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Factors influencing nurses and nursing students' attitudes towards vaccinations: A cross-sectional study

Jeremia Keisala [a], Erika Jarva [a,*], Dania Comparcini [b], Valentina Simonetti [c], Giancarlo Cicolini [c], John Unsworth [d,e], Marco Tomietto [a,d,1], Kristina Mikkonen [a,d,f,1]

[a] Research Unit of Health Sciences and Technology, University of Oulu, Oulu, Finland
[b] Interdisciplinary Department of Medicine, "Aldo Moro" University of Bari, Bari, Italy
[c] Department of Innovative Technologies in Medicine & Dentistry, "G.d'Annunzio" University of Chieti, Pescara, Italy
[d] Department of Nursing, Midwifery and Health, Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, United Kingdom
[e] University of Bari, Aldo Moro, Italy
[f] Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland

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ABSTRACT

Background: Vaccination hesitancy remains the main obstacle to improving vaccination coverage. Influenza and COVID-19 vaccination coverage among healthcare professionals is essential. It is crucial to study the vaccination attitudes of healthcare professionals as they significantly influence the vaccination attitudes and behaviour of the rest of the population.

Objective: The aim of this study was to describe the attitudes of Finnish nurses and nursing students towards COVID-19 and Influenza vaccination and explain what factors influence these attitudes.

Design: A cross-sectional study.

Setting and participants: A total of 1353 nurses from five hospital organisations and 580 nursing students from eight Universities of Applied Sciences participated in the survey. Participants were invited to complete the questionnaire through Webropol between March and September 2023.

Methods: To collect data anonymously, a self-reported web-based questionnaire combining the Vaccination Attitude Examination (VAX) scale and Bergen's Social Media Addiction (BSMA) scale was used. K-means cluster analysis was performed to describe vaccination attitude profiles.

Results: Four distinct vaccination attitude profiles were identified: Profile A - Confident Pro-Vaccine (n = 605) exhibited low hesitancy, with high confidence in vaccine safety and effectiveness; Profile B – Cautiously Pro-Vaccine (n = 764) showed moderate hesitancy, mainly concerned about unforeseen future effects; Profile C - Hesitant with Mistrust (n = 405) expressed high hesitancy, with significant worries about vaccine safety and mistrust in health authorities; and Profile D – Strongly Vaccine-Hesitant (n = 159) demonstrated very high hesitancy, marked by strong beliefs in potential long-term negative effects of vaccination. Significant differences in VAX-scale mean scores were found between the profiles, ranging from 1.27 for Profile A to 6.65 for Profile D. Overall, nursing students were more hesitant than practising nurses, with students being overrepresented in the more hesitant profiles. Clinical training in a COVID-19 unit was associated with more favourable vaccination attitudes among nursing students. The uptake of the full series of COVID-19 and annual Influenza vaccines was generally high in the sample (90.8 % and 87 %, respectively). However, a clear pattern between specific social media use and vaccination attitudes was not found. Major concerns related to vaccine hesitancy focused on the uncertainty of vaccines' long-term effects.

Conclusion: This study provides valuable insights into the complex nature of vaccination hesitancy among nurses and nursing students. These findings underscore the need for targeted interventions to address underlying concerns and promote vaccine acceptance within this demographic. In future research, it would be essential to gather more in-depth knowledge, particularly regarding nursing students' attitudes towards vaccination and the factors influencing them.

* Corresponding author at: Research Unit of Health Sciences and Technology, Faculty of Medicine, P.O. Box 5000, FI-90014, University of Oulu, Finland
E-mail addresses: erika.jarva@oulu.fi (E. Jarva), dania.comparcini@uniba.it (D. Comparcini), v.simonetti@unich.it (V. Simonetti), g.cicolini@unich.it (G. Cicolini), john.unsworth@northumbria.ac.uk (J. Unsworth), marco.tomietto@northumbria.ac.uk (M. Tomietto), kristina.mikkonen@oulu.fi (K. Mikkonen).
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What is already known

- Vaccine hesitancy is a complex issue and the decision to vaccinate can be a complex process, influenced by many factors.
- The unknown future effects of vaccines are the main concern for the vaccine hesitancy.
- Finns' acceptance of both COVID-19 and Influenza vaccines and trust in the authorities is generally good.

What this paper adds

- Almost half of the most hesitant group were nursing students, highlighting the importance of targeting them for future surveys and vaccination campaigns.
- Previous clinical training in COVID-19 area was associated with lower vaccination hesitancy.
- No clear association was found between vaccine hesitancy and social media use.

1. Introduction

Vaccination is one of the most cost-effective ways to prevent disease, currently preventing 3.5–5 million deaths annually from infectious diseases (WHO, 2023). Despite the proven effectiveness of vaccines, vaccination hesitancy remains a global issue. The World Health Organization identified vaccine hesitancy as one of the top ten health threats worldwide (WHO, 2019). Nurses and other healthcare professionals play a critical role in promoting vaccination among the public, but vaccination hesitancy also exists within these groups, potentially influencing public health efforts (McCready et al., 2023).

This study focuses on understanding the vaccination attitudes of nurses and nursing students, given their potential to influence vaccination coverage in two key ways: 1) by being vaccinated themselves, which directly impacts healthcare safety and staff availability, and 2) by advising and influencing the public. Particularly in contexts where vaccination is mandatory or highly encouraged, such as the Finnish healthcare system, healthcare professionals' own vaccination behaviour and attitudes are crucial. Research shows that healthcare professionals' vaccination behaviour is closely linked to their likelihood of recommending vaccines to patients (Paterson et al., 2016). Hence, understanding the factors that influence vaccination hesitancy among this group is vital for improving vaccination coverage in both healthcare settings and the wider population.

Acceptance rates for COVID-19 and Influenza vaccines among nursing students vary widely internationally, from 44 %–60 % for COVID-19 (Geng et al., 2022; Patelarou et al., 2021) to as low as 15 %–33 % for Influenza (Cheung et al., 2017; Salem et al., 2019). This highlights the importance of studying attitudes not only among current nursing staff but also among students, who represent the future workforce. Ensuring high vaccination coverage among healthcare professionals is essential, as they are at increased risk of exposure to infectious diseases and play a key role in protecting vulnerable patients.

Moreover, the influence of healthcare professionals on public vaccination behaviour is well documented, although this effect is likely indirect and depends on their role and contact with the public. In contexts where vaccination is mandatory for healthcare workers, such as in Finland under the Communicable Diseases Act (1227/2016), the role of healthcare professionals becomes even more relevant. While COVID-19 vaccination was mandatory for nurses during 2022, it is now recommended for their protection. Studies indicate that the vaccination attitudes of healthcare professionals significantly affect vaccination rates, both among their peers and in the broader community (McCready et al., 2023).

Vaccination behaviour encompasses an individual's attitude towards vaccines and their decision to get vaccinated. The literature uses various terms to describe these behaviours and attitudes (Bussink-Voorend et al., 2022; Nurmi, 2021), leading to some inconsistency in how the concept of vaccination hesitancy is defined and applied. According to Nurmi (2021), vaccination hesitancy refers to an individual's contemplation of whether a vaccine is necessary and safe. This phenomenon is complex and context-dependent, as the reasons for hesitancy can vary based on the type of vaccine, the individual or group, and the broader social or cultural context (Rodrigues et al., 2022; MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015).

Vaccination hesitancy also encompasses factors that contribute to non-vaccination, such as accessibility of vaccination services, trust in vaccines and authorities, concerns and misconceptions, and other social and cultural influences (MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015). Bussink-Voorend et al. (2022) further describe vaccination hesitancy as indecision about whether to proceed with vaccination. In this study, we adopt the WHO's (2015) definition of vaccination hesitancy, which refers to a delay in accepting or a refusal of safe vaccines despite the availability of vaccination services.

Research on the attitudes of healthcare professionals towards vaccination has been previously conducted, especially on Influenza and COVID-19 vaccination. Many reasons for vaccination hesitancy have been identified in the studies, including concerns about safety, efficacy and side effects of the vaccine, as well as unexplored future effects due to the rapid development of the vaccine. Other reasons included distrust of the authorities and the idea of violating self-determination by pressuring people to vaccinate (Tomietto et al., 2022a; Jiang et al., 2021; Belingheri et al., 2021; Kwok et al., 2021; Zhang et al., 2022; Peterson et al., 2022; Nurmi et al., 2023).

A review by McCready et al. (2023) highlights the critical role healthcare professionals play in promoting vaccination coverage, as they are generally trusted sources of information and are frequently consulted for vaccine advice. Higher levels of trust in healthcare professionals are strongly associated with increased vaccine acceptance among the public. Therefore, it is essential that healthcare professionals not only possess comprehensive knowledge about vaccines but also develop the necessary skills to address and alleviate concerns among individuals hesitant about vaccination (Karlsson et al., 2019; Yeung et al., 2016).

Nurses, as the largest professional group within the healthcare system, maintain the closest and most sustained contact with patients, especially in hospital settings. Their direct influence on patient care underscores the importance of their vaccination behaviour. A review by Paterson et al. (2016) found that nurses who are vaccinated themselves are significantly more likely to recommend vaccines to their patients. Thus, understanding nurses' attitudes towards vaccination is vital for improving both professional compliance and public health outcomes.

Additionally, exploring the attitudes of nursing students is equally important, as they represent the future of the healthcare workforce. Studying their perspectives provides valuable insights into potential future trends and allows us to anticipate how attitudes may evolve with age and professional experience. This forward-looking approach helps identify whether early interventions during their education can positively shape vaccination behaviours over the long term.

Given the increasing role of misinformation spread through social media, healthcare professionals must be equipped with accurate knowledge to address vaccine hesitancy (Burki, 2019; Shakeel et al., 2022; Trzebiński et al., 2021; Lazarus et al., 2021). Studies suggest that misinformation and lack of knowledge contribute to hesitancy, even among healthcare workers (McCready et al., 2023). Social media's influence on vaccine attitudes is particularly relevant for nursing students and younger professionals, who may be more exposed to unregulated information.

This study explores the attitudes of Finnish nurses and nursing students towards COVID-19 and Influenza vaccination, as well as the factors influencing their attitudes. It also examines the role of social media in shaping vaccine perceptions, a topic underexplored in previous research. By identifying these determinants, the study aims to provide

insights that can inform the development of more effective vaccination campaigns, ultimately contributing to higher vaccination coverage.

The research questions were:

1. What are the attitudes of nurses and nursing students towards COVID-19 and Influenza vaccination?
2. What factors influence the vaccination attitudes of nurses and nursing students?

2. Methods

2.1. Study design

This research was conducted by using a cross-sectional study design. Strengthening the reporting of observational studies in epidemiology (STROBE) guidelines (von Elm et al., 2007) was used.

2.2. Participants

A total of 8952 nurses and 7241 nursing students from five central Finnish Wellbeing Services, hospital organisations, and eight universities of applied sciences offering nursing degree programmes were invited to participate in the study through a convenience sampling approach. The inclusion criteria required participants to be either a nurse or nursing student, to provide informed consent, and to be proficient in reading and answering the questionnaire in Finnish.

The selection of organisations was carefully made to ensure geographical representativeness across Finland. Hospital units within the selected organisations were identified in consultation with key contact persons, typically representing staff managers, to target units that offer specialised healthcare. Specialised care units were specifically chosen due to their higher likelihood of engaging respondents who work with more acute care patients, thus enriching the study with insights from a diverse and critical sector of the healthcare system. This deliberate sampling strategy aimed to balance accessibility with the need to capture perspectives from professionals working in high-intensity clinical environments, providing a comprehensive view of the study's target population.

2.3. Instruments

The Vaccination Attitudes Examination (VAX) scale was used to assess vaccination hesitancy, both in general and specifically for COVID-19 and Influenza vaccines. The scale, developed by Martin and Petrie (2017), includes 12 items across four key factors: mistrust of vaccine benefits, worries about unforeseen future effects, concerns about commercial profiteering, and a preference for natural immunity. Each item is rated on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree), with lower scores representing more positive attitudes towards vaccination. To align responses, the three items measuring mistrust of vaccine benefits were reverse-scored so that lower scores consistently reflected more favourable attitudes towards vaccines.

While the VAX scale was originally developed in English, it has been validated in several languages, including Italian (Tomietto et al., 2022b) and Spanish (Espejo et al., 2022). In this study, the scale was translated into Finnish using a rigorous back-and-forward translation method (Mikkonen et al., 2022). To ensure the validity and reliability of the Finnish version, we calculated Cronbach's alpha for internal consistency, which demonstrated excellent reliability: 0.92 for the overall scale for Influenza (with subscale reliabilities between 0.78 and 0.91) and 0.94 for COVID-19 (with subscales between 0.84 and 0.94) (DeVellis, 2016).

The survey also included an optional social media questionnaire using Bergen's Social Media Addiction (BSMA) Scale, translated into Finnish (Supplementary File 1). The scale contains six statements related to social media use, which are answered on a 5-point Likert scale (from 1 = Very rarely to 5 = Very often) (Andreassen et al., 2012). The internal consistency of the Finnish translated BSMA scale showed a Cronbach's alpha of 0.82. The survey also asked how often the listed social media channels are used on a scale of 1 to 4, where 1 = never and 4 = very often (Supplementary File 1).

2.4. Data collection

The data was collected through an electronic Webropol survey between March and September 2023. A contact person from each organisation was assigned to disseminate the invitation to the survey within the organisation. An email message was sent to the contact persons containing the survey cover message, a link to the survey and the QR code. The preferred method of disseminating the survey invitation was an email sent by the contact person directly to the respondents. The other option was for the contact person to download the study invitation onto the organisation's intranet, which would be available to anyone with access. Two bi-weekly reminders were sent in an attempt to improve the response rate. The researcher personally reminded the contact persons to forward the reminder. Confirmation of reminder messages was not always received from all organisations.

The background data questions in the survey were about gender, age, and province of residence. In addition to these, everyone was asked about background information related to COVID-19 and vaccination, which included whether you receive the flu vaccination annually, whether you have been infected with COVID-19, whether you have current recommended vaccination protection against COVID-19, and how many doses of COVID-19 you have received. In addition to the common questions, nurses were asked about the department/service they work in most, their role in the workplace, time working in their current job in years, time working in the nursing profession in years, speciality and highest degree. Student nurses were also asked about their level of study, field of study, year of study, any interruptions in their studies, whether they had undertaken a clinical placement in a Covid area (unit which had patient (s) with COVID-19 infection) and how many clinical placements they had undertaken in the last 12 months.

2.5. Data analysis

The data were analysed using IBM SPSS 28.0 Statistics (IBM Corp, 2021), with K-Means clustering selected as the most appropriate method for categorising the sample into distinct profiles. K-Means clustering is a widely used machine learning approach that groups similar data points into clusters based on the mean value of the cluster's objects. This method was chosen because it allows for the identification of natural groupings within the data and is particularly well-suited for large datasets with continuous variables, aligning with the structure of our dataset.

The researchers pre-defined the number of clusters based on a theoretical understanding of the subject matter and data distribution. To ensure that each cluster had a meaningful representation, we set a condition that no cluster would represent less than 5 % of the total sample. Several runs were conducted with different pre-defined cluster values (ranging from 3 to 5 clusters) to determine the most suitable model. The optimal number of clusters was selected by balancing the interpretability of the cluster profiles with the theoretical framework, ensuring that the resulting clusters reflected meaningful differences in the data.

Additionally, we verified key assumptions for K-Means clustering, such as ensuring that the variables used were ordinal and that the sample size was large enough to provide robust and stable clusters. Assumptions related to the homogeneity of variance within clusters and the minimisation of within-group variability were considered in the iterative runs to refine the number of clusters. The final model was selected based on these considerations, as well as the interpretability and practical significance of the clusters identified (Ikotun et al., 2023).

VAX-scale items were used as input for clustering to differentiate participants' vaccination attitudes. This way, reasonable sample representation was ensured. One-way analysis of variance (ANOVA) test with multiple pairwise comparisons between all four VAX factors for both COVID-19 and Influenza scales demonstrated statistically significant differences ($p < .001$), confirming that the selection of four clusters was appropriate. VAX-scale outcomes were interpreted according to the meaning of Likert scores: 1.00–3.49 represents positive attitude, 3.50–4.49 is neutral, and 4.50–7.00 represents negative attitudes.

Descriptive statistics, including mean, standard deviation (SD) and percentages, were used to analyse differences between these profiles. Furthermore, cluster profiles' relationships between the background variables, BSMA scale, and social media use were detected using a one-way ANOVA test for normally distributed data. In cases of skewed data, a nonparametric Mann–Whitney test was used. Differences in categorical variables were detected using the Chi-square test, and if the expected frequency was less than 20 %, Fisher's exact test was used. Any discovered differences between the four cluster profiles were considered statistically significant at $p < .05$ (Munro, 2005; Di Leo and Sardanelli, 2020). Sample effect size was interpreted according to Cohen's d equivalence: small ($d \leq 0.2$), medium ($d \leq 0.5$) and large ($d \leq 0.8$) (Cohen, 1992).

2.6. Ethical considerations

Research permission was obtained from five hospital organisations and eight applied sciences universities according to the ethical requirements of Finnish regulations (TENK, 2023). Formal ethics committee approval was not required since the participants were not exposed to harmful influences. Participants were informed in writing about the study and the voluntary nature of their participation. Throughout the research process, the Finnish Code of Conduct for

Table 1
Sample characteristics of nurses and nursing students (n = 1933), based on their distribution to vaccination attitude profiles.

Characteristics	Profile A (n = 605)	Profile B (n = 764)	Profile C (n = 405)	Profile D (n = 159)	Total (n = 1933)	p-value
Age in years,						**<.001**[b,*]
Mean (SD)	38.82	39.90	38.84	35.16	38.96	
Median	(12.60)	(12.84)	(12.59)	(10.41)	(12.58)	
Min–Max	37.00	39.00	38.00	34.00	38.00	
Missing values	19–66	18–67	19–68	19–62	18–68	
	2	3	5	5	15	
Gender, n (%)						
Female	502 (85.5)	668 (90.0)	363 (91.7)	140 (89.7)	1673 (88.9)	0.093
Male	77 (13.1)	70 (9.4)	32 (8.1)	14 (9.0)	193 (10.3)	
Other	6 (1.0)	3 (0.4)	0 (0.0)	1 (0.6)	10 (0.5)	
Does not want to answer	2 (0.3)	1 (0.1)	1 (0.3)	1 (0.6)	5 (0.3)	
Missing values	18	22	9	3	52	
Role, n (%)						
Nurses	453 (74.9)	549 (71.9)	269 (66.4)	82 (51.6)	1353 (70.0)	**<.001**[a]
Student nurses	152 (25.1)	215 (28.1)	136 (33.6.)	77 (48.4)	580 (30.0)	
Using Social Media Apps %						
Facebook (n = 1428)	84.0	88.2	86.2	92.6	86.8	.052[a]
YouTube (n = 1424)	95.3	96.7	95.1	91.7	95.5	.111[a]
WhatsApp (=1429)	99.4	99.5	100.0	98.3	99.4	.183
Instagram (=1422)	83.9	82.9	85.7	84.2	83.9	.770[a]
TikTok (=1416)	41.8	44.0	49.7	49.2	44.8	.137[a]
Snapchat (=1417)	38.7	41.2	49.0	45.8	42.3	**.035**[a]
Pinterest (=1416)	49.8	48.8	50.7	42.0	48.9	.428[a]
Reddit (=1415)	20.6	12.5	12.8	15.8	15.5	**.002**[a]
LinkedIn (=1412)	20.8	18.9	17.5	11.7	18.6	.137[a]
Twitter/X (=1417)	27.1	22.6	23.3	16.8	23.7	.089[a]
Bergen Social Media Addiction Scale (Likert scale 1-5[d]),						.509[b]
Mean (SD)	1.88 (0.73)	1.92 (0.72)	1.93 (0.72)	1.98 (0.76)	1.91 (0.73)	
Missing values	136	217	115	38	506	
Get vaccinated for Influenza annually, n (%)						**<.001**[a]
Yes	578 (95.5)	715 (93.6)	318 (78.5)	71 (44.7)	1682 (87.0)	
No	11 (1.8)	15 (2.0)	35 (8.6)	50 (31.4)	111 (5.7)	
Not every year	16 (2.6)	34 (4.5)	52 (12.8)	38 (23.9)	140 (7.2)	
Been affected by COVID-19, n (%)						.176[a]
No	108 (17.9)	317 (17.9)	62 (15.3)	19 (11.9)	326 (16.9)	
Once	362 (59.8)	456 (59.7)	241 (59.5)	88 (55.3)	1147 (59.3)	
Twice	114 (18.8)	135 (17.7)	85 (21.0)	42 (26.4)	376 (19.5)	
More than twice	21 (3.5)	36 (4.7)	17 (4.2)	10 (6.3)	84 (4.3)	
Fully vaccinated against COVID-19**, according to current recommendations, n						**<.001**[a]
(%)	592 (97.7)	734 (96.1)	347 (85.7)	83 (52.2)	1756 (90.8)	
Yes	13 (2.1)	30 (3.9)	58 (14.3)	76 (47.8)	177 (9.2)	
No						
Number of COVID-19 vaccine doses received, n (%)						**<.001**[a]
0	1 (0.2)	0 (0.0)	10 (2.5)	41 (25.8)	52 (2.7)	
1	1 (0.2)	2 (0.3)	15 (44.1)	16 (10.1)	34 (1.8)	
2	67 (11.1)	100 (13.1)	102 (25.2)	52 (32.7)	321 (16.6)	
3 or more	536 (88.6)	662 (86.6)	278 (68.6)	50 (31.4)	1526 (78.9)	

Note: The mean difference is statistically significant at $p < .05$ (marked in bold). Missing values are indicated in questions that are not mandatory.
[a] Pearson Chi-square test.
[b] One-way ANOVA test including multiple pairwise comparisons with Bonferroni correction.
[d] Likert scale: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often.
[*] Cluster D differed significantly in age from profile A ($p = .007$) profile B ($p < .001$), and profile C ($p = .012$).
[**] Current Finnish recommendation was three doses or combination of two doses and previous Covid-19 infection for those not at-risk group.

Research Integrity (TENK, 2023) the ethical principles of research with human participants and ethical review in the human sciences in Finland (TENK, 2019) were followed. The data collected and generated during the study were processed and stored following EU data protection regulation (GDPR, 2018) and the Data Protection Act (Data Protection Act, 2018). The data was archived according to these regulations at the end of the study process.

3. Results

3.1. Participant characteristics

A total of 1933 nurses and nursing students participated in the study, resulting in a response rate of 11.94 %. The effect size of the sample was calculated using Cohen's d, which indicated a medium to large effect size, ranging from 0.65 to 6.80. This range suggests that the sample size was sufficient to detect meaningful differences, supporting the practical significance of the study's results (Cohen, 1992; Lakens, 2013). The sample included n = 1353 (70 %) nurses and n = 580 (30 %) nursing students. The mean age for nurses was 43.30 years (SD 11.26, Median 43.00, Min 22; Max 68) and for nursing students, 28.82 years (SD 9.24, Median 25; Min 18; Max 58). The mean age of the total sample was 38.96 years (SD = 12.58, Median 38.00, Min 18; Max 68). Most respondents were female (n = 1673, 88.9 %) (Table 1). Respondents' characteristics are reported according to their distribution in cluster profiles. Characteristics are reported to be broken down into common characteristics (Table 1), specific characteristics for nurse respondents (Table 2), and specific characteristics for nursing student respondents (Table 3).

Nurses reported their highest academic qualification as Diploma/Advanced Diploma n = 360 (26.6 %), BSc n = 865 (63.9 %), and MSc/PhD n = 128 (9.5 %). The average work experience in the nursing profession was 15.50 years (SD 11.28, Median 14.00, Min 0; Max 47) and in a current work placement, 9.94 years (SD = 9.60, Median 6.00, Min 0; Max 41). The clinical area of nurses in the sample was divided into ten different areas, medical units representing the largest group (n = 255, 18.8 %), emergency units the second largest (n = 217, 16.0 %), followed by paediatric care units (n = 181, 13.4 %) and intensive care units (n = 178, 13.2 %) which were relatively evenly distributed (Table 2). Most nursing students (n = 437, 75.3 %) reported participating in a clinical placement in a Covid area. The average number of clinical placements for all nursing students in the last 12 months was 2.32 (SD = 1.62, Median 2). The sample of nursing students was broadly distributed due to academic year, as 27.6 % (n = 160) were first-year students, 33.6 % (n = 195) second-year students, 30.9 % (n = 179) third-year students, and the rest of the sample were fourth-year students. Most students (n = 533, 91.9 %) had no interruptions in study (Table 3).

3.2. Nurses and nursing students' vaccination attitude profiles

Four distinct vaccination attitude profiles (see Table 4 and Fig. 1) were identified from the sample data by K-means clustering, showing statistical significance at $p < .001$ among each profile. Profiles were named as profile A - Confident Pro-Vaccine (n = 605, 31.3 %), profile B - Cautiously Pro-Vaccine (n = 764, 39.5 %), profile C - Hesitant with Mistrust (n = 405, 21.0 %) and profile D - Strongly Vaccine-Hesitant (n = 159, n = 8.2 %). For all VAX factors, the mean VAX scale scores of the profiles were in the same order A < B < C < D, meaning that the profile A demonstrated the lowest level of vaccination hesitancy (COVID-19: mean = 2.07, SD = 0.42, Influenza: mean = 1.98, SD = 0.39), whereas profile D demonstrated the highest level of vaccination hesitancy (COVID-19: mean = 6.08, SD = 0.64, Influenza: mean = 5.34, SD = 0.77).

In all VAX scale factors (COVID-19 and Influenza), profile A participants' mean score was lower than neutral (3.50–4.49), varying from 1.27 to 3.38, representing a positive attitude towards vaccination. This profile shows the lowest level of vaccination hesitancy, with participants expressing positive attitudes towards both COVID-19 and Influenza vaccines. They have the highest vaccination uptake and the least concerns about vaccine safety or unforeseen effects.

Table 2
Special sample characteristics of nurses (n = 1353) based on their distribution to vaccination attitude profiles.

Characteristics	Profile A (n = 453)	Profile B (n = 549)	Profile C (n = 269)	Profile D (n = 82)	Total (n = 1353)	p-value
Work experience in nursing,						**.003**[c,**]
Mean (SD)	14.73 (11.39)	16.46 (11.45)	15.87 (11.04)	12.12 (9.52)	15.50 (11.28)	
Median	11.00	15.00	15.00	9.25	14.00	
Min–Max	0–42	0–47	0–45	0–38	0–47	
Work experience in current placement,						**.020**[c,*]
Mean (SD)	9.36 (9.43)	10.85 (10.14)	9.63 (9.22)	8.11 (7.36)	9.94 (9.60)	
Median	5.00	6.00	6.00	5.00	6.00	
Min–Max	0–41	0–40	0–38	0–32	0–41	
Highest academic award, n (%)						**.008**[a]b
Diploma/Advanced diploma	98 (21.6)	159 (29.0)	85 (31.6)	18 (22.0)	360 (26.6)	
BSc	302 (66.7)	337 (61.4)	166 (61.7)	60 (73.2)	865 (63.9)	
MSc/PhD	53 (11.7)	53 (9.7)	18 (6.7)	4 (4.9)	128 (9.5)	
Area of clinical practice, n (%)						**<.001**[a]
Medical	70 (15.5)	107 (19.5)	62 (23.0)	16 (19.5)	255 (18.8)	
Surgical	33 (7.3)	67 (12.2)	35 (13.0)	6 (4.3)	141 (10.4)	
Outpatient- and homecare	15 (3.3)	19 (3.5)	15 (5.6)	11 (13.4)	60 (4.4)	
Emergency	81 (17.9)	76 (13.8)	42 (15.6)	18 (22.0)	217 (16.0)	
Intensive care unit	75 (16.6)	76 (13.8)	20 (7.4)	7 (8.5)	178 (13.2)	
Obstetrics and maternity	22 (4.9)	23 (4.2)	14 (5.2)	2 (2.4)	61 (4.5)	
Paediatric	72 (15.9)	74 (13.5)	28 (10.4)	7 (8.5)	181 (13.4)	
Psychiatric	19 (4.2)	22 (4.0)	18 (6.7)	3 (3.7)	62 (4.6)	
Perioperative and anaesthesia	42 (9.3)	60 (10.9)	21 (7.8)	3 (3.7)	126 (9.3)	
Other	24 (5.3)	25 (4.6)	14 (5.2)	9 (11.0)	72 (5.3)	

Note: The mean difference is statistically significant at $p < .05$ (marked in bold).
[a] Pearson Chi-square test.
[b] Fisher exact test.
[c] One-way ANOVA test including multiple pairwise comparisons with Bonferroni correction.
[*] In multiple pairwise comparison any cluster did not significantly differ from any other profile in work experience in current placement.
[**] Profile D differed significantly in work experience in nursing from profile A (p = .007) and profile C (p = <0.05).

Table 3
Special sample characteristics of nursing students (n = 580), based on their distribution to vaccination attitude profiles.

Characteristics	Profile 1 (n = 152)	Profile 2 (n = 215)	Profile 3 (N = 136)	Profile 4 (n = 77)	Total (n = 580)	p-value
Clinical placement(s) in COVID-19 area, n (%)						**.024**[a]
Yes	124 (81.6)	167 (77.7)	95 (69.9)	51 (66.2)	437 (75.3)	
No	28 (18.4)	48 (22.3)	41 (30.1)	26 (33.8)	143 (24.7)	
Number of clinical placements in the last 12 months, Mean (SD)	2.55 (1.64)	2.43 (1.65)	1.99 (1.56)	2.14 (1.54)	2.32 (1.62)	**.015**[b, c*,*]
Academic year, n (%)						.094[a]
1	33 (21.7)	60 (27.9)	49 (36.0)	18 (23.4)	160 (27.6)	
2	49 (32.2)	69 (32.1)	42 (30.9)	35 (45.5)	195 (33.6)	
3	57 (37.5)	66 (30.7)	37 (27.2)	19 (24.7)	179 (30.9)	
4	13 (8.6)	20 (9.3)	8 (5.9)	5 (6.5)	46 (7.9)	
Interruptions in study, n (%)						.100[a]
Yes	18 (11.8)	15 (7.0)	6 (4.4)	8 (10.4)	47 (8.1)	
No	134 (88.2)	200 (93.0)	130 (95.6)	69 (89.6)	533 (91.9)	

Note: The mean difference is statistically significant at $p < .05$ (marked in bold).
[a] Pearson Chi-square test.
[b] One-way ANOVA test including multiple pairwise comparisons with Bonferroni correction.
[c] Mann-Whitney Test.
[*] Profile 3 differed significantly in number of clinical placements in the last 12 months from profile 1 ($p^a = 0.015$, $p^b = 0.015$) and profile 2 ($p^a = 0.003$, $p^b = 0.002$).

Profile B overcame this neutral line only in *worries about unforeseen future effects, with* mean score variation for all factors being 1.83–4.80. Participants in this profile generally have a positive attitude towards vaccines but express moderate concern, particularly about the unforeseen future effects of vaccines. Their overall vaccine uptake is high, but their concerns about specific vaccine risks are somewhat elevated compared to Profile A.

The same can be seen from profile C scores regarding to Influenza (mean score variation = 3.04–5.32). However, regarding to COVID-19, profile C participants' mean score was barely positive in the *concerns about commercial profiteering (3.49)*, negative in the *worries about unforeseen future effects (5.60)* and neutral in the other two factors varying from 4.05–4.28. This group exhibits significant vaccine hesitancy, particularly concerning COVID-19. They are sceptical about the benefits of vaccination, with elevated concerns about safety and the long-term effects of vaccines. However, they still engage in some vaccination behaviours, albeit at lower rates than Profiles A and B.

Profile D participants can be seen as most hesitant against COVID-19 and Influenza, for their mean score variation is 4.76–6.65, representing a negative attitude towards all the factors (Table 4). This profile represents the highest level of vaccine hesitancy. Participants express distrust in vaccines, particularly in their benefits and safety, and are the least likely to be vaccinated. They have high concerns about unforeseen future effects and prefer natural immunity over vaccination.

For all profiles, *concerns about commercial profiteering* of COVID-19 (profile A: mean = 1.27, SD = 0.39; Profile B: mean = 1.97, SD = 0.70; Profile C: mean = 3.49, SD = 1.07; Profile D: mean = 5.62, SD = 1.18) and of Influenza (profile A: mean = 1.28, SD = 0.38; Profile B: mean = 1.83, SD = 0.59; Profile C: mean = 3.04, SD = 0.95; Profile D: mean = 4.76, SD = 1.16) was reported as the lowest factor of vaccination hesitancy. On the other hand, in all cluster profiles participants reported that *worries about unforeseen future effects* as the highest factor of vaccination hesitancy against COVID-19 (Profile A: mean = 3.38, SD = 0.97, Profile B: mean = 4.80, SD = 0.79, Profile C: mean = 5.60, SD = 0.90, Profile D: mean = 6.65, SD = 0.66) and Influenza (Profile A: mean = 3.25, SD = 0.96, Profile B: mean = 4.55, SD = 0.89, Profile C: mean = 5.32, SD = 0.93, Profile D: mean = 6.27, SD = 0.86) (Table 4).

Table 4
Nurses and nursing students' (n = 1933) vaccination attitude profiles.

VAX Factors (Likert scale 1–7[a])		Profile A (n = 605) 31.3 % Mean (SD)	Profile B (n = 764) 39.5 % Mean (SD)	Profile C (n = 405) 21.0 % Mean (SD)	Profile D (n = 159) 8.2 % Mean (SD)	Total (n = 1933) 100.0 % Mean (SD)	p-value[b,c]	Cohen's d (min–max)
COVID-19	Mistrust of vaccine benefit	2.02 (0.80)	2.73 (0.89)	4.28 (1.21)	6.44 (0.84)	3.14 (1.58)	**<.001**	0,83–5,47
	Worries about unforeseen future effects	3.38 (0.97)	4.80 (0.79)	5.60 (0.90)	6.65 (0.66)	4.67 (1.34)	**<.001**	0,96–3,58
	Concerns about commercial profiteering	1.27 (0.39)	1.97 (0.70)	3.49 (1.07)	5.62 (1.18)	2.37 (1.47)	**<.001**	1,20–6,80
	Preference for natural immunity	1.62 (0.66)	2.91 (0.97)	4.05 (0.98)	5.63 (1.13)	2.97 (1.49)	**<.001**	1,17–5,13
	Overall scale	2.07 (0.42)	3.10 (0.40)	4.36 (0.53)	6.08 (0.64)	3.29 (1.25)	**<.001**	0,83–6,80
Influenza	Mistrust of vaccine benefit	1.73 (0.69)	2.25 (0.73)	3.37 (1.18)	5.15 (1.41)	2.56 (1.32)	**<.001**	0,73–3,85
	Worries about unforeseen future effects	3.25 (0.96)	4.55 (0.89)	5.32 (0.93)	6.27 (0.85)	4.44 (1.31)	**<.001**	0,85–3,22
	Concerns about commercial profiteering	1.28 (0.38)	1.83 (0.59)	3.04 (0.95)	4.76 (1.16)	2.15 (1.22)	**<.001**	1,08–5,55
	Preference for natural immunity	1.64 (0.68)	2.79 (0.91)	3.78 (1.04)	5.19 (1.17)	2.84 (1.38)	**<.001**	0,65–2,54
	Overall scale	1.98 (0.39)	2.86 (0.37)	3.88 (0.54)	5.34 (0.77)	3.00 (1.08)	**<.001**	0,65–5,55

Note: The mean difference is statistically significant at $p < .05$ (marked in bold).
[a] Likert scale: 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree, 4 = Neither disagree or agree, 5 = Somewhat agree, 6 = Agree, 7 = Strongly agree. Lower score represents lower level of vaccination hesitancy.
[b] One-way ANOVA test, including multiple pairwise comparisons with Bonferroni correction; each comparison demonstrated a p-value <.001.
[c] Mann–Whitney test between each profile demonstrated a p-value <.001 in all four factors.

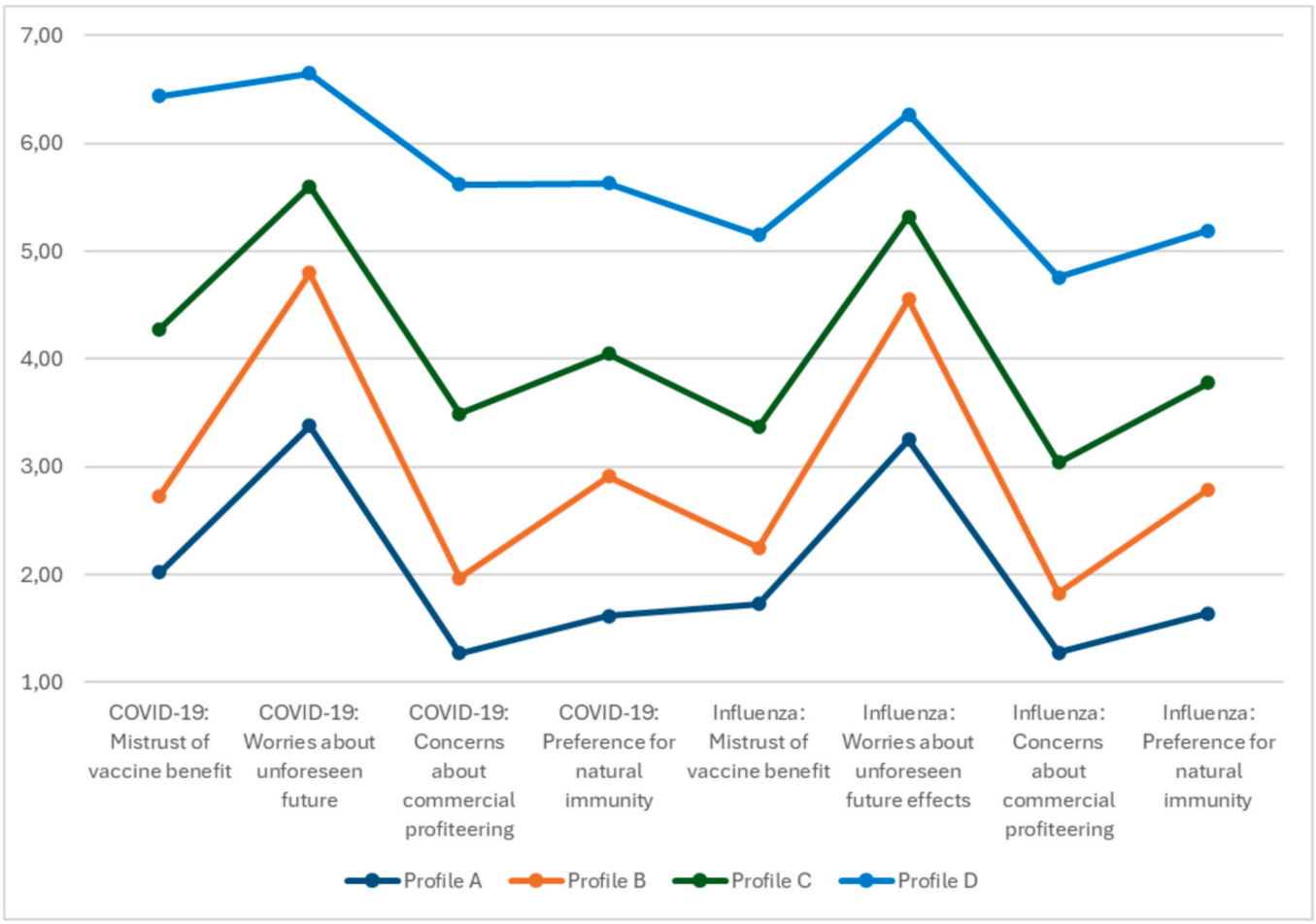

Fig. 1. Nurses and nursing students' vaccination.

For profiles A, C and D, the *mistrust of vaccine benefits* regarding COVID-19 scored higher (Profile A: mean = 2.02, SD = 0.80, Profile C: mean = 4.28, SD = 1.21, Profile D: mean = 6.44, SD = 0.84) than the *preference for natural immunity* regarding COVID-19 (Profile A: mean = 1.62, SD = 0.66, Profile C: mean = 4.05, SD = 0.98, Profile D: mean = 5.63, SD = 0.64). However, for profile B, the scoring was the other way around (*mistrust of vaccine benefit*: mean = 2.73, SD = 0.89; *preference for natural immunity*: mean = 2.91, SD = 0.97). Regarding Influenza, only profile participant A scored in *mistrust of vaccine benefit* (mean = 1.73, SD = 0.69) higher than the *preference for natural immunity* (mean = 1.64, SD = 0.68) (Table 4).

3.3. Factors associated with nurses and nursing students' vaccination attitude profiles

Several background factors showed statistically significant differences between vaccination attitude profiles. The most hesitant attitude representing profile D participants had the lowest average age (35.16 years, SD = 10.41, median 34 years), work experience in nursing (12.12 years, SD = 9.52, median 9.25 years and work experience in current placement (mean = 8.11 years, SD = 7.36, median 6 years). The age difference was statistically different compared to participants in profile A (p = .007), profile B (p = .001) and profile C (p = .012). Profile B participants had the highest average age (39.90 years, SD = 12.84, median 39 years), work experience in nursing (16.46 years, SD = 10.14, median 15 years) and work experience in current placement (mean = 10.85 years, SD = 10.14, median 6 years). The role of the participants also had statistical significance (p < .001); they were divided into nurses or nursing students. The higher the score on the VAX scale, the higher the proportion of nursing students were in the profiles. For instance, 48.4 % of participants in profile D were students, compared to only 25.1 % in profile A (see Tables 1, 2 and 4).

All three vaccination behaviour questions showed statistically significant differences between profiles (p < .001 in all three questions). The majority of participants who get vaccinated against Influenza annually were in profile A (95.5 %), compared to 93.6 % in profile B, 78.5 % in profile C and only 44.7 % in profile D. The same order was followed regarding COVID-19 vaccination. In profile A, 97.7 % reported being fully vaccinated against COVID-19 compared to 52.2 % in profile D. Result was similar when reporting the number of COVID-19 vaccine doses received. Most participants (88.6 %) in Profile A reported receiving three or more doses of the COVID-19 vaccine, while 25.8 % of participants in Profile D reported receiving 0 doses of the COVID-19 vaccine (see Tables 1 and 4.)

There were no statistically significant differences between the profiles regarding gender, the BSMA scale, or whether COVID-19 was infecting them. Social media usage, however, did show statistically significant differences, but only regarding the use of Snapchat (p = .035) and Reddit (p = .002). There was no clear pattern between vaccination attitude profiles and social media usage; profile A participants reported using Snapchat the least but Reddit the most, profile C participants used Snapchat the most and profile B participants used Reddit the least.

Furthermore, there were statistically significant between-cluster differences in the education background of nurses (p = .008). The biggest portion of master's degrees or doctoral degrees (MSc/PhD) participants were in profile A (11.7 %, n = 53) and the smallest in profile D (4.9 %, n = 4). Profile D had the highest percentage of nurses with bachelor's degrees (73.2 %, n = 60) as their highest academic award,

while profile B had the lowest percentage of nurses with bachelor's degrees (61.4 %, n = 337). There were also statistically significant differences between profiles (p = .024) regarding the proportion of nursing students who underwent clinical placements in a Covid area, with 66.2 % (n = 51) in profile D, 69.9 % (n = 95) in profile C, 77.7 % (n = 167) in profile B and 81.6 % (n = 124) in profile A.

4. Discussion

The aim of this study was to describe the attitudes of nurses and nursing students towards COVID-19 and Influenza vaccination and explain the factors influencing these attitudes. A cluster analysis approach identified four distinct profiles from the data. Profile A (Confident Pro-Vaccine) showed a low level of hesitancy; profile B (Cautiously Pro-Vaccine) showed slight hesitancy; profile C (Hesitant with Mistrust) showed average hesitancy; and finally, profile D (Strongly Vaccine-Hesitant) showed the highest level of hesitancy. Each profile significantly differed from the others, but the largest gap in vaccination attitudes was between profiles A (overall VAX-scale mean score for Influenza: 1.98 and for COVID-19: 2.07) and D (overall VAX-scale mean score for Influenza: 5.34 and for COVID-19: 6.08). Based on VAX-scale scores, most participating nurses and nursing students expressed low or intermediate levels of vaccination hesitancy. Overall, the level of vaccination hesitancy was low in this study, with over 70 % of participants grouped in the least hesitant profiles A and B. However, a small group of participants (profile D 8.2 %) expressed extreme level of vaccination hesitancy. Furthermore, Profile C participants (21 %) expressed an intermediate level of vaccination hesitancy.

Although the VAX scale is designed to measure attitudes rather than behaviour directly, its validity as a measure of vaccine hesitancy is supported by its strong association with vaccination behaviour. Results showed that participants with lower VAX scores (indicating more positive vaccination attitudes) were significantly more likely to have been vaccinated against Influenza annually and to have completed the full series of COVID-19 vaccinations. For example, 95.5 % of participants in Profile A (low hesitancy) reported annual Influenza vaccination, compared to 93.6 % in Profile B, 78.5 % in Profile C, and 44.7 % in Profile D (high hesitancy). Similarly, 97.7 % of participants in Profile A reported being fully vaccinated against COVID-19, compared to only 52.2 % in Profile D.

Furthermore, when looking at the number of COVID-19 vaccine doses received, all in all 99.7 % of participants in Profile A reported receiving two or more doses, while 25.8 % of participants in Profile D reported receiving 0 doses of the COVID-19 vaccine. These findings provide additional evidence for the scale's validity in this context, showing a clear relationship between positive attitudes (as measured by the VAX scale) and actual vaccination behaviour. Profiles of vaccine hesitancy derived from the VAX scale revealed that individuals with higher hesitancy scores (Profiles C and D) were significantly less likely to report vaccine uptake, demonstrating the scale's utility in differentiating between those more or less likely to engage in vaccination behaviour. This suggests that the VAX scale is not only a reliable measure of attitudes but also a meaningful predictor of vaccination behaviours.

The results are consistent with previous studies, as vaccination coverage among Finnish healthcare professionals has generally been high (Kontio et al., 2021; Hammer et al., 2022; Sivelä et al., 2018). In this study, vaccination behaviour was associated with the VAX scale score regarding Influenza and COVID-19 vaccines, confirming the scale's usability and ability to identify those with vaccination hesitancy (Martin and Petrie, 2017). This study revealed that the main reason for vaccination hesitancy and refusal among nurses and nursing students is a perceived lack of safety associated with receiving the vaccine. The *worries about unforeseen future effects* scored the highest among all factors in every profile regarding Influenza and COVID-19 vaccines. In addition to that, the mistrust of vaccine benefits regarding COVID-19 scored the second highest in all but one profile (profile B). Similarly to that, Biswas et al. (2021) and Li et al. (2023) reported that the top reasons for healthcare professionals' COVID-19 vaccination hesitancy included concerns about safety, efficacy, and potential side effects. The fact that *concerns about commercial profiteering* scored the lowest among all factors supports the previous finding indicating high levels of trust in authorities among Finns (Väliverronen et al., 2020).

However, it should be noted that the mean score for the most hesitant profile D was high in this factor as well, although it was the lowest among the factors for profile D. The mean score for w*orries about unforeseen future effects* and *mistrust of vaccine benefit* was high, especially regarding COVID-19. The score for *preference for natural immunity* was slightly lower, but it still showed strong hesitancy. In conclusion, the VAX-scale results suggest that nurses and nursing students (in profile D) lacked trust in the COVID-19 or Influenza vaccine, expressed concerns about vaccine adverse effects, believed that authorities and pharmaceutical companies promote vaccination for financial gain, and preferred natural immunity over-vaccination. At the same time, 52.2 % of profile D participants were fully vaccinated (according to current recommendations) against COVID-19, and 44.7 % got vaccinated for Influenza annually, highlighting the complexity of vaccine decision-making (Rodrigues et al., 2022; Blahut et al., 2023). The difference in COVID-19 vaccination uptake rate is significant between profile D and profile C, which expressed intermediate levels of vaccination hesitancy, as 85.7 % of them were fully vaccinated. The Influenza vaccination uptake rates of participants in different profiles were similar but slightly lower than in COVID-19.

Nursing students comprised a significant proportion of the most hesitant group, as almost half of the profile D participants were students. According to Patwary et al. (2022), the attitudes of healthcare students towards vaccinations vary significantly by country, with their global review reporting an average COVID-19 acceptance rate of 68.8 %. McCready et al. (2023) found in their systematic review that the acceptance rates among nursing students were higher than those of registered nurses, which is completely opposite to the results of this study. Additionally, the average age within profile D was the youngest, with a difference of 3.66 years compared to the least hesitant profile A. Moreover, nurses in profile D exhibited the lowest level of work experience, and student nurses had the most minor exposure to clinical placements in COVID-affected areas. In previous studies, the association between age and vaccination hesitancy has not been consistently clear. Even though most studies suggest that younger age is associated with higher vaccination hesitancy (Wie et al., 2023; Truong et al., 2022; Li et al., 2023), some findings indicate that older age predicts vaccination hesitancy (Tomietto et al., 2022a; Kose et al., 2020). In this study, the average age and work experience do not correspond directly with the VAX-scale scores across profiles. Similarly, while significant differences exist between profiles regarding work experience, the least hesitant profile does not necessarily have the highest average work experience.

However, there is a clear association between vaccination hesitancy and student nurses' experience of clinical placements in Covid areas. This suggests that witnessing or caring for patients infected with COVID-19 is linked to more favourable attitudes towards the COVID-19 vaccine among nursing students. However, personal experience of being infected with COVID-19 was not associated with vaccination hesitancy. Interestingly, the percentage of individuals affected by COVID-19 was highest among the most hesitant group despite the lack of statistically significant differences between profiles. Findings are aligned to the study of Kara Esen et al. (2021). Previous studies have shown mixed findings on this topic, suggesting that caring for COVID-19 patients is associated with more positive and negative attitudes towards vaccination (Li et al., 2023). Similar patterns likely exist in this study based on nurses' working areas. Notably, the majority of the most hesitant nurses worked in the emergency unit (22.0 %), outpatient or homecare (13.4 %), and medical wards (19.5 %), while the least hesitant nurses were primarily from intensive care units (16.6 %) and paediatric units (15.9

%).

Social media usage and BSMA scale scores displayed a low association with vaccination hesitancy. BSMA scores were not statistically significant, but all profiles scored low, indicating a low level of social media addiction. However, a clear pattern emerged as the score increased in alignment with the VAX-scale score. Regarding social media usage, significant differences between profiles were observed only in Snapchat and Reddit usage, but these did not follow the previously mentioned pattern. Despite the lack of statistically significant differences, it is noteworthy that Facebook usage was highest among the most hesitant participants and lowest among the least hesitant participants. Conversely, the pattern was reversed for Twitter usage, with the least hesitant individuals using it the most. Previous studies (Jennings et al., 2021; Zhang et al., 2023) have suggested a connection between the use of various social media platforms and vaccination hesitancy. However, in this study, clear evidence of such a link was not found.

4.1. Strengths and limitations

This study has several notable strengths. First, it utilises a large dataset comprising 1353 nurses and 580 nursing students, enhancing the findings' reliability. Including such a substantial sample allows for more robust statistical analysis and meaningful conclusions. Second, the study's solid national representation further strengthens its generalisability. Respondents were drawn from various regions across Finland and represented a wide range of nursing fields, ensuring that the findings capture diverse perspectives and professional contexts within the nursing population. Additionally, the study demonstrated a large effect size, emphasising the strength and practical significance of the findings. Lastly, the findings align with previous studies regarding vaccination coverage in Finland, providing further validation and consistency with existing literature. This connection reinforces the credibility of the results and underscores the importance of the study's contributions to the field.

4.2. Limitations

This study has several limitations. First, the study sample of nurses was gathered from four (out of five) university hospitals, excluding smaller size hospitals, which limits the generalisability of the results to the broader population, even though the sample was representative of Finland geographically. The study sample was predominantly female, which limits generalizability as more male participants could have produced different results. Unfortunately, nurse participants were not explicitly asked about their experience working in a Covid area, which could have provided insight into how caring for COVID-19 patients relates to nurses' vaccine attitudes. One limitation arose from variations in survey invitation distribution methods across organisations, impacting response rates. Invitations were emailed directly or uploaded to the intranet depending on the organisation. In some cases, invitations were sent to respondents by a contact person, while in others, they were relayed through multiple levels of management. Organisations using the intranet method saw fewer responses. The highest response rates occurred when invitations were sent directly to participants. Nurses were more likely to respond to the survey at work, as access to the hospital organisation's intranet or work email from home is often limited. Finally, a potential selection bias should be considered, given the convenience sampling approach.

4.3. Conclusions

The overall result of the study showed that the attitudes of Finnish nurses and nursing students towards COVID-19 and Influenza vaccination were mainly favourable. The uptake rate of COVID-19 and Influenza vaccines was also high in the sample. However, the result revealed a spectrum of hesitancy levels among participants, and a small group of participants were very hesitant. The vaccines' unforeseen future effects were the participants' central concern, especially among the most hesitant ones. One significant finding was that the higher the VAX-scale score, the more nursing students were in the group. This suggests that targeted efforts should be made to promote vaccination uptake among nursing students. The experience of witnessing or caring for COVID-19 patients in clinical placements resulted in lower hesitancy levels among nursing students, highlighting the importance of practical experience in shaping perceptions. Based on these findings, it would be necessary for future research to gather more in-depth knowledge, particularly on nursing students' attitudes towards vaccination and the factors influencing them. As future healthcare professionals, they have a significant impact on the entire field and also on the attitudes of the general population. Therefore, understanding their perspectives on vaccination is essential for developing effective strategies to address vaccination hesitancy and promote vaccine uptake. Overall, this study provides valuable insights into the complex nature of vaccination hesitancy among nurses and nursing students. Outlining distinct profiles and exploring the influence of various factors contributes to a comprehensive understanding of vaccine decision-making in this population. These findings can be used in cross-country comparisons, leveraging Finland's exceptionally high trust in authorities, a factor confirmed by this study. Furthermore, these findings will inform targeted interventions like educational programmes and communication strategies to address vaccination hesitancy and promote vaccination uptake among healthcare professionals and students in Finland and other countries.

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CRediT authorship contribution statement

Jeremia Keisala: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Erika Jarva:** Writing – review & editing, Supervision. **Dania Comparcini:** Writing – review & editing, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Valentina Simonetti:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Data curation, Conceptualization. **Giancarlo Cicolini:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization. **John Unsworth:** Writing – review & editing, Validation, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Marco Tomietto:** Writing – review & editing, Validation, Supervision, Software, Resources, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Kristina Mikkonen:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

None of the authors has a relevant conflict of interest to declare.

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Data availability

The datasets generated and analysed during the current study are not publicly available due to restrictions to the participants' privacy but are available from the corresponding author on reasonable request.

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