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COVID-19 vaccine hesitancy in eastern Oslo: Addressing sociodemographic determinants and main reasons for vaccine hesitancy

A cross-sectional study

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Abstract

Background: Vaccines are an essential public health strategy to curb viral infection spreading and hinge on vaccine uptake which may be threatened by vaccine hesitant individuals. This study therefore aims to address sociodemographic predictors of vaccine hesitancy, main reasons for vaccine hesitancy, and how these reasons are explained by sociodemographic characteristics during the COVID-19 pandemic.

Methods: A cross-sectional study (N = 5442) was carried out in June 2021 among six eastern Oslo districts with high infection pressure. Sociodemographic variables included gender, age, country of birth, education, and household income. Binary logistic regression models were used to explore predictors of both vaccine hesitancy and specific reasons. Main reasons for vaccine hesitancy were assessed through descriptive statistics.

Results: Vaccine hesitancy was overall low (5.8%). Findings stress the vulnerable position of younger age, participants born outside of Norway, lower education, and lower household income in relation to vaccine hesitancy proneness. Hesitancy was mainly grounded in confidence barriers such as fear of side effects (55.8%) and little experience with the vaccines (50.2%). Otherwise, complacency barriers such as not feeling to belong to a risk group (46.1%), not needing the vaccines (39.1%), and wanting the body to develop natural immunity (29.3%) were frequently present. Results indicated overall high trust in health authorities and professionals. Women and participants born in Norway were more likely hesitant due to a lack of confidence in the vaccines. Complacency barriers were less likely present among older age (60+) and participants born outside of Norway.

Conclusions: Varying determinants of vaccine hesitancy and barrier trends among population groups emphasize the importance of clear public health communication about the risks, benefits, and importance of vaccines. Future studies with a larger sample should verify current findings and further explore the prevalence of convenience barriers. Norwegian health authorities should take these results into account and develop different public health strategies targeted at vulnerable population groups during the current and forthcoming pandemics to increase vaccine uptake and reach sufficient immunization.

Keywords: COVID-19; sociodemographic characteristics; vaccine hesitancy; vaccine intention; reasons for vaccine hesitancy; barriers to vaccine uptake.

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PART I – INTRODUCTORY CHAPTER

List of abbreviations

Health literacy - HL

National Institute of Public Health (*Folkehelseinstituttet*) – FHI

Norwegian kroner – NOK

Strategic Advisory Group of Experts – SAGE

World Health Organization – WHO

1. Introduction

Vaccines are an essential public health strategy to curb viral infection spreading that hinge on vaccine uptake (ECDC, 2022; WHO, 2014). This may greatly be threatened by vaccine hesitant individuals. Therefore, identifying predictors and assessing barriers that counteract uptake are in high demand. Thus, this master's thesis shall address sociodemographic predictors of vaccine hesitancy, explore the main reasons for this hesitancy, and how these reasons are explained by sociodemographic characteristics in Norway's anticipated COVID-19 epicenter: eastern Oslo. An introductory chapter is first presented. Then, an article manuscript for BMC Public Health is attached in part two.

1.1 Background

In March 2021, several municipalities in eastern Norway received extra vaccine doses due to consistent high COVID-19 infection rates (Holmes & Fausko, 2021, March 13; Stoksvik, 2021, March 2). These were mostly assigned to six eastern districts with high infection pressure in Oslo where vaccine hesitancy was suspected (Capar, 2021, July 5). Vaccine hesitancy is defined by the WHO as either delayed acceptance or refusal of a vaccine despite its availability, a known phenomenon long before COVID-19. It has been addressed as one of top ten major global health threats which may undermine global efforts to control the viral spreading of disease and efforts to reach sufficient immunization, referred to as herd immunity (MacDonald & SAGE Working Group on Vaccination Hesitancy, 2015; World Health Organization, 2019). Vaccine hesitancy is a complex problem as it differs across context, time, place, and different vaccines (WHO, 2015; WHO, 2014). Research across- and within countries on a subnational and regional level is therefore crucial to address specific barriers to vaccine uptake to identify vulnerable population groups and react deftly (Dubé et al., 2014; Paul et al., 2021; Murphy et al., 2021; Cascini et al., 2021; WHO, 2014). Meanwhile, few studies have been done after the arrival of the vaccines to address vaccine hesitancy determinants. Therefore, using survey data collected during the COVID-19 pandemic from the eastern Oslo districts of Gamle Oslo, Bjerke, Grorud, Stovner, Alna, and Søndre Nordstrand, this study formulated the following research questions:

- *How do sociodemographic characteristics predict vaccine hesitancy?*
- *What are the main reasons for vaccine hesitancy?*
- *How do sociodemographic characteristics predict main reasons for vaccine hesitancy?*

1.2 Previous research

1.2.1 Sociodemographic predictors of vaccine hesitancy

It is important to acknowledge that disease impact is unequal and that many (social) factors contribute to this (Hoven et al., 2022). Previous research has shown that sociodemographic characteristics significantly influence the uptake of vaccines. Current literature has however mostly focused on measuring hypothetical vaccine intention as few studies have assessed sociodemographic predictors of vaccine hesitancy after the arrival of the COVID-19 vaccines. Additionally, inconsistent results across studies demonstrate that vaccine hesitancy determinants cannot be assumed (WHO, 2015).

The vast majority of COVID-19 studies found significant gender differences, generally displaying higher hesitancy among women (Alabdulla et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Kasrine et al., 2021; Magadmi & Kamel, 2021; Rodríguez-Blanco, 2021; Fisher et al., 2020; Murphy et al., 2021; Paul et al., 2021; Cascini et al., 2021; Edwards et al., 2021; Mondal et al., 2021). Some studies however found men to be more hesitant, including one study from Norway (Luk et al., 2021; Cascini et al., 2021; Ebrahimi et al., 2021). Most literature seems to focus on gender differences in virus exposure such as high exposure for women as they frequently work as frontline healthcare workers (Goodman & Heidari, 2021), but few studies substantiate differences in vaccine hesitancy.

Public health messaging emphasizes the increased vulnerability for severe COVID-19 illness of older adults (especially 60+) and those with underlying health conditions compared to others (WHO, 2022; CDC, 2021; Helsedirektoratet, 2022). Not surprisingly, higher vaccine hesitancy is mostly found among younger age groups (Luk et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Rodríguez-Blanco, 2021; Fisher et al., 2020; Robertson et al., 2021; Murphy et al., 2021; Edwards et al., 2021; Cascini et al., 2021). Still, some studies found older adults to be more vaccine hesitant (Abedin et al., 2021; Magadmi & Kamel, 2021; Dubé et al., 2014; Mondal et al., 2021), whilst no significant associations with age were indicated in Norway (Ebrahimi et al., 2021).

A systematic review by the Norwegian Institute of Public Health (FHI) showed that in Norway and other Nordic countries (e.g., Denmark), immigrant and ethnic minority groups have suffered disproportionately from COVID-19 compared to native Norwegians (Vist et al., 2021). Studies across different places have yielded similar results, displaying increased

vulnerability for severe COVID-19 outcomes among these population groups (Hildreth & Alcendor, 2021; Vist et al., 2021). Meanwhile, though vaccine hesitancy is believed to be prevalent across all population groups, many studies found higher levels among ethnic minorities (Dubé et al., 2014; Robertson et al., 2021; Paul et al., 2021; Murphy et al., 2021; Khubchandani et al., 2021; Mondal et al., 2021; Crawshaw et al., 2021; Cascini et al., 2021). In contrast to this, a previous Norwegian study found no differences in hesitancy between immigrants and native Norwegians (Ebrahimi et al., 2021). As previously mentioned, vaccine hesitancy differs across regions (Dubé et al., 2014). Eastern Oslo, a deprived area relative to other parts of the city, is known for its diversity in ethnic minorities and socioeconomic deprivation (Mouratidis, 2020). This may connect to the increased vulnerability of ethnic minorities mostly living in Oslo's eastern districts (Statistisk sentralbyrå, 2021). The majority of literature found people living in rural, semi-urban, slum, or more broadly stated 'disadvantaged areas' to be more vaccine hesitant (Abedin et al., 2021; Cascini et al., 2021; Murphy et al., 2021; Khubchandani et al., 2021; Edwards et al., 2021; Ebrahimi et al., 2021).

Health literacy (HL) is understood as people's capacity to access, understand, evaluate and use health information to make informed health decisions (Institute of Medicine (US) Committee on Health Literacy, 2004; Berkman, Davis & McCormack, 2010). As the world is battling the COVID-19 pandemic, it is also dealing with an infodemic where misinformation about COVID-19 and vaccines is amplified due to social media (Zarocostas, 2020). In turn, such information shortage may add to people's vaccine hesitancy. Low education and income levels have generally been associated with poor HL (Umakanthan & Lawrence, 2022), yet in the face of the current pandemic where less is known, people with higher levels of education or income may also show lower HL (Spring, 2020). As educated people may search actively for health information, increased levels of vaccine hesitancy were found in higher education by a systematic review pre-COVID-19 (Dubé et al., 2014). Contrastingly, Tahir et al., (2021) suggested that higher educated individuals may have increased awareness resulting in the renunciation of conspiracy theories and myths. Lower education has however quite persistently been associated with vaccine hesitancy in the current pandemic (Abedin et al., 2021; Tahir et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Magadmi & Kamel, 2021; Rodríguez-Blanco et al., 2021; Larson et al., 2014; Fisher et al., 2020; Robertson et al., 2021; Paul et al., 2021; Edwards et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Khubchandani et al., 2021). Contrary to most literature, education was not significant in studies from Norway and Lebanon, illustrating the overall inconsistency (Ebrahimi et al.,

2021; Kasrine et al., 2021). Furthermore, both with the current pandemic as in previous literature, lower income is also generally associated with higher vaccine hesitancy (Tahir et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Larson et al., 2014; Murphy et al., 2021; Paul et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Khubchandani et al., 2021). This may result from a lack of information about the vaccines due to lower access to healthcare services (Guay, Gosselin, Petit, Baron & Gagneur, 2019).

1.2.2 Vaccine hesitancy in Norway

There is a general need for adequate information about countries that are underrepresented in literature on vaccine hesitancy (Larson et al., 2014), which applies to Norway. Low rates of vaccine hesitancy were previously measured among the Norwegian population (+/- 11%) compared to other European countries (between 17-46%) (Ebrahimi et al., 2021). General high levels of trust in authorities by the Norwegian population are mentioned as possible explanations for this (Helsingen et al., 2020; Edlund, 1999) and were found a strong predictor of vaccine acceptance in other countries as well (Lazarus et al., 2021). However, vaccine hesitancy has not been addressed after the arrival of the COVID-19 vaccines whilst concerns about vaccine hesitancy in eastern Oslo have been expressed (Stoksvik, 2021, March 2; Capar, 2021, July 5). Furthermore, Cascini et al., (2021) highlight the importance of identifying contributors to vaccine hesitancy in individualistic societies (such as Norway) where vaccination is voluntary. Timely understanding of COVID-19 vaccine hesitation in specific contexts is therefore urgently stressed by many, on a national, regional, and even district level (Larson et al., 2014; Luk et al., 2021; Dubé et al., 2014; Robertson et al., 2021; WHO, 2014; Cascini et al., 2021).

1.2.3 The "3Cs" model: categorizing reasons for vaccine hesitancy

Drawing upon previous research (Betsch et al., 2015; Dubé et al., 2015; MacDonald & SAGE Working Group on Vaccine Hesitancy, 2015; WHO, 2014), the WHO's Strategic Advisory Group of Experts (SAGE) developed the "3Cs" model which categorizes reasons for vaccine hesitancy among three main factors: confidence, complacency, and convenience. Confidence barriers refer to worries about the safety and effectiveness of the vaccine, including trust in authorities, professional competencies, as well as the vaccine delivery systems. Complacency encompasses individuals with low self-perceived risk of a disease that may be prevented by vaccination where other life or health values weigh heftier (WHO, 2014). Self-efficacy may be high, where individuals may have high confidence in personal abilities for prevention,

viewing vaccines as an unnecessary preventive measure (WHO, 2017). Matters such as availability, accessibility, affordability, and the widespread reach and understanding of health messages from authorities about the vaccine contribute to vaccine convenience. COVID-19 vaccines in Norway are free of charge and have been actively offered to all residents, which may reduce chances of vaccination failures due to practical concerns (Folkehelseinstittutet, n.d.). Nevertheless, Minister of Integration and Education, Guri Melby, suggested that such barriers may still exist in eastern Oslo due to the high proportion of immigrants in these districts (Capar, 2021, July 5). As such, convenience barriers may be present due to low health literacy or language barriers, as also suggested by district director of Ullern, Marie Anbjørg, (WHO, 2017; MacDonald & SAGE Working Group on Vaccine Hesitancy, 2015; Stoksvik, 2021, March 2).

1.2.4 Empirical studies on reasons for vaccine hesitancy

With the rapid development of the COVID-19 vaccines, confidence barriers have played a central role (McAteer et al., 2020; Alabdulla et al., 2021; Luk et al., 2021; Fisher et al., 2020; Paul et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Ebrahimi et al., 2021; Magadmi & Kamel, 2021). Relating to complacency, the COVID-19 vaccines were frequently viewed as unnecessary or unwanted (Cascini et al., 2021; Luk et al., 2021; Fisher et al., 2020; Tahir et al., 2021). In general with vaccines, lack of knowledge and misinformation may result in wrongly interpreting side effects (e.g. flu) resulting from vaccines as an adverse effect of the vaccine itself (Dubé et al., 2014). Individuals may disbelieve the benefits resulting from vaccines (Paul et al., 2021). High levels of self-efficacy were found among Norwegians where individuals rather incorporated protective measures or preferred natural development of immunity (Ebrahimi et al., 2021). Lack of trust in health authorities, other services, and systems involved in vaccination programs has also shown to play into vaccine hesitancy, both with the COVID-19 vaccines as well as others (Fisher et al., 2020; Dubé et al., 2014; Ebrahimi et al., 2021). Media and other communication channels also influence the spreading of unjust information resulting in vaccine mistrust (Fisher et al., 2020; Dubé et al., 2014; Cascini et al., 2021). Furthermore, religious beliefs have been found as an important factor for vaccine hesitancy in previous pandemics (Dubé et al., 2014). Even in the current pandemic, associations between vaccine hesitancy and high levels of religiosity were found (Edwards et al., 2021). Although religions do not frequently prohibit vaccines, they may impede vaccine acceptance. Lastly, convenience barriers may strongly vary per country as geographical or economic factors may facilitate (or complicate) the accessibility and affordability of the

vaccine. Expectedly, vaccine hesitancy in Norway links more to confidence and complacency barriers as COVID-19 vaccines have actively been offered free of charge to all residents.

1.2.5 Summing up

The world is not prepared to respond to pandemics. The WHO therefore stresses the cruciality of pandemic preparedness in which countries ought to continuously plan, develop and revise (sub)national responses to pandemic outbreaks (WHO Regional Office for Europe, n.d.). With the current COVID-19 pandemic, all efforts are aimed at counteracting further viral spreading. Undoubtedly, vaccine development is necessary for combatting a pandemic, but it is not sufficient. If enough people refuse to take vaccines, pandemics cannot be controlled and detrimental health consequences will follow. This denotes an urgent need for social research. The WHO's SAGE has therefore long called upon governments' responsibilities to address vaccine hesitancy 'hotspots' in new research to shape more tailored and nuanced approaches (WHO, 2014), as this study aims to do in Norway's anticipated epicenter. Because few studies have been done after the arrival of the vaccines, this study contributes to the current literature by first addressing how vaccine hesitancy is predicted by sociodemographic characteristics. This may enable the identification of vulnerable population groups who are prone to disproportionately suffering. To develop tailored public health strategies, main reasons for vaccine hesitancy are explored. Lastly, this study shall address how these reasons are predicted by sociodemographic characteristics. Insights into these reasons and comparison between these predictors may further aid the development of prioritization strategies to tailor and target public health responses effectively to hesitant subgroups and increase vaccine uptake (Goodman & Heidari, 2021; Fisher et al., 2020; Abedin et al., 2021; Dubé et al., 2014; Luk et al., 2021; Cascini et al., 2021; Robertson et al., 2021). As similar results may be found in other hotspots in other countries, these questions need to be addressed properly. Moreover, vaccine hesitancy research is a concern for all as it is crucial for life and death and the burden of this behavior can have a worldwide impact. This study therefore has an immediate global implication both in fighting the current pandemic, as well as preparedness for ones to come.

2. Methods and data

2.1 Study design and data collection procedure

This cross-sectional study used primary data from a survey database developed between researchers at OsloMet's Center for Research on Pandemics & Society (PANSOC) and the Pandemic Center at the University of Bergen. The survey was administered by an external

firm, Kantar, and conducted online in June 2021 among residents in six eastern districts of Oslo (Alna, Bjerke, Gamle Oslo, Grorud, Søndre Nordstrand, and Stovner) with consistently high COVID-19 infection rates. The sample was recruited proportionately according to the population in the different districts. Moreover, these districts were chosen due to high migrant density. Additionally, the survey was translated into six different languages (English, Somali, Arabic, Urdu, Polish, and Norwegian) to encourage participation among ethnic minorities. With Kantar's access to all phone numbers from a population database, 59,978 texts were sent out to residents in the six parishes (+/- 10,000 per parish). Response rates were low (9.1%) with 5,447 participants completing the survey. Six respondents were excluded during the data cleaning processes due to rapid survey completion, unclarity of open-ended questions, or a large number of skipped questions. This resulted in a total sample of 5,442 respondents.

2.2 Measurement of variables

Sociodemographic characteristics were employed as predictor variables and included gender, age, born in Norway, education, and household income (see appendix 1 or table 1 in the article). As an indicator for ethnic minority status, participants were asked whether they were born in Norway (yes/no). Data comparison between Norway's statistical office and the survey indicated overrepresentations of women, older age, participants born outside of Norway, and higher education (university) (Oslo kommune statistikkbanken, 2021).

Table A. The relative representativeness of population and sample

Sociodemographic characteristics	**Composition of population**	**Composition of sample**
	n (%)	***n* (%)**
Gender		
Male	12,2776 (50.5)	2,270 (41.7)
Female	12,0511 (49.5)	3,171 (58.3)
Age		
18-29	41,292 (21.4)	737 (13.5)
30-44	63,981 (33.2)	1,637 (30.1)
45-59	45,715 (23.8)	1,496 (27.5)
60+	41,636 (21.6)	1,571 (28.9)
Born in Norway		
Yes	121,081 (49.8)	3,553 (78.6)
No	122,206 (50.2)	966 (21.4)

Education		
Primary	55,848 (28.9)	329 (6.1)
High school/ vocational school	60,209 (31.1)	1,812 (33.6)
University <= 4 years	49,994 (25.9)	1,702 (31.6)
University > 4 years	27,347 (14.1)	1,550 (28.7)

Note. *Population and sample frequencies represent the six districts of Alna, Gamle Oslo, Bjerke, Grorud, Søndre Nordstrand, and Stovner.

*Due to different categories at Norway's statistical office, the education variable in the survey was collapsed to match and compare categories.

*Only average income in a specific year was available for the different districts. Median income from the survey income variable was therefore used to compare.

Outcome variables included the variable on vaccine intention and main reasons for vaccine hesitancy (see figure 1). This study follows the definition of vaccine hesitancy as stated by the WHO which measures vaccine hesitancy through vaccine intention. Hesitant individuals are the sum of those who show no intention or are unsure about taking the vaccine (WHO, 2014). As this study focuses on hesitant versus non-hesitant people, a binary variable was created that grouped hesitant individuals (no and unsure) versus the rest of the (non-hesitant) sample. Vaccine hesitant participants were subsequently asked about their main motivations against taking the vaccine (multiple options). All 16 reasons were coded as binary variables (no vs. yes). This resulted in varying frequencies for various reasons as no minimum nor limit was set to the number of reasons participants had to choose.

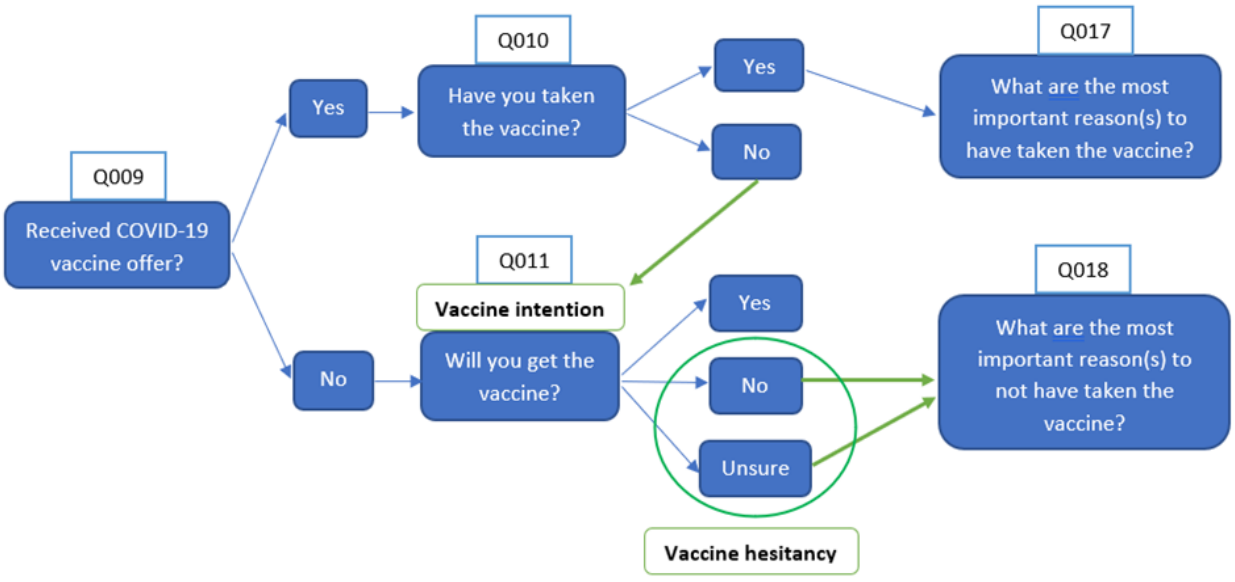

Figure 1. Overview of survey variables capturing vaccine hesitancy.

2.3 Statistical Analyzes

Statistical analyses were conducted in IBM SPSS Statistics 27. All statistical tests used a significant alpha level of .05. No concerns for multicollinearity among the variables were indicated as no VIF-values exceeded 1.2. Non-answered questions were excluded from analyses and resulted in sometimes large numbers of missing cases in the analyses due to several variables including a 'prefer not to answer'-option. Missing cases mostly derived from non-answers on income, education and country of birth which may be because this is viewed as sensitive information by participants (Barnett et al., 2017). Due to the categorical nature of all variables, descriptive analyses were generated to assess the distribution of all variables through proportions and percentages. Rather than using a chi-square test to assess (descriptive) associations between the variables, this study aimed to explore how sociodemographic characteristics could predict likelihood of two outcomes/behaviors: 1) vaccine hesitancy, 2) reasons for vaccine hesitancy. As these outcome variables were categorical and binary coded, logistic regression models were found appropriate (Field, 2017). Main reasons for vaccine hesitancy were discovered through descriptive statistics.

2.4 Strengths and limitations

To our knowledge, this is the first study that not only addresses sociodemographic predictors of-, but also reasons for vaccine hesitancy in Norway after the arrival of the COVID-19 vaccines. Simultaneously, findings are linked to theory to add durability to results for forthcoming pandemics. Moreover, this study addresses vaccine hesitancy in the anticipated hotspot of a country that is underrepresented in literature, thus providing an important contribution to empirical literature. As such, in-depth insights into vaccine hesitancy are provided in which behavioral trends may be discovered which will be crucial in pandemic preparedness. This study is limited as no causal inferences can be made due to the studies' cross-sectional design (Bryman, 2016), and results cannot be compared with other districts in Oslo or areas in Norway because the survey data contains information from six eastern parishes in Oslo. Furthermore, the sample size was small due to the small hesitant sample and many missing cases due to blank answers on the income, education, and/or country of birth variable. Statistical power and generalizability of the regression models were therefore less strong than desired. This may have also contributed to fewer significant relationships between the variables. Moreover, the risk of a non-response bias is amplified in (web-based) surveys (Groves & Peytcheva, 2008; Sax & Bryant, 2003). This refers to wrongly interpreting population characteristics based on the sample whilst certain subgroups may be

underrepresented (Berg, 2005). As aforementioned, table A suggests underrepresentation of several subgroups. These sampling biases seem frequently present in epidemiological studies that require voluntary survey participation, especially in surveys that measure controversial behavior such as vaccine hesitancy. Also, non-response biases are typically high among individuals that engage in risky behavior which may further contribute to underestimation of vaccine hesitancy. Although this problematizes assessment of vaccine hesitancy, associations between variables seem rather insensitive to this (Cheung et al., 2017). It can however be argued that even with high nonresponse rates, results are not necessarily biased and are still scientifically valuable (Hellevik, 2016).

2.5 Ethical considerations

As stated by Bryman (2016), ethical values such as informed consent, autonomy, and confidentiality should be taken into account. The survey required informed consent and autonomy was maintained as participation was voluntary and participants were free to withdraw from the survey at any time. Also, questions frequently included a 'prefer not to answer'-option. This study used data that was collected, processed, and anonymized by third parties and subsequently made available to the author of this study. The original survey was granted ethical approval by the Regional Ethics Committee (reference: 250310). Privacy was thus protected as no personal information of participants was available to the author. Text messages were sent to potential participants who were at least 18 years old.

3. Results

In total, 316 participants showed no intention, or were unsure about taking the vaccine (table 2 in the article). The relative proportion of vaccine hesitant individuals was thus (316/5,442) x 100 = 5.8% of the total sample. Low likelihood of hesitancy was found among participants older than 45 years, completing over 4 years of university education, and in the highest income group compared to those who were younger, primary educated, and with low household income (table 3 in article). Participants born outside of Norway predicted higher odds ratios for vaccine hesitancy than those born in Norway. Table 4 in the article shows the main reasons for vaccine hesitancy. Women, age group 30-44 years and those born in Norway were more likely hesitant due to little experience with the vaccines compared to men, those aged under 29 and born outside of Norway (table 5 in the article). Similarly, participants born in Norway and women were more likely hesitant due to risk of side effects of the vaccines. Participants over 60 years reported substantially low odds ratios for not feeling to belong to a

COVID-19 risk group or not needing the vaccine compared to younger participants (<29 years). Results among income strongly varied and showed no tendency.

4. Discussion and conclusion

This study raised three research questions. Firstly, to discover sociodemographic predictors of vaccine hesitancy. Results suggest that participants of younger age (<45), born outside of Norway, with lower education (primary) and lower household income (<200,000 NOK) show increased likelihood of vaccine hesitancy. Vaccine hesitancy proneness among these groups is plausible as they align with the majority of literature (Abedin et al., 2021; Tahir et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Magadmi & Kamel, 2021; Rodríguez-Blanco et al., 2021; Luk et al., 2021; Murphy et al., 2021; Fisher et al., 2020; Robertson et al., 2021; Paul et al., 2021; Edwards et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Khubchandani et al., 2021; Crawshaw et al., 2021).

Secondly, this study aimed to address main reasons for vaccine hesitancy. As expected from previous literature, vaccine hesitancy is mainly due to confidence and complacency barriers as grouped by the "3Cs" model (MacDonald & SAGE Working Group on Vaccine Hesitancy, 2015; WHO, 2014; McAteer et al., 2020; Alabdulla et al., 2021; Luk et al., 2021; Fisher et al., 2020; Paul et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Ebrahimi et al., 2021; Magadmi & Kamel, 2021; Tahir et al., 2021). Considering that data collection took place not long after the introduction of the rapidly developed COVID-19 vaccines, confidence barriers are conceivable. Complacency barriers may have resulted from a lack of evidence at the time related to how long immunity following infection persists and the risk of re-infection. Furthermore, few participants were hesitant due to distrust in health authorities and professionals which further confirms the aforementioned high trust in Norwegian authorities compared to other nations (Ebrahimi, 2021; Ritchie et al., 2020; Helsingen et al., 2020; Edlund, 1999). Factors such as a high-trust society in combination with a transparent government and a strong welfare state in Norway are suggested contributors to this (Christensen & Lægreid, 2020).

Lastly, this study aimed to explore how main reasons for vaccine hesitancy are explained by sociodemographic characteristics. Findings indicate that women and participants born in Norway were most likely to experience confidence barriers in the vaccines. Using country of birth as an indicator for ethnic minorities, current findings aligned with the majority of

literature in which ethnic minorities showed increased likelihood of vaccine hesitancy regardless of their widely documented increased vulnerability to severe COVID-19 outcomes (Hildreth & Alcendor, 2021; Vist et al., 2021; Dubé et al., 2014; Robertson et al., 2021; Paul et al., 2021; Murphy et al., 2021; Khubchandani et al., 2021; Mondal et al., 2021; Crawshaw et al., 2021; Cascini et al., 2021). However, current findings indicated lower likelihood of vaccine hesitancy due to specific reasons compared to participants born in Norway. This emphasizes the vulnerability of ethnic minorities, as this may denote convenience barriers in which health information is misunderstood or not accessed resulting from barriers in health literacy or possibly language (WHO, 2017; MacDonald & SAGE Working Group on Vaccine Hesitancy, 2015; Stoksvik, 2021, March 2). Although education significantly predicted differences in vaccine hesitancy likelihood, no significant relations were found with any of the main reasons. This may also denote convenience barriers linked to health literacy as education has been identified as a robust predictor of vaccine hesitancy (Abedin et al., 2021; Tahir et al., 2021; Graeber, Schmidt-Petri & Schröder, 2021; Magadmi & Kamel, 2021; Rodríguez-Blanco et al., 2021; Larson et al., 2014; Fisher et al., 2020; Robertson et al., 2021; Paul et al., 2021; Edwards et al., 2021; Cascini et al., 2021; Mondal et al., 2021; Khubchandani et al., 2021).

This study provides important insights for public health responses into varying sociodemographic predictors of-, and barrier trends for COVID-19 vaccine hesitancy in a vulnerable area that was yet to be addressed. The vulnerable position of younger age, ethnic minorities, lower education, and lower household income to COVID-19 vaccine hesitancy proneness is emphasized. As in this study, future research should integrate both empirical and theoretical literature on vaccine hesitancy to develop durable strategies for pandemic preparedness. To verify current results, similar research should be carried out with a larger sample to produce more robust analyses on both vaccine hesitancy prevalence and relationships between variables. Moreover, the presence of convenience barriers among ethnic minorities and lower education needs further exploration. Varying barrier trends suggest the need for tailored policy strategies targeted to vulnerable subgroups to increase vaccine willingness. As results indicated that they are highly trusted, health authorities and professionals may be of significant importance to lower existing barriers and improve health literacy by providing clear health communication about the risks, benefits and importance of vaccines. Counteracting these barriers is critical to public health in both the current and forthcoming pandemics.

Bibliography

Abedin, M., Islam, M. A., Rahman, F. N., Reza, H. M., Hossain, M. Z., Hossain, M. A., Arefin, A., & Hossain, A. (2021). Willingness to vaccinate against COVID-19 among Bangladeshi adults: Understanding the strategies to optimize vaccination coverage. *PloS one, 16*(4), 1-17. https://doi.org/10.1371/journal.pone.0250495.

Alabdulla, M., Reagu, S. M., Al-Khal, A., Elzain, M., & Jones, R. M. (2021). COVID-19 vaccine hesitancy and attitudes in Qatar: A national cross-sectional survey of a migrant-majority population. *Influenza & Other Respiratory Viruses, 15*(3), 361-370. https://doi.org/10.1111/irv.12847.

Barnett, A. G., McElwee, P., Nathan, A., Burton, N. W., & Turrell, G. (2017). Identifying patterns of item missing survey data using latent groups: an observational study. *BMJ open, 7*(10), e017284-e017284. https://doi.org/10.1136/bmjopen-2017-017284.

Berkman, N. D., Davis, T. C., & McCormack, L. (2010). Health literacy: what is it? *J Health Commun, 15 Suppl 2*, 9-19. https://doi.org/10.1080/10810730.2010.499985.

Beredskapsetaten-K2. (2021). Korona (Covid-19): *Statistikk over smittede i Oslo og bydelene.* Helseetaten i Oslo kommune. Retrieved 20/10/2021 from https://experience.arcgis.com/experience/742a281a0fa74ab79147a76e6b52833b.

Berg, N. (2005). Non-Response Bias. *ENCYCLOPEDIA OF SOCIAL MEASUREMENT, 2*. https://doi.org/10.1016/B0-12-369398-5/00038-4.

Betsch, C., Böhm, R., & Chapman, G. B. (2015). Using Behavioral Insights to Increase Vaccination Policy Effectiveness. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 61-73. https://doi.org/10.1177/2372732215600716.

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford: Oxford University Press.

Capar, R-I. (2021, July 5). *Vaccination: Priority districts in Oslo are struggling to reach the immigrant population.* Norway Today. https://norwaytoday.info/news/vaccination-priority-districts-in-oslo-are-struggling-to-reach-the-immigrant-population/.

Cascini, F., Pantovic, A., Al-Ajlouni, Y., Failla, G., & Ricciardi, W. (2021). Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review. *EClinicalMedicine, 40,* 101113. https://doi.org/10.1016/j.eclinm.2021.101113.

Centers for Disease Control and Prevention (CDC). (2021). *COVID-19 Risks and Vaccine Information for Older Adults.* https://www.cdc.gov/aging/covid19/covid19-older-adults.html.

Cheung, K. L., Ten Klooster, P. M., Smit, C., de Vries, H., & Pieterse, M. E. (2017). The impact of non-response bias due to sampling in public health studies: A comparison of voluntary versus mandatory recruitment in a Dutch national survey on adolescent health. *BMC Public Health, 17*(1), 276. https://doi.org/10.1186/s12889-017-4189-8.

Christensen, T., & Lægreid, P. (2020). Balancing Governance Capacity and Legitimacy: How the Norwegian Government Handled the COVID-19 Crisis as a High Performer. *Public Administration Review, 80*(5), 774-779. https://doi.org/https://doi.org/10.1111/puar.13241.

Crawshaw, A. F., Deal, A., Rustage, K., Forster, A. S., Campos-Matos, I., Vandrevala, T., Würz, A., Pharris, A., Suk, J. E., Kinsman, J., Deogan, C., Miller, A., Declich, S., Greenaway, C., Noori, T., & Hargreaves, S. (2021). What must be done to tackle vaccine hesitancy and barriers to COVID-19 vaccination in migrants? *Journal of Travel Medicine, 28*(4). https://doi.org/10.1093/jtm/taab048.

Dubé, E., Gagnon, D., & MacDonald, N. E. (2015). Strategies intended to address vaccine hesitancy: Review of published reviews. *Vaccine, 33*(34), 4191-4203. https://doi.org/10.1016/j.vaccine.2015.04.041.

Dubé, E., Gagnon, D., Nickels, E., Jeram, S., & Schuster, M. (2014). Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. *Vaccine, 32*(49), 6649-6654. https://doi.org/https://doi.org/10.1016/j.vaccine.2014.09.039.

Ebrahimi, O. V., Johnson, M. S., Ebling, S., Amundsen, O. M., Halsøy, Ø., Hoffart, A., Skjerdingstad, N., & Johnson, S. U. (2021). Risk, Trust, and Flawed Assumptions: Vaccine Hesitancy During the COVID-19 Pandemic. *Frontiers in Public Health, 9*(849). https://doi.org/10.3389/fpubh.2021.700213.

Edlund, J. (1999). Trust in government and welfare regimes: Attitudes to redistribution and financial cheating in the USA and Norway. *European Journal of Political Research, 35*(3), 341-370. https://doi.org/10.1111/1475-6765.00452.

Edwards, B., Biddle, N., Gray, M., & Sollis, K. (2021). COVID-19 vaccine hesitancy and resistance: Correlates in a nationally representative longitudinal survey of the Australian population. *PloS one, 16*(3), e0248892. https://doi.org/10.1371/journal.pone.0248892.

European Centre for Disease Prevention and Control (ECDC). (2022). *COVID-19 vaccination.* https://www.ecdc.europa.eu/en/covid-19/prevention-and-control/vaccines.

Field, A. (2017). *Discovering Statistics Using IBM SPSS Statistics* (5 ed.). SAGE Publications Ltd.

Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., & Mazor, K. M. (2020). Attitudes Toward a Potential SARS-CoV-2 Vaccine. Annals of Internal Medicine, 173(12), 964-973. https://doi.org/https://doi.org/10.7326/M20-3569.

Folkehelseinstittutet. (n.d.). Koronavaksinasjonsprogrammet. https://www.fhi.no/sv/vaksine/koronavaksinasjonsprogrammet/.

Goodman, T., & Heidari, S. (2021). *Critical sex and gender considerations for equitable research, development and delivery of COVID-19 vaccines.* World Health Organization. https://cdn.who.int/media/docs/default-source/immunization/sage/covid/gender-covid-19-vaccines-sage-background-paper.pdf?sfvrsn=899e8fca_15&download=true.

Graeber, D., Schmidt-Petri, C., & Schröder, C. (2021). Attitudes on voluntary and mandatory vaccination against COVID-19: Evidence from Germany. *PloS one*, *16*(5), 1-18. https://doi.org/10.1371/journal.pone.0248372.

Groves, R. M., & Peytcheva, E. (2008). The impact of nonresponse rates on nonresponse bias: a meta-analysis. *Public opinion quarterly*, *72*(2), 167-189.

Guay, M., Gosselin, V., Petit, G., Baron, G., & Gagneur, A. (2019). Determinants of vaccine hesitancy in Quebec: a large population-based survey. *Human Vaccines & Immunotherapeutics*, *15*(11), 2527-2533. https://doi.org/10.1080/21645515.2019.1603563.

Hellevik, O. (2016). Extreme nonresponse and response bias. *Quality & Quantity*, *50*(5), 1969-1991. https://doi.org/10.1007/s11135-015-0246-5.

Helsedirektoratet. (2022). *Risikogrupper*. Helse Norge. https://www.helsenorge.no/koronavirus/risikogrupper/.

Helsingen, L. M., Refsum, E., Gjøstein, D. K., Løberg, M., Bretthauer, M., Kalager, M., Emilsson, L., & for the Clinical Effectiveness Research, g. (2020). The COVID-19 pandemic in Norway and Sweden – threats, trust, and impact on daily life: a comparative survey. *BMC Public Health*, *20*(1), 1597. https://doi.org/10.1186/s12889-020-09615-3.

Hildreth, J. E. K., & Alcendor, D. J. (2021). Targeting COVID-19 Vaccine Hesitancy in Minority Populations in the US: Implications for Herd Immunity. *Vaccines*, *9*(5), 489. https://www.mdpi.com/2076-393X/9/5/489.

Holmes, M.C.S., & Fausko, L. (2021, March 13). *Oslo får 18.000 vaksiner neste uke – minst 13.000 går til Oslo øst*. VG. https://www.vg.no/nyheter/innenriks/i/7KRk2o/oslo-faar-18000-vaksiner-neste-uke-minst-13000-gaar-til-oslo-oest.

Hoven, H., Dragano, N., Angerer, P., Apfelbacher, C., Backhaus, I., Hoffmann, B., Icks, A., Wilm, S., Fangerau, H., & Söhner, F. (2022). Striving for Health Equity: The Importance of Social Determinants of Health and Ethical Considerations in Pandemic Preparedness Planning. *International Journal of Public Health, 67.* https://doi.org/10.3389/ijph.2022.1604542.

Institute of Medicine (US) Committee on Health Literacy. (2004). *Health Literacy: A Prescription to End Confusion* (L. Nielsen-Bohlman, A. Panzer, & D. Kindig, Eds.). National Academies Press (US). https://doi.org/10.17226/10883.

Kasrine Al Halabi, C., Obeid, S., Sacre, H., Akel, M., Hallit, R., Salameh, P., & Hallit, S. (2021). Attitudes of Lebanese adults regarding COVID-19 vaccination. *BMC Public Health*, *21*(1), 1-7. https://doi.org/10.1186/s12889-021-10902-w.

Khubchandani, J., Sharma, S., Price, J. H., Wiblishauser, M. J., Sharma, M., & Webb, F. J. (2021). COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. *Journal of Community Health*, *46*(2), 270-277. https://doi.org/10.1007/s10900-020-00958-x.

Larson, H. J., Jarrett, C., Eckersberger, E., Smith, D. M. D., & Paterson, P. (2014). Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. Vaccine, 32(19), 2150-2159. https://doi.org/https://doi.org/10.1016/j.vaccine.2014.01.081.

Lazarus, J. V., Ratzan, S. C., Palayew, A., Gostin, L. O., Larson, H. J., Rabin, K., Kimball, S., & El-Mohandes, A. (2021). A global survey of potential acceptance of a COVID-19 vaccine. *Nature Medicine, 27*(2), 225-228. https://doi.org/10.1038/s41591-020-1124-9.

Luk, T. T., Zhao, S., Wu, Y., Wong, J. Y.-h., Wang, M. P., & Lam, T. H. (2021). Prevalence and determinants of SARS-CoV-2 vaccine hesitancy in Hong Kong: A population-based survey. *Vaccine, 39*(27), 3602-3607. https://doi.org/https://doi.org/10.1016/j.vaccine.2021.05.036.

MacDonald, N. E., & SAGE Working Group on Vaccine Hesitancy. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, *33*(34), 4161–4164. https://doi.org/10.1016/j.vaccine.2015.04.036.

Magadmi, R. M., & Kamel, F. O. (2021). Beliefs and barriers associated with COVID-19 vaccination among the general population in Saudi Arabia. *BMC Public Health, 21*(1), 1-8. https://doi.org/10.1186/s12889-021-11501-5.

McAteer, J., Yildirim, I., Chahroudi, A., & Committee, f. t. S. f. P. R. A. (2020). The VACCINES Act: Deciphering Vaccine Hesitancy in the Time of COVID-19. *Clinical Infectious Diseases, 71*(15), 703-705. https://doi.org/10.1093/cid/ciaa433.

Mondal, P., Sinharoy, A., & Su, L. (2021). Sociodemographic predictors of COVID-19 vaccine acceptance: a nationwide US-based survey study. *Public Health, 198*, 252-259. https://doi.org/https://doi.org/10.1016/j.puhe.2021.07.028.

Mouratidis, K. (2020). Neighborhood characteristics, neighborhood satisfaction, and well-being: The links with neighborhood deprivation. *Land Use Policy, 99*, 104886. https://doi.org/https://doi.org/10.1016/j.landusepol.2020.104886.

Murphy, J., Vallières, F., Bentall, R. P., Shevlin, M., McBride, O., Hartman, T. K., McKay, R., Bennett, K., Mason, L., Gibson-Miller, J., Levita, L., Martinez, A. P., Stocks, T. V. A., Karatzias, T., & Hyland, P. (2021). Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nature Communications, 12*(1), 29. https://doi.org/10.1038/s41467-020-20226-9.

Oslo kommune statistikkbanken. (2021). *Oslo kommunes statistikkbank.* https://statistikkbanken.oslo.kommune.no/webview/.

Paul, E., Steptoe, A., & Fancourt, D. (2021). Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. *The Lancet Regional Health - Europe, 1*, 100012. https://doi.org/https://doi.org/10.1016/j.lanepe.2020.100012.

Statistisk sentralbyrå. (2021). *Personer med innvandrerbakgrunn.* Bydelsfakta Oslo kommune. https://bydelsfakta.oslo.kommune.no/bydel/alle/innvandrerbefolkningen/.

Ritchie, H., Mathieu, E., Rodés-Guirao, L., Appel, C., Giattino, C., Ortiz-Ospina, E., Hasell, J., Macdonald, B., Beltekian, D., & Roser, M. (2020). *Coronavirus Pandemic (COVID-19).* Published online at OurWorldInData.org. https://ourworldindata.org/coronavirus.

Robertson, E., Reeve, K. S., Niedzwiedz, C. L., Moore, J., Blake, M., Green, M., Katikireddi, S. V., & Benzeval, M. J. (2021). Predictors of COVID-19 vaccine hesitancy in the UK household longitudinal study. *Brain, Behavior, and Immunity, 94*, 41-50. https://doi.org/https://doi.org/10.1016/j.bbi.2021.03.008.

Rodríguez-Blanco, N., Montero-Navarro, S., Botella-Rico, J. M., Felipe-Gómez, A. J., Sánchez-Más, J., & Tuells, J. (2021). Willingness to Be Vaccinated against COVID-19 in Spain before the Start of Vaccination: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health, 18*(10). https://doi.org/10.3390/ijerph18105272.

Sax, L. J., Gilmartin, S. K., & Bryant, A. N. (2003). Assessing response rates and nonresponse bias in web and paper surveys. *Research in higher education, 44*(4), 409-432.

Spring, H. (2020). Health literacy and COVID-19. *Health Information & Libraries Journal, 37*(3), 171-172. https://doi.org/https://doi.org/10.1111/hir.12322.

Stoksvik, M. (2021, March 2). *Oslo får flere vaksiner: – En gledens dag.* NRK. https://www.nrk.no/osloogviken/flere-vaksiner-til-oslo-og-andre-kommuner-med-mye-smitte-1.15397600.

Tahir, M. J., Saqlain, M., Tariq, W., Waheed, S., Tan, S. H. S., Nasir, S. I., Ullah, I., & Ahmed, A. (2021). Population preferences and attitudes towards COVID-19 vaccination: a cross-sectional study from Pakistan. *BMC Public Health, 21*(1), 1-12. https://doi.org/10.1186/s12889-021-11814-5.

Umakanthan, S., & Lawrence, S. (2022). Predictors of COVID-19 vaccine hesitancy in Germany: a cross-sectional, population-based study. *Postgraduate Medical Journal.* https://doi.org/10.1136/postgradmedj-2021-141365.

Vist, G. E., Arentz-Hansen, E. H., Vedøy, T. F., Spilker, R. S., Hafstad, E. V., & Giske, L. (2021). *Incidence and severe outcomes from COVID-19 among immigrant and minority ethnic groups and among groups of different socio-economic status: A systematic review.* Norwegian Institute of Public Health - Division for Health Services.

World Health Organization. (2022). *COVID-19: vulnerable and high risk groups.* https://www.who.int/westernpacific/emergencies/covid-19/information/high-risk-groups.

World Health Organization. (2014). *Report of the SAGE Working Group on Vaccine Hesitancy.* https://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf.

World Health Organization. (2015). *Summary WHO SAGE conclusions and recommendations on Vaccine Hesitancy*. https://cdn.who.int/media/docs/default-source/immunization/demand/summary-of-sage-vaccinehesitancy-en.pdf?sfvrsn=abbfd5c8_2.

World Health Organization. (2019). *Ten threats to global health in 2019.* https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019.

World Health Organization. (2017). *Vaccination and trust. How concerns arise and the role of communication in mitigating crises.* https://www.euro.who.int/__data/assets/pdf_file/0004/329647/Vaccines-and-trust.PDF.

WHO Regional Office for Europe. (n.d.). *Pandemic preparedness.* https://www.euro.who.int/en/health-topics/communicable-diseases/influenza/pandemic-influenza/pandemic-preparedness#:~:text=Pandemic%20preparedness%20should%20be%20seen,natural%20disasters%20or%20chemical%20incidents.

Zarocostas, J. (2020). How to fight an infodemic. *The Lancet, 395*(10225), 676. https://doi.org/10.1016/s0140-6736(20)30461-x.

Appendix 1: Overview of included variables

Q009 - Tilbudvaksine: Fått tilbud om vaksine

Har du fått tilbud om vaksine mot COVID-19?

Have you been offered a vaccine against COVID-19?

1 - Ja – *yes*

2 - Nei - *no*

Q010 - Vaksinertcovid: Har vaksinert seg mot Covid-19

Har du vaksinert deg mot COVID-19?

Have you been vaccinated against COVID-19?

1 - Ja – *yes*

2 - Nei – *no*

Q011 - Kommercovid: Kommer til å ta vaksinen

Kommer du til å ta vaksine mot COVID-19?

If you have not yet, are you going to get vaccinated against COVID-19?

1 - Ja – *yes*

2 - Nei – *no*

3 - Usikker – *unsure*

Q018 - Viktigstikkevaksinen: Viktigste grunner til ikke å ha tatt vaksinen

Hva er viktigste grunner til at du ikke har tatt eller vil ta, eller er usikker på om du vil ta koronavaksinen?

What are the most important reasons that you have not taken-, or want to take-, or are unsure whether you want to take the COVID-19 vaccine?

1 - Jeg tilhører ikke en av risikogruppene for alvorlig COVID-19 sykdom

- *I do not belong to any of the risk groups for severe COVID-19 disease*

2 - Har ikke behov for vaksine: Sjelden/aldri syk, ikke i målgruppen, tåler en influensa og sannsynligvis også COVID-19

- *Do not need the vaccine: Rarely / never sick, not in the target group, I tolerate the flu and probably COVID-19 also*

3 - Religiøse grunner

- *Religious reasons*

4 - Det er ikke mye smitte i samfunnet

- *There is not much infection in the community*

5 - Har ikke behov for å beskytte meg selv

- *Do not need to protect myself*

6 - Har ikke behov for å beskytte familie/samfunn

- *Do not need to protect family / community*

7 - Redd for/liker ikke leger/sprøyter

- *Afraid of / do not like doctors / syringes*

8 - Ønsker at kroppen skal utvikle naturlig immunitet

- *Want the body to develop natural immunity*

9 - Tror ikke koronavaksinene virker

- *Do not think the COVID-19 vaccines work*

10 - Risiko for bivirkninger av koronavaksinene

- *Risk of adverse reactions to COVID-19 vaccines*

11 - Det er for lite erfaring med bruk av vaksinene

- *There is too little experience with the use of the vaccine*

12 - Generelle motforestillinger mot vaksine: jeg er vaksinemotstander, aldri tatt vaksiner, prinsipielt, ikke komfortabel med nye vaksiner, hørt mye rart, etc.

- *General objections to vaccines: I am a vaccine opponent, never taken vaccines, in principle, not comfortable with new vaccines, heard a lot of strange things, etc.*

13 - Jeg stoler ikke på helsepersonell

- *I do not trust healthcare professionals*

14 - Jeg stoler ikke på anbefaling fra helsemyndighetene/kommunen

- *I do not trust the recommendation from the health authorities / municipality*

15 – Mediaoppmerksomhet

- *Media attention*

16 - Annet

- *Different*

Q024 - Alder (fødselsdato)

Hva er din alder?

What is your age?

**open*

Later grouped into categories:

18-29 år - *18-29 years*

30-44 år - *30-44 years*

45-59 år - *45-59 years*

60+ år - *60+ years*

Q025 – Kjønn

Hva er ditt kjønn?

What is your gender?

1 - Kvinne – *Female*

2 - Mann - *Male*

Q026 – Utdanning

Hva er din høyeste fullførte skolegang?

What is your highest completed schooling?

1 - Grunnskoleutdanning - 10-årig grunnskole, 7-årig folkeskole

- *Primary school education - 10-year primary school, 7-year primary school*

2 - Videregående allmennfaglig utdanning

- *Upper secondary general education*

3 - Videregående yrkesfaglig utdanning

- *Upper secondary vocational educatio*n

4 - Fagskole / Yrkesrettede utdanninger (1/2 - 2 år) som bygger på videregående yrkesfaglig utdanning

- *Vocational school / Vocational education (1/2 - 2 years) based on upper secondary vocational education*

5 - Universitets-/høgskoleutdanning med inntil 4 års varighet

- *University / college education with up to 4 years duration*

6 - Universitets-/høgskoleutdanning med mer enn 4 års varighet

- *University / college education with more than 4 years duration*

Q030 - Husstands inntekt

Omtrent hvor stor er din husstands samlede brutto årsinntekt (før skatt og fradrag)?

Approximately how large is your household's total gross annual income (before taxes and deductions)?

1- Under 200 000 kroner - *Less than 200 000*

2 - 200 000 - 399 999 kroner

3 - 400 000 - 599 999 kroner

4 - 600 000 - 799 999 kroner

5 - 800 000 - 999 999 kroner

6 - 1 000 000 - 1 199 000 kroner

7 - 1 200 000 - 1 399 000 kroner

8 - 1 400 000 kroner eller mer - *1 400 000 kroners or more*

9 - Ønsker ikke å svare - *Do not want to answer*

Q031 – Fodelandnorge

Er du født i Norge?

Are you born in Norway?

1 - Ja – *yes*

2 - Nei – *no*

PART II – ARTICLE

Sociodemographic predictors of COVID-19 vaccine hesitancy and main reasons against the vaccines in eastern Oslo: A cross-sectional study.

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Background

Vaccines are an essential public health strategy to curb viral infection spreading that hinge on vaccine uptake (1, 2). Vaccine hesitancy may however greatly threaten this. Vaccine hesitancy is defined by the WHO as either delayed acceptance or refusal of a vaccine despite its availability. It has been addressed as one of top ten major global health threats which may undermine global efforts to control the viral spreading of disease and efforts to reach sufficient immunization, referred to as herd immunity (3, 4). Vaccine hesitancy is however a complex problem as it continuously evolves across context, time, place, and different vaccines (2, 5).

Previous literature has identified several sociodemographic factors contributing to vaccine hesitancy. Overall, women show more vaccine hesitancy than men (6-16). As public health messages have emphasized the increased vulnerability for severe COVID-19 outcomes for older adults (especially 60+) and those with underlying health conditions compared to others (17-19), vaccine hesitancy is mostly found among younger age groups (7, 10-12, 14, 15, 20, 21). Increased vaccine hesitancy is also found among ethnic minorities even though they have shown prone to disproportionate suffering from COVID-19 (12-14, 16, 21-26). Additionally, the majority of literature has found associations between vaccine hesitancy and low education (7, 9-11, 13-16, 21, 25, 27-29), as well as low-income levels (7, 12-14, 16, 25, 28, 29). Moreover, both low education and income are associated with low health literacy which may contribute to vaccine hesitancy. Still, many inconsistent results across studies demonstrate that sociodemographic predictors of vaccine hesitancy cannot be assumed (5).

The WHO's Strategic Advisory Group of Experts (SAGE) developed the "3Cs" model which categorizes reasons for vaccine hesitancy among three main factors: confidence, complacency, and convenience (2, 3). Confidence barriers refer to worries about the safety and effectiveness of the vaccine. Complacency encompasses individuals with low self-perceived risk of a disease that may be prevented by vaccination where other life or health values weigh heftier (2). Self-efficacy may be high, where individuals may have high confidence in personal abilities for prevention, viewing vaccines as an unnecessary preventive measure (30). Matters such as availability, accessibility, affordability, and the widespread reach and understanding of health messages (health literacy) from authorities about the vaccine contribute to vaccine convenience. Although COVID-19 vaccines have been actively offered to all Norwegian residents free of charge, convenience barriers resulting from low

health literacy or language barriers cannot be excluded due to the high migrant density in eastern Oslo (3, 30, 31).

As current literature has primarily focused on measuring hypothetical vaccine intention, few studies have assessed sociodemographic predictors of vaccine hesitancy after the arrival of the COVID-19 vaccines. Due to its continuous evolution, research across- and within countries on a subnational and regional level is crucial to identify predictors and address specific barriers in vaccine uptake to identify vulnerable population groups and react deftly with more tailored and nuanced approaches (2, 12-14, 24). In March 2021, several municipalities in Norway received extra vaccine doses due to consistent high COVID-19 infection rates (31, 32). In Oslo, these were mostly assigned to six eastern districts with high infection pressure. Although vaccine acceptance is expected to be high in Norway due to generally high levels of trust in Norwegian authorities (33-36), eastern Oslo is known as a deprived area relative to other parts of the city with high ethnic minority density where vaccine hesitancy is suspected (37). Therefore, by using survey data collected during the COVID-19 pandemic from these prioritized districts, this study aims to investigate sociodemographic predictors of vaccine hesitancy, explore what main reasons for vaccine hesitancy are, and how these reasons are predicted by sociodemographic characteristics. This may enable the identification of vulnerable subgroups and in turn aid the development of tailored public health strategies targeted accordingly to increase vaccine uptake (11, 14, 20, 21, 24, 27, 38). Furthermore, this study shall address vaccine hesitancy after the arrival of the vaccines, thus adding to the current underrepresentation of Norway in related literature. This may be of substantial importance for public health responses in the current and forthcoming pandemics.

Methods

This cross-sectional study used primary data from a survey database developed between researchers at OsloMet's Center for Research on Pandemics & Society (PANSOC) and the Pandemic Center at the University of Bergen. The survey was administered by an external firm, Kantar, and conducted online in June 2021 among residents in six eastern districts of Oslo (Alna, Bjerke, Gamle Oslo, Grorud, Søndre Nordstrand, and Stovner). The sample was recruited proportionately according to the population in the different districts. These areas were also chosen due to high migrant density as one goal of the overall project was to investigate disparities based on migrant status. Additionally, the survey was translated into six different languages (English, Somali, Arabic, Urdu, Polish, and Norwegian) to encourage

participation among ethnic minorities. With access to all phone numbers from a population database, 59,978 texts were sent out to residents in the six districts (approximately 10,000 per parish). Response rates were low (9.1%) and 5,447 participants completed the survey. Six respondents were excluded during the data cleaning processes due to rapid survey completion, unclarity of open-ended questions, or a large number of skipped questions. This resulted in a total sample of 5,442 respondents.

Sociodemographic characteristics included gender, age, born in Norway, education, and household income (see table 1). As an indicator for ethnic minority status, participants were asked whether they were born in Norway (yes/no). Hesitant individuals are the sum of those who show no intention or are unsure about taking the vaccine (2). Vaccine hesitant participants were subsequently asked about their main motivations against taking the vaccine (multiple options). Only reasons chosen by more than 15% of the hesitant sample were considered as main reasons for further analyses.

Statistical analyses

Statistical analyses were conducted in IBM SPSS Statistics 27.0 (Armonk, NY: IBM Corp). Due to the categorical nature of all variables, descriptive analyses were generated to assess the distribution of all variables through proportions and percentages. All statistical tests used a significant alpha level of .05. As outcome variables were also categorical and binary, logistic regression models were employed to predict odds ratios. First, to explore how sociodemographic characteristics predicted vaccine hesitancy. Subsequently, binary logistic models assessed how sociodemographic characteristics predicted main reasons for vaccine hesitancy. Main reasons for vaccine hesitancy were discovered through descriptive statistics.

Results

Sociodemographic characteristics

Of the 5,442 participants, nearly 60% were women (table 1). Participants aged between 18-29 years constituted 13.5% of the sample compared to roughly double representation rates for other age groups. The majority of the sample was born in Norway (78.6%) and most participants completed a university/college degree equivalent to 4 years (31.3%) or over 4 years (28.5%). Nearly 50% of the sample earned under the median household income of 800,000-999,999 Norwegian kroner (NOK).

Table 1. Sociodemographic characteristics of participants (N = 5442)

Sociodemographic characteristics	***n* (%)**
Gender	
Male	2,270 (41.7)
Female	3,171 (58.3)
Age	
18-29	737 (13.5)
30-44	1,637(30.1)
45-59	1,496 (27.5)
60+	1,571 (28.9)
Born in Norway	
Yes	3,553 (78.6)
No	966 (21.4)
Highest completed education	
Primary (10, 7 year)	329 (6.0)
Higher general	785 (14.4)
Higher vocational	512 (9.4)
Vocational school/vocational education (1/2 - 2 years) based on upper secondary vocational education	515 (9.5)
University <= 4 years	1,702 (31.3)
University > 4	1,550 (28.5)
Gross household annual income	
Under 200.000 kroner	142 (3.1)
200.000-399.999 kroner	435 (9.6)
400.000-599.999 kroner	797 (17.6)
600.000-799.999 kroner	742 (16.4)
800.000-999.999 kroner	667 (14.8)
1.000.000-1.199.000 kroner	626 (13.9)
1.200.000-1.399.000 kroner	469 (10.4)

1.400.000 kroner or more	641 (14.2)

Note. Unanswered questions were excluded from analyses. This resulted in sometimes large numbers of missing cases in the analyses which mostly derived from blank answers on income (*n* = 876) and otherwise education (*n* = 54) or country of birth (*n* = 35).

Vaccine distribution, uptake, and intention

The majority of participants (77.1%) had received a vaccine offer of whom 87.1% (*n* = 3,657) had taken the vaccine (table 2). Participants who had not received the vaccine yet and those who declined the offer were asked about their vaccine intention ("Will you take the vaccine?") (*n* = 1,785). Those who answered 'no' or 'unsure' to vaccine intention compose the vaccine hesitant proportion of the sample. On the vaccine intention variable, 5.8% (*n* = 104) showed no intention and 11.9% (*n* = 212) were unsure about taking the vaccine, resulting in a total of 316 hesitant individuals. This brings the relative proportion of hesitant individuals to (316/5,442) x 100 = 5.8% of the total sample.

Table 2. COVID-19 vaccine offers, recipients, and intention

	***n* (%)**
Received COVID-19 vaccine offer	
Yes	4,198 (77.1)
No	1,244 (22.9)
Total	5,442 (100)
Taken COVID-19 vaccine	
Yes	3,657 (87.1)
No	541 (12.9)
Total	4,198 (100)
Will take COVID-19 vaccine	
Yes	1,469 (82.3)
No	104 (5.8)
Uncertain	212 (11.9)
Total	1,785 (100)

Sociodemographic predictors of vaccine hesitancy

Age differences in hesitancy were observed where those aged above 45 years predicted lower

likelihood of hesitancy compared to those younger than 29 (table 3). Furthermore, participants born outside of Norway predicted higher likelihood of vaccine hesitancy than those born in Norway. Individuals with more than 4 years of university education were nearly 50% less likely hesitant compared to those completing primary education. Participants in the highest income group were also less likely hesitant compared to the lowest income group.

Table 3. Logistic regression predicting vaccine hesitancy by sociodemographic predictors (*n* = 4518)

Predictor variables	**Vaccine hesitancy** OR (95% CI)
Gender	
Male	1.00 (Ref)
Female	.99 (.74-1.32)
Age	
18-29	1.00 (Ref)
30-44	1.13 (.76-1.67)
45-59	.25 (.15-.41)***
60+	.21 (.12-.35)***
Born in Norway	
Yes	1.00 (Ref)
No	2.27 (1.67-3.07)***
Highest completed education	
Primary (10, 7 year)	1.00 (Ref)
Higher general	.82 (.43-1.58)
Higher vocational	.84 (.42-1.67)
Vocational school/vocational education (1/2-2 years) based on upper secondary vocational education	.94 (.47-1.89)
University <= 4 years	.54 (.29-1.00)
University > 4	.47 (.25-.89)*
Gross annual household income	
Under 200.000 kroner	1.00 (Ref)

200.000-399.999 kroner	.90 (.46-1.75)
400.000-599.999 kroner	.75 (.39-1.43)
600.000-799.999 kroner	.70 (.36-1.35)
800.000-999.999 kroner	.69 (.35-1.35)
1.000.000-1.199.000 kroner	.50 (.24-1.01)
1.200.000-1.399.000 kroner	.64 (.31-1.34)
1.400.000 kroner or more	.46 (.22-.97)*
Nagelkerke R2	.120

Note. *p < .05; ** p < .01; *** p < .001.

Unanswered questions were excluded from analyses. This resulted in sometimes large numbers of missing cases in the analyses which mostly derived from blank answers on income (*n* = 876) and otherwise education (*n* = 54) or country of birth (*n* = 35).

Reasons for vaccine hesitancy

From the hesitant subsample, over half feared the risk of side effects (55.8%) or thought there was too little experience with the use of the vaccine (50.2%) (see table 4). Otherwise, hesitant individuals did not feel like they belonged to a risk group for severe COVID-19 disease (46.1%), did not feel the need for the vaccine (39.1%), or wanted their body to develop natural immunity (29.3%).

Table 4. Main reasons to not take the COVID-19 vaccine (*n* = 317)

Reasons for vaccine hesitancy	**No**	**Yes**
	***n* (%)**	
I do not belong to any of the risk groups for severe COVID-19 disease	171 (53.9)	146 (46.1)
Do not need the vaccine: rarely/never sick, not in the target group, I tolerate the flu well and probably COVID-19 also	193 (60.9)	124 (39.1)
Religious reasons	313 (98.7)	4 (1.3)
There is little infection in society	282 (89.0)	35 (11.0)
Do not need to protect myself	300 (94.6)	17 (5.4)
Do not need to protect family/community	304 (95.9)	13 (4.1)
Afraid of/do not like doctors/syringes	296 (93.4)	21 (6.6)
I want my body to develop natural immunity	224 (70.7)	93 (29.3)
I do not think that the COVID-19 vaccines work	273 (86.1)	44 (13.9)

Risk of side effects from the COVID-19 vaccines	140 (44.2)	177 (55.8)
There is too little experience with the use of the vaccines	158 (49.8)	159 (50.2)
General objections to vaccines: I am vaccine opponent, never taken vaccines, in principle, not comfortable with new vaccines, heard a lot of strange things, etc.	295 (93.1)	22 (6.9)
I do not trust healthcare professionals	309 (97.5)	8 (2.5)
I do not trust the recommendations from the health authorities/municipality	271 (85.5)	46 (14.5)
Media attention	295 (93.1)	22 (6.9)
Other	254 (80.1)	63 (19.9)

Note. One inconsistent respondent was not captured as hesitant in the variable on vaccine intention (*n = 316)* but was included in the variable on reasons against the COVID-19 vaccine. Hence, *n = 317*. This inconsistency did not influence any further results and was thus kept in the analysis.

Sociodemographic predictors of main reasons for vaccine hesitancy

Women demonstrated higher likelihood of vaccine hesitancy due to the risk of side effects (table 5). Participants born outside of Norway reported a significantly lower likelihood of hesitancy due to this reason. Women also reported higher likelihood than men due to concerns about lack of experience with the vaccines. Participants aged between 30-44 years demonstrated higher odds ratios for hesitancy compared to those aged under 29. Otherwise, participants born outside Norway were less likely hesitant due to little vaccine experience compared to those born in Norway. Odds ratios among respondents above 60 years for not feeling like one belongs to a COVID-19 risk group were 97% lower compared to respondents under 29. The highest income group (>1,400,000 NOK or more) showed substantially higher odds ratios for not feeling part of a risk group compared to the lowest income group (<200,000 NOK). Similarly, participants in the median (800,000-999,999 NOK) and second-lowest income group (200,000-399,999 NOK) were more likely hesitant compared to the lowest income group. Participants aged over 60 years reported low odds ratios for not needing the COVID-19 vaccine. Compared to the lowest income group, the highest income group showed substantially high odds ratios for not feeling the need for the COVID-19 vaccine. Participants with a household income between 1,200,000-1,399,000 NOK and 400,000-599,999 NOK were also more likely to not feel the need for the vaccine. Vaccine hesitancy due to the desire to naturally develop immunity was not significantly predicted by any of the sociodemographic characteristics.

Table 5. Logistic regression predicting the likelihood of vaccine hesitancy due to main reasons based on sociodemographic predictors (N = 210)

Predictor variables	Risk of side effects	Too little experience	Not in risk group	No need	Natural immunity
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender					
Male	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Female	1.99 (1.07-3.70)*	1.88 (1.02-3.46)*	1.09 (.59-2.01)	.78 (.42-1.45)	.67 (.35-1.26)
Age					
18-29	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
30-44	1.83 (.80-4.16)	2.70 (1.16-6.25)*	.64 (.28-1.45)	.62 (.27-1.43)	1.59 (.65-3.89)
45-59	.88 (.30-2.54)	2.54 (.85-7.65)	.42 (.14-1.21)	.39 (.13-1.20)	1.26 (.39-4.00)
60+	1.21 (.37-3.92)	1.14 (.36-3.62)	.05 (.01-.26)***	.29 (.08-.97)*	1.20 (.34-4.20)
Born in Norway					
Yes	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
No	.45 (.23-.87)*	.33 (.17-.64)**	.65 (.34-1.24)**	.56 (.29-1.09)	1.01 (.51-2.01)
Highest completed education					
Primary (10, 7 year)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Higher general	3.56 (.90-14.06)	1.39 (.36-5.34)	.94 (.22-4.04)	2.35 (.51-10.89)	.82 (.22-3.08)
Higher vocational	1.31 (.31-5.59)	.45 (.10-2.03)	.97 (.20-4.67)	1.65 (.32-8.44)	.45 (.10-1.97)
Vocational school/vocational education (1/2-2 years) based	1.70 (.40-7.26)	1.40 (.32-6.13)	.72 (.15-3.39)	2.64 (.52-13.29)	.52 (.12-2.23)

on upper secondary vocational education					
University <= 4 years	1.51 (.40-5.64)	.88 (.23-3.32)	1.27 (.30-5.39)	1.35 (.30-6.12)	.42 (.11-1.62)
University > 4	1.34 (.35-5.08)	1.49 (.39-5.77)	1.19 (.28-5.07)	1.31 (.28-6.03)	.31 (.08-1.26)
Gross annual household income					
Under 200.000 kroner	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
200.000-399.999 kroner	3.09 (.75-12.70)	.97 (.24-3.86)	2.70 (.54-13.52)	4.79 (.82-27.89)	.62 (.14-2.66)
400.000-599.999 kroner	1.59 (.42-6.03)	1.20 (.32-4.56)	5.80 (1.26-26.68)*	11.60 (2.09-64.42)**	1.58 (.42-6.00)
600.000-799.999 kroner	3.73 (91-15.36)	1.57 (.40-6.16)	4.10 (.87-19.32)	4.34 (.76-24.79)	1.03 (.26-4.12)
800.000-999.999 kroner	2.85 (.69-11.78)	1.70 (.42-6.89)	4.30 (.90-20.63)	4.34 (.75-25.21)	.58 (.13-2.58)
1.000.000-1.199.000 kroner	3.48 (.73-16.53)	1.96 (.42-9.18)	4.82 (.91-25.68)	2.66 (.40-17.68)	.99 (.20-4.79)
1.200.000-1.399.000 kroner	2.24 (.49-10.33)	1.28 (.28-5.82)	4.01 (.75-21.37)	7.77 (1.23-49.27)*	.64 (.13-3.29)
1.400.000 kroner or more	3.06 (.61-15.30)	1.53 (.31-7.57)	16.58 (2.58-106.78)**	32.90 (4.43-244.16)**	3.02 (.61-14.91)
Nagelkerke R2	.162	.196	.221	.218	.101

Note. *p < .05; ** p < .01; *** p < .001.

Unanswered questions were excluded from analyses. This resulted in sometimes large numbers of missing cases in the analyses which mostly derived from blank answers on income (*n* = 876) and otherwise education (*n* = 54) or country of birth (*n* = 35).

Discussion

Several sociodemographic predictors of vaccine hesitancy were identified. Increasing age (45+) predicted lower likelihood of vaccine hesitancy compared to younger participants. Contrastingly, using country of birth as indicator for ethnic minorities, participants born outside of Norway reported higher likelihood of vaccine hesitancy compared to those born in Norway. Although results align with an abundance of literature (7, 10-16, 20, 21, 25, 26), both older age and ethnic minorities have increased vulnerability to severe COVID-19 outcomes (17-19, 22, 23). Whilst results suggest a suitable reaction among older adults regarding their vulnerable position, the opposite may be claimed for ethnic minorities which magnifies their vulnerability. Furthermore, higher education (university) and high household income (>1,400,000 NOK) predicted lower likelihood of vaccine hesitancy compared to lower education (primary) and low household income (<200,000 NOK). This aligns with the majority of literature and indicates hesitancy proneness among lower education and income (7, 9-11, 13-16, 21, 25, 27-29). No significant gender differences in COVID-19 vaccine hesitancy were found.

Vaccine hesitancy was mainly due to confidence and complacency concerns as grouped by the "3Cs" model (2, 3). Findings suggest that barriers relating to convenience were successfully reduced by actively offering the COVID-19 vaccines to all Norwegian residents without costs. As such, confidence concerns were predominantly grounded in fear of side effects and little experience with the vaccines. Taking into account that data collection took place not long after the introduction of the rapidly developed COVID-19 vaccines, these results are conceivable. Relating to complacency, participants mostly did not feel like they belonged to a risk group, felt no need for the vaccine, and/or wanted their body to develop natural immunity. This may result from a lack of evidence at the time related to how long immunity following infection persists and the risk of re-infection. Few participants stated that they had no need to protect themselves, family, and their community which aligns with low observed hesitancy rates. Furthermore, results showed little distrust in health authorities and professionals which supports high trust in Norwegian authorities compared to other nations (33-36). Still, in an area where vaccine hesitancy was anticipated to be high, observed rates were nearly twice as low as anticipated in Norway (33), which may indicate an underestimation of vaccine hesitancy. Furthermore, hesitancy due to religious reasons was least present. As Oslo has the highest density of religious groups in Norway (39), this was unanticipated and may reflect an underrepresentation of ethnic minorities.

Findings show that women are more likely hesitant due to confidence barriers such as the risk of side effects and little experience with the COVID-19 vaccines than men. Although participants born outside of Norway were more likely vaccine hesitant, they predicted lower likelihood of hesitancy due to confidence barriers compared to those born in Norway. This may denote convenience barriers among ethnic minorities in which health information is misunderstood or not accessed, possibly resulting from barriers in health literacy or language (3, 30, 31, 37). Complacency barriers seemed least present among older age (45+), participants born outside of Norway and household income. This further suggests successful public health communication and good health literacy among participants concerning age-related risk factors of COVID-19. Due to the high number of missing values on income, the reliability of results can be argued and may explain why findings do not allow for any concluding trends on this variable. Although education significantly predicted vaccine hesitancy likelihood, no significant relations were found with any of the main reasons. This may also denote convenience barriers linked to health literacy as education is identified as a robust predictor of vaccine hesitancy (7, 9-11, 13-16, 21, 25, 27-29).

Strengths and limitations

To our knowledge, this is the first study that addresses vaccine hesitancy in Norway after the arrival of the COVID-19 vaccines. It addresses vaccine hesitancy in an anticipated hotspot of a country that is underrepresented in literature, thus providing an important contribution to empirical literature. Moreover, findings are linked to theory to increase durability for forthcoming pandemics. There are also some limitations to this study. Statistical power and generalizability of the regression models were less strong than desired due to the small sample size and missing cases on the income, education, and/or country of birth variable. Furthermore, possible underrepresentation of several subgroups may have resulted in a non-response bias. Although this problematizes assessment of vaccine hesitancy, associations between variables seem rather insensitive to this. It can however be argued that even with high nonresponse rates, results are not necessarily biased and are still scientifically valuable (Hellevik, 2016). Lastly, results cannot be compared with other districts or areas in Norway as the data contains information from six eastern districts in Oslo and due to the studies' cross-sectional design, no causal inferences can be made (40).

Implications

Future research should further explore the presence of convenience barriers among ethnic

minorities and lower education. Moreover, varying barrier trends suggest the need for tailored policy strategies targeted to vulnerable subgroups to increase vaccine willingness. As results indicated high trust in health authorities and professionals, clear health communication about the risks, benefits, and importance of the vaccines should be provided to improve health literacy and vaccine willingness. Similar research should be carried out on a larger sample to produce more robust analyses. Research efforts should further aim to integrate empirical and theoretical literature on vaccine hesitancy to develop durable strategies.

Conclusion

Results highlight the vulnerability of younger age, ethnic minorities, lower education, and lower household income in relation to COVID-19 vaccine hesitancy proneness. Varying barrier trends among subgroups emphasize the importance of clear public health communication about the risks, benefits and importance of vaccines. Norwegian health authorities should consider these findings when developing tailored strategies targeted at hesitant subgroups during the COVID-19 pandemic to increase vaccine uptake and reach sufficient immunization.

List of abbreviations

Norwegian kroner – NOK

Strategic Advisory Group of Experts – SAGE

World Health Organization – WHO

Declarations

Ethics approval and consent to participate

This study was granted ethical approval by the Regional Ethics Committee (reference: 250310).

Consent for publication

Not applicable

Availability of data and materials

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

Competing interests

The author declares that they have no competing interests

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Bibliography

1. European Centre for Disease Prevention and Control. COVID-19 vaccination 2022 [Available from: https://www.ecdc.europa.eu/en/covid-19/prevention-and-control/vaccines.
2. World Health Organization. Report of the SAGE Working Group on Vaccine Hesitancy.; 2014.
3. MacDonald NE, SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015;33(34):4161-4.
4. World Health Organization. World health statistics overview 2019: monitoring health for the SDGs: WHO; 2019.
5. World Health Organization. Summary WHO SAGE conclusions and recommendations on Vaccine Hesitancy. 2015.
6. Alabdulla M, Reagu SM, Al-Khal A, Elzain M, Jones RM. COVID-19 vaccine hesitancy and attitudes in Qatar: A national cross-sectional survey of a migrant-majority population. Influenza and other respiratory viruses. 2021;15(3):361-70.
7. Graeber D, Schmidt-Petri C, Schröder C. Attitudes on voluntary and mandatory vaccination against COVID-19: Evidence from Germany. PLoS One. 2021;16(5):1-18.
8. Kasrine Al Halabi C, Obeid S, Sacre H, Akel M, Hallit R, Salameh P, et al. Attitudes of Lebanese adults regarding COVID-19 vaccination. BMC Public Health. 2021;21(1):1-7.
9. Magadmi RM, Kamel FO. Beliefs and barriers associated with COVID-19 vaccination among the general population in Saudi Arabia. BMC Public Health. 2021;21(1):1-8.
10. Rodríguez-Blanco N, Montero-Navarro S, Botella-Rico JM, Felipe-Gómez AJ, Sánchez-Más J, Tuells J. Willingness to Be Vaccinated against COVID-19 in Spain before the Start of Vaccination: A Cross-Sectional Study. International journal of environmental research and public health. 2021;18(10).
11. Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes Toward a Potential SARS-CoV-2 Vaccine. Annals of Internal Medicine. 2020;173(12):964-73.
12. Murphy J, Vallières F, Bentall RP, Shevlin M, McBride O, Hartman TK, et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. Nature Communications. 2021;12(1):29.
13. Paul E, Steptoe A, Fancourt D. Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. The Lancet Regional Health - Europe. 2021;1:100012.
14. Cascini F, Pantovic A, Al-Ajlouni Y, Failla G, Ricciardi W. Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review. EClinicalMedicine. 2021;40:101113.
15. Edwards B, Biddle N, Gray M, Sollis K. COVID-19 vaccine hesitancy and resistance: Correlates in a nationally representative longitudinal survey of the Australian population. PLoS One. 2021;16(3):e0248892.
16. Mondal P, Sinharoy A, Su L. Sociodemographic predictors of COVID-19 vaccine acceptance: a nationwide US-based survey study. Public Health. 2021;198:252-9.
17. World Health Organization. COVID-19: vulnerable and high risk groups 2022 [Available from: https://www.who.int/westernpacific/emergencies/covid-19/information/high-risk-groups.
18. Centers for Disease Control and Prevention (CDC). COVID-19 Risks and Vaccine Information for Older Adults 2021 [Available from: https://www.cdc.gov/aging/covid19/covid19-older-adults.html.
19. Helsedirektoratet. Risikogrupper: Helse Norge; 2022 [Available from: https://www.helsenorge.no/koronavirus/risikogrupper/.

20. Luk TT, Zhao S, Wu Y, Wong JY-h, Wang MP, Lam TH. Prevalence and determinants of SARS-CoV-2 vaccine hesitancy in Hong Kong: A population-based survey. Vaccine. 2021;39(27):3602-7.
21. Robertson E, Reeve KS, Niedzwiedz CL, Moore J, Blake M, Green M, et al. Predictors of COVID-19 vaccine hesitancy in the UK household longitudinal study. Brain, Behavior, and Immunity. 2021;94:41-50.
22. Vist GE, Arentz-Hansen EH, Vedøy TF, Spilker RS, Hafstad EV, Giske L. Incidence and severe outcomes from COVID-19 among immigrant and minority ethnic groups and among groups of different socio-economic status: A systematic review. Oslo: Norwegian Institute of Public Health; 2021.
23. Hildreth JEK, Alcendor DJ. Targeting COVID-19 Vaccine Hesitancy in Minority Populations in the US: Implications for Herd Immunity. Vaccines. 2021;9(5):489.
24. Dubé E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. Vaccine. 2014;32(49):6649-54.
25. Khubchandani J, Sharma S, Price JH, Wiblishauser MJ, Sharma M, Webb FJ. COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. Journal of Community Health. 2021;46(2):270-7.
26. Crawshaw AF, Deal A, Rustage K, Forster AS, Campos-Matos I, Vandrevala T, et al. What must be done to tackle vaccine hesitancy and barriers to COVID-19 vaccination in migrants? Journal of Travel Medicine. 2021;28(4).
27. Abedin M, Islam MA, Rahman FN, Reza HM, Hossain MZ, Hossain MA, et al. Willingness to vaccinate against COVID-19 among Bangladeshi adults: Understanding the strategies to optimize vaccination coverage. PLoS One. 2021;16(4):1-17.
28. Tahir MJ, Saqlain M, Tariq W, Waheed S, Tan SHS, Nasir SI, et al. Population preferences and attitudes towards COVID-19 vaccination: a cross-sectional study from Pakistan. BMC Public Health. 2021;21(1):1-12.
29. Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. Vaccine. 2014;32(19):2150-9.
30. World Health Organization. Vaccination and trust. How concerns arise and the role of communication in mitigating crises. 2017.
31. Stoksvik M. Oslo får flere vaksiner: – En gledens dag. NRK. 2021, March 2.
32. Holmes MCS, & Fausko, L. Oslo får 18.000 vaksiner neste uke – minst 13.000 går til Oslo øst. VG. 2021, March 13.
33. Ebrahimi OV, Johnson MS, Ebling S, Amundsen OM, Halsøy Ø, Hoffart A, et al. Risk, Trust, and Flawed Assumptions: Vaccine Hesitancy During the COVID-19 Pandemic. Frontiers in Public Health. 2021;9(849).
34. Ritchie H, Mathieu E, Rodés-Guirao L, Appel C, Giattino C, Ortiz-Ospina E, et al. Coronavirus Pandemic (COVID-19): Published online at OurWorldInData.org.; 2020 [Available from: https://ourworldindata.org/coronavirus.
35. Helsingen LM, Refsum E, Gjøstein DK, Løberg M, Bretthauer M, Kalager M, et al. The COVID-19 pandemic in Norway and Sweden – threats, trust, and impact on daily life: a comparative survey. BMC Public Health. 2020;20(1):1597.
36. Edlund J. Trust in government and welfare regimes: Attitudes to redistribution and financial cheating in the USA and Norway. European Journal of Political Research. 1999;35(3):341-70.
37. Capar R-I. Vaccination: Priority districts in Oslo are struggling to reach the immigrant population. Norway Today. 2021, July 5.
38. Goodman T, Heidari S. Critical sex and gender considerations for equitable research, development and delivery of COVID-19 vaccines. 2021.

39. Taule L. Hva forteller statistikkene om religion, tro og livssyn i Norge? Samfunnsspeilet. 2012;1.
40. Bryman A. Social research methods. 5th ed. ed. Oxford: Oxford University Press; 2016 2016. XXXV, 747 s. p.