongest positive predictor of vaccine acceptance [50]. Interestingly, complacency was found to reduce resistance—indicating that passive hesitancy and active refusal can create a difference in the context of a crisis. While in Syria, unofficial sources and conspiracy beliefs showed strong effects on the 5C, vaccine attributes and official sources had the largest positive impact on psychological determinants of vaccination. As in Syria, unofficial sources and conspiratorial beliefs in Ukraine promoted hesitancy in the context of war, indicating the complexity of these areas when trying to understand what leads to vaccine hesitancy [50].

A detailed multivariate multiple regression was conducted to explore the influence of the significant factors affecting the 5C, as shown in (Figure 7). Among the 5C, collective responsibility and calculation had the highest explained variance, indicating stronger effects, while confidence, complacancy, and constraints showed lower levels of explained variance. Positive perceptions of vaccine attributes enhanced confidence, calculation, and collective responsibility. Support for vaccine passports increased confidence, although it reduced complacency, constraints, and calculation, mirroring findings from the United

Kingdom that endorsement of mandates can temper hesitancy by lowering perceived barriers [51]. Reliance on official sources increased confidence and collective responsibility while lowering constraints, whereas unofficial sources had the opposite impact and facilitated conspiracy thinking, which in turn diminished confidence and increased perceived barriers—patterns aligning with reports from Zambia and a survey with 24 nations on conspiracy mentality [52–54].

Taken together, these findings represent the first 5C assessment in a prolonged-conflict LMIC to reveal a calculation-plus-complacency profile with moderate levels of confidence and low structural barriers [55–57]. By integrating effect sizes, it is evident that the study program had the largest direct effect on vaccination behavior, while factors such as vaccine attributes and information sources (official and unofficial) had strong effects on the 5C, and other factors like being fully informed had a moderate to small effect. By challenging the prevailing narrative from studies in the MENA region that low confidence or limited supply dominates, this study extends existing literature and stresses the decisive role of psychological and informational factors even when vaccines are available. From a policy standpoint, several actions follow logically. Peer-to-peer education in which medical students deliver concise, evidence-based sessions can address calculation and complacency directly among non-medical peers. Complementary official campaigns should publish transparent risk-versus-benefit data through channels already trusted by students, reinforcing baseline confidence. In parallel, publicly televised vaccination by respected local influencers or religious leaders can model collective responsibility and counter conspiracy narratives, an approach validated by Loomba et al. [58]. Furthermore, mobile vaccination clinics on insecure or remote university campuses can help ensure that any rise in vaccination willingness translates into actual uptake, a crucial step in conflict-affected settings where static services remain vulnerable to disruption.

5. Conclusions

This study has examined vaccine hesitancy in Syrian university students, using the 5C psychological model. Our findings indicate that a large number of students, particularly students, remain unvaccinated and hesitant toward COVID-19 vaccination. Important psychological and information factors associated with vaccine hesitancy were low confidence, high complacency, more calculation, lower collective responsibility, conspiracy thinking, and relying on unofficial information. Conversely, trust in official information and positive perceptions of vaccine attributes were associated with greater vaccine acceptance. These findings serve as a basis for targeted, evidence-based interventions and evidence-based communication to target the factors that were associated with vaccine hesitancy in a conflict-affected context and resource-constructed context.

6. Limitations of the Study

Various points should be considered when interpreting these results. First, the cross-sectional design does not allow for conclusions about causality between the identified factors and vaccine hesitancy. This prevents inference of temporal or causal relationships. Second, this study is the first to use the 5C questionnaire in Syria. We established the psychometric properties of the translated scale and found that, while the Arabic questionnaire was able to capture the 5C construct reasonably well, the items for collective responsibility may be suboptimal and should be further developed for future applications (see Supplements for details). Third, students from rural campuses and high-insecurity areas were likely under-represented due to convenience sampling being restricted only to accessible universities. Consequently, the reported “constraints” results may be underestimated due to recruitment primarily from urban/safer campuses, introducing a potential sampling

bias. This may have introduced selection bias, as it may affect the representativeness of the sample and limit the generalizability of findings to the entire Syrian university student population. Moreover, security and safety issues limited the mobility of volunteers and inclusion of other universities. Furthermore, the rapidly evolving nature of the COVID-19 pandemic and related information may have influenced participants' attitudes at the time of data collection, limiting the temporal generalizability of the findings [59]. Finally, there may also be unmeasured variables, and the explanatory power of the models, while informative, indicates that other factors not captured in this study also contribute to vaccine decision-making.

Supplementary Materials: The following supporting information can be downloaded at: https://osf.io/ekmd8/, accessed on 16 Septermber 2025.

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