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High overall confidence in childhood vaccination in Norway, slightly lower among the unemployed and those with a lower level of education

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ABSTRACT

In Norway, childhood immunisation is offered on voluntary basis, free of charge and is delivered through trained nurses at > 650 child health centres and school health services. Maintaining high confidence in the vaccination programme is key to sustaining high vaccine uptake. We aimed to investigate confidence in childhood vaccination in the general population and to identify determinants for lower confidence.

In 2017 and 2018, Statistics Norway asked questions on confidence in childhood vaccination (to all respondents) and children's vaccination history (to parents) in their routine cross-sectional survey. Respondents reported their level of agreement on a five-point Likert scale. Using a weighted analysis we calculated proportions agreeing [95% confidence interval] by respondent characteristics.

Overall, 2169 individuals participated (54% response). 95.8% [94.8–96.7] answered that vaccination is important, 93.4% [92.2–94.4] thought that vaccines are safe, 96.0% [95.0–96.8] thought that vaccines are effective and for 93.4% [92.2–94.4] vaccination was compatible with their basic values. Those with lower level of education expressed lower confidence in vaccination due to conflict with their basic values (88.2% [84.7–91.0] answered positively). Those unemployed expressed lower confidence due to conflict with their basic values (81.9% [71.8–88.9]) and because of concerns about vaccines' safety (83.5% [73.7–90.1]). 96.3% [94.3–97.6] of parents (n = 580) had their children fully vaccinated, despite that one fifth answered that they at least once have had doubts on whether or not to vaccinate their children.

There is high confidence in childhood vaccination in Norway. Those with a lower level of education and the unemployed reported comparatively lower confidence. To maintain high confidence in childhood vaccination, we recommend maintaining the well-informed system with easily accessible vaccinations. Furthermore, we recommend maintaining surveillance of vaccine confidence, supplemented with targeted studies on subgroups who are less confident, express doubts and/or oppose vaccination. Those studies should inform communication strategies tailored to subgroups.

1. Introduction

Vaccination is one of the most cost effective interventions to prevent infectious diseases. As a result of vaccination programmes with high uptake, the frequency of many diseases has dramatically decreased. Maintaining high confidence in the vaccination programme is key to sustain high vaccine uptake in the population and prevent re-emergence of currently well controlled preventable diseases. To achieve elimination, the vaccination coverage in the entire population must be at least 80–95%, depending on the reproduction rate of the infection and the vaccine effectiveness [1]. The programme needs to identify and monitor subgroups at risk for missed vaccination in order to plan targeted interventions.

In Norway, the childhood immunisation programme is offered on voluntary basis free of charge and is delivered through trained nurses at more than 650 child health centres and school health services. The routine programme includes vaccinations against rotavirus; diphtheria, tetanus, pertussis, poliomyelitis, *Haemophilus influenzae* B (Hib) and hepatitis B; pneumococcal disease; measles, mumps and rubella; and human papilloma virus (HPV) [2]. Each completed vaccination is registered in a central database, the Norwegian Immunisation Register (SYSVAK) [3,4]. Currently, Norway maintains a high uptake for the childhood immunisation programme. The latest figures for 2019 indicate that the minimum proportion of 2-year olds vaccinated against diphtheria, tetanus, pertussis, poliomyelitis and Hib was 97%, against measles also 97% and against hepatitis B 96%. Slightly lower figures were recorded among 16 year olds – 95% for the second dose of measles and 89% against HPV [5]. Catch up strategies are only considered when new vaccines are included into the programme.

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The main concern is that when many diseases have almost disappeared in the population due to vaccination, the motivation of parents to vaccinate their children may decrease. The attention might be more focused on possible side effects of vaccines, than on diseases that are prevented through vaccination [6,7]. Some subgroups in the society may choose to not vaccinate their children for different reasons [8,9]. The attitudes towards vaccination in Norway were assessed only once before, in 2009, among parents of children aged <24 months of age [10]. That time, 99% answered that they were willing to vaccinate their child in the future despite the fact that 20% had at least once been in doubt about vaccinating their child [11]. However, in the previous decade, the Nordic countries experienced several debates on the safety of pandemic influenza vaccines [12]. These debates were also vocal in the Norwegian media, and might have affected the uptake of vaccines against A (H1N1)pdm09 influenza during the pandemic response [13]. More recently Nordic countries experienced a vocal debate about the safety of HPV vaccines, affecting vaccine uptake, especially in Denmark [14]. However, these debates did not result in decreased vaccination uptake for the Norwegian childhood immunisation programme. Additionally, small scale measles outbreaks in Norway have revealed pockets of unvaccinated groups, mostly among under-immunised immigrants and one with possible link with anthroposophical beliefs [15,16]. However, the above-mentioned reports also suggested that most measles cases are imported and do not lead to secondary transmission. Unfortunately, SYSVAK does not include information allowing identification of subgroups at risk for lower vaccine uptake.

The aim of this study was to investigate the confidence in childhood vaccination in the general population and to identify determinants of lower confidence.

2. Material and methods

2.1. Study design

Four times a year, Statistics Norway carries out a population-based cross-sectional behavioural survey (“Travel and holiday study”; [17,18]). Each time, 2000 Norwegian residents from aged 15 (turning 16 the same year) up to 79 years are randomly selected from the National Population Register, stratified by age, sex and region of residence. This register contains demographic information, addresses and telephones of all persons residing in Norway. Its registration number allows access to all basic services in Norway. Invitees to the behavioural survey receive a letter with information on the study and are subsequently contacted for a computer-assisted telephone interview. The interview generally covers questions on travel, shopping abroad, use of tobacco and other drugs, use of internet and information technology, wood burning, attitudes towards immigrants and vaccination against influenza. In July-August 2017 and 2018, questions on confidence in the childhood immunisation programme were added to this survey. Respondents provided informed consent before participation and the study followed requirements of the Personal Data Act. We did not have access to personal identifiable information.

2.2. Variable definitions

The socio-demographic variables collected for each respondent were: region of residence; urbanisation category; year of birth; sex; marital status; number of persons living in the household; work type, level of education.

In the section on the childhood immunisation programme, each respondent was asked to rate their agreement to the following four questions that were based on the statements used in the global State of Vaccine Confidence study [19]:

- It is important that children receive vaccines.
- Overall I think that vaccines are safe.
- Overall I think that vaccines provide protection against disease.
- Overall, vaccines are compatible with my basic values.

Respondents had to rate agreement on a five-point Likert scale (Strongly agree, Agree, Neither agree nor disagree, Disagree and Strongly disagree). Additionally, two questions were asked to parents of children aged 16 years or younger and were based on questions asked in a 2009 survey among Norwegian parents which was part of a larger European study [10]:

- Have you vaccinated your child/ children according to the Norwegian immunisation programme?
- Have you ever had any doubts about vaccinating your child?

2.3. Data analysis

We categorised the four responses on vaccine confidence into binary variables, thereby defining “Agree” and “Strongly agree” as agreement, and the remaining answers including “I don’t know” and “I do not want to answer” as disagreement. Data was missing for a maximum of 15 individuals. We described the results by calculating the proportion agreeing with each statement stratified by socio-demographic characteristic and its 95% confidence interval [95%CI]. These results were weighted according to the response rate, taking into account age, sex, and level of education.

To investigate which factors were independently associated with confidence in vaccination, we performed logistic regression to determine odds ratios (OR). The model included all socio-demographic characteristics as presented in Table 1, as well as having children aged 16 years or younger. As we included the variables used for weighting in the analysis, we did not add the weights to the model. Single parameters Wald-tests were used to test for significance of linear and binary variables while multiple parameter Wald-tests were used for categorical variables with more than two categories. We did not correct for multiple testing (note, we ran the model 4 times, separately for each dependent variable addressing the different aspects of vaccine confidence).

3. Results

3.1. Description of the respondents

In the 2017 survey, 1104 individuals participated of 1990 invited (response rate 55.5%) and in the 2018 survey, 1065 participated of 1991 invited (response rate 53.3%). In both surveys, the lowest response rate was observed for those aged 25–44 years and higher educated individuals were overrepresented [17,18]. The socio-demographics and answers of the respondents to the two surveys were generally very similar and are therefore presented together. The median age of the respondents was 46 years (range 15–79), and 52.4% was male. For 20%, the highest level of education was lower secondary education, for 38% upper secondary education, 29% had attended apprenticeship training or had a bachelor and 11% had Master/PhD as highest education degree. Sixty-five percent was employed, 12% was in school or studied, 4% was unemployed and 19% was disabled to work or retired. Twenty-seven percent reported to have children aged 16 years or younger.

Table 1
Confidence in childhood vaccination. The percentages presents the percentage agreeing to the questions on Importance, Safety, Effectiveness and Compatibility with their basic values and are calculated using a weighted analysis. The 95%CI is provided in brackets.

	Number per subgroup	Importance	Safety	Effective protection	Compatibility with basic values
Total	2169	95.8 [94.8–96.7]	93.4 [92.2–94.4]	96.0 [95.0–96.8]	93.4 [92.2–94.4]
Study year					
2017	1104	96.1 [94.6–97.1]	94.4 [92.7–95.7]	95.8 [94.3–96.9]	92.4 [90.5–93.9]
2018	1065	95.6 [94.1–96.7]	92.4 [90.1–93.9]	96.2 [94.8–97.3]	94.4 [92.8–95.8]
Age groups (years)					
15–24	334	97.7 [95.1–98.9]	93.8 [90.4–96.0]	95.2 [92.0–97.1]	90.7 [86.9–93.4]
25–34	334	95.0 [91.8–97.0]	91.6 [87.6–94.3]	95.1 [91.7–97.2]	93.1 [89.3–95.6]
35–44	358	94.9 [91.7–96.9]	94.0 [90.8–96.1]	96.4 [93.5–98.0]	92.7 [89.1–95.2]
45–66	838	96.3 [94.7–97.4]	93.9 [92.0–95.4]	96.4 [94.8–97.5]	94.8 [93.0–96.2]
67–79	305	94.5 [91.1–96.6]	93.3 [89.7–95.8]	96.7 [93.7–98.3]	94.4 [90.8–96.6]
Sex					
Female	1033	96.7 [95.3–97.7]	94.9 [93.2–96.2]	96.2 [94.6–97.3]	93.7 [91.8–95.1]
Male	1136	94.9 [93.4–96.1]	92.0 [90.1–93.5]	95.8 [94.4–96.9]	93.2 [91.4–94.6]
Level of education[1]					
Lower secondary	427	94.5 [91.7–96.3]	91.6 [88.5–94.0]	93.7 [90.8–95.7]	88.2 [84.7–91.0]
Higher secondary	816	95.7 [94.1–96.9]	93.5 [91.6–95.1]	97.2 [95.8–98.2]	94.9 [93.1–96.2]
Apprenticeship training/Bachelor	619	97.4 [95.8–98.4]	95.7 [93.8–97.0]	98.0 [96.5–98.8]	96.8 [95.1–98.0]
Masters/PhD	228	97.4 [94.4–98.8]	95.6 [92.0–97.6]	97.3 [94.2–98.8]	96.8 [93.5–98.5]
Work type[2]					
Unemployed	93	93.4 [85.6–97.1]	83.5 [73.7–90.1]	91.8 [82.7–96.3]	81.9 [71.8–88.9]
Retired/disabled	406	95.0 [92.2–96.8]	93.6 [90.6–95.6]	96.5 [94.0–97.9]	93.5 [90.4–95.7]
In school/student	253	96.6 [93.0–98.4]	95.9 [92.1–97.9]	96.1 [92.2–98.0]	92.9 [88.6–95.6]
Part-time	227	97.0 [93.7–98.6]	95.5 [91.7–97.6]	97.4 [94.2–98.8]	95.8 [92.1–97.8]
Full-time	1187	96.1 [94.7–97.2]	93.4 [91.8–94.8]	96.2 [94.7–97.2]	94.2 [92.6–95.5]

[1] Those following lower secondary education are generally aged 13–15 years; this is compulsory education. Upper secondary education is not compulsory; those following upper secondary education are generally aged 16–18 years.
[2] For those who have reported to work but did not report the amount of time, we assumed to be full time if they were aged 25 years or older (n = 7), and part time if they were younger than 25 years (n = 2). Those answering «I do not want to answer» (n = 3) were defined as missing, except for one person that was older than 67 years (defined as retired/disabled).

3.2. Confidence in childhood vaccination of the general population

Overall, 95.8% [95%CI 94.8–96.7] stated that vaccination of children is important, 93.4% [92.2–94.4] thought that vaccines are safe, 96.0% [95.0–96.8] thought that vaccines provide effective protection against diseases and for 93.4% [92.2–94.4] childhood vaccination was compatible with their basic values (Table 1). The largest differences between subgroups in the proportion agreeing to the vaccine confidence statements were for compatibility with basic values. Answers of respondents with various levels of education ranged from 88.2 to 96.8% agreement, and of respondents with different work types from 81.9 to 95.8% agreement (Table 1). The smallest difference between subgroups was found for the importance that children receive vaccines. The lowest proportion agreeing with that statement was found for the unemployed (93.4% [85.6–97.1]) and the highest proportion for those aged 15–24 years (97.7% [95.1–98.9]).

When taking into account answers to the four confidence statements, those who had lower level of education (lower secondary education) and those who were unemployed were generally least positive towards vaccination. See otherwise below for factors that were independently associated with confidence in vaccination.

3.3. Children's vaccine history and confidence of parents

Overall, 580 respondents answered to have children aged 16 years or younger. Of them, 96.3% [94.3–97.6] had their child(ren) fully vaccinated, 2.4% [1.4–4.3] partly and 1.3% [0.6–2.6] had not vaccinated their child(ren). The confidence in vaccination did not significantly differ between those having and those not having children aged 16 years or younger (Table 2), though those without children had slightly lower confidence in vaccination. Except for safety, this difference was more pronounced for potential future parents; those not having children and aged less than 40 years old expressed slightly lower confidence (Table 2). Parents who did not vaccinate their children, and those who partially vaccinated them, expressed lower confidence in relation to all studied aspects than those who vaccinated their children. Interestingly, for those who did not vaccinate their children, only 58.0% [17.6–89.9] agreed on the question that vaccination is important for children. This proportion was lower than the proportion agreeing on that vaccination is compatible with their basic values (73.7% [25.9–95.8]), though, the numbers were small and the 95%CIs were overlapping.

Twenty-one percent (21.3% [17.2–24.1]) of the parents reported to have at least once doubts about vaccinating their child. All parents with doubts had their children vaccinated (94.5% [88.6–97.5] fully, 5.5% [2.6–14.4] partly). Those who had been in doubt agreed less often that vaccines are safe, and that vaccines protect against diseases (non-overlapping confidence intervals; Table 2).

3.4. Factors independently associated with confidence in childhood vaccination

The multivariable regression identified the following factors to be independently associated with the confidence statements. Men agreed less frequently that vaccination is important for children (OR: 0.58 [0.35–0.95]; Table 3). Men and those unemployed agreed less frequently that vaccines are safe (0.57 [0.38–0.85] and 0.44 [0.22–0.87], respectively). Lower educated respondents and those not having children agreed less frequently that vaccines effectively protect against diseases (0.36 [0.19–0.68] and 0.48 [0.24–0.98], respectively). Respondents who were unemployed and those with lower education agreed less frequently that vaccines are compatible with their basic values (0.42 [0.21–0.82] and 0.38 [0.24–0.69], respectively). Additionally, study year was associated with compatibility with basic values (OR for 2017: 0.66 [0.45–0.98]; slightly fewer agreed with it in 2017 than in 2018). Being in school or studying was most positively associated with all of the questions (Table 3).

Table 2
Confidence in childhood vaccination, stratified by having children aged ≤16 years or not, and the vaccine behaviour of the parents. The percentages present the percentage agreeing to the question and are calculated using a weighted analysis. The 95%CI is provided in brackets.

	Importance	Safety	Effective protection	Compatibility with basic values
Having children aged 16 years or younger				
Yes (n = 580)	97.6 [95.7–98.6]	95.4 [93.3–96.9]	98.0 [96.3–98.9]	95.4 [93.1–97.0]
No (n = 1580)	95.8 [94.6–96.7]	93.3 [91.9–94.5]	96.0 [94.7–96.9]	93.3 [91.9–94.5]
Potential future parents [1] (n = 593)	96.4 [94.3–97.7]	92.8 [90.2–94.8]	95.1 [92.8–96.7]	91.6 [88.8–93.7]
For parents: did you have your children vaccinated				
Yes, fully (n = 554)	98.2 [96.5–99.1]	96.2 [94.1–97.6]	98.4 [96.6–99.2]	96.0 [93.8–97.4]
Partially (n = 14)	100 [2]	80.5 [47.9–94.9]	94.8 [63.5–99.5]	83.7 [33.3–98.1]
No (n = 8)	58.0 [17.6–89.9]	63.1 [20.8–91.7]	73.7 [25.9–95.8]	73.7 [25.9–95.8]
For parents: have you ever had any doubts about vaccinating your child?				
Yes (n = 117)	97.0 [90.9–99.0]	89.2 [81.5–93.9]	94.1 [87.1–97.4]	94.9 [88.0–98.0]
No (n = 450)	98.8 [96.9–99.6]	97.8 [95.7–98.8]	99.4 [97.5–99.9]	96.1 [93.5–97.7]

[1] Potential future parents were defined as those not having children aged 16 or younger, and being younger than 40 years old.
[2] Because all agreed, it was not possible to calculate the 95%CI.

Table 3
Multivariable logistic regression analysis for confidence in childhood vaccination. Odds ratios (OR) are reported with the 95%CI in brackets. ORs that are significantly different from 1 ($p < 0.05$ in the Wald-test) are shown in bold. For variables with multiple categories, the overall p-value, determined using multiple parameter Wald-tests, is shown. The regression model included all determinants that are shown in this model; no variable selection has been done.

Determinants	Importance	Safety	Effective protection	Compatibility with basic values
Study year				
2017	1.11 [0.70–1.78]	1.40 [0.96–2.04]	0.82 [0.49–1.37]	**0.66 [0.45–0.98]**
2018	Reference	Reference	Reference	Reference
Age (in years)	1.00 [0.98–1.02]	1.00 [0.99–1.02]	1.00 [0.99–1.02]	1.01 [0.99–1.03]
Sex				
Female	Reference	Reference	Reference	Reference
Male	**0.58 [0.35–0.95]**	**0.57 [0.38–0.85]**	0.76 [0.44–1.29]	1.05 [0.70–1.57]
Level of education				
Lower secondary	0.69 [0.38–1.24]	0.68 [0.42–1.10]	**0.36 [0.19–0.68]**	**0.38 [0.24–0.69]**
Higher secondary	Reference	Reference	Reference	Reference
Apprenticeship training/Bachelor	1.29 [0.69–2.40]	1.25 [0.76–2.03]	1.15 [0.55–2.38]	1.48 [0.84–2.62]
Masters/PhD	1.57 [0.59–4.13]	1.52 [0.73–3.17]	1.11 [0.41–3.03]	1.91 [0.79–4.64]
Overall p-value for education	*0.229*	*0.091*	***0.002***	***<0.001***
Work type				
Unemployed	0.65 [2.45–1.74]	**0.44 [0.22–0.87]**	0.99 [0.34–2.93]	**0.42 [0.21–0.82]**
Retired/disabled	0.92 [0.45–1.91]	0.99 [0.54–1.81]	1.05 [0.46–2.37]	0.85 [0.45–1.60]
In school/student	2.27 [0.71–7.23]	**3.68 [1.35–10.02]**	**5.38 [1.49–19.42]**	**2.46 [1.13–5.32]**
Part-time	1.08 [0.47–2.49]	1.29 [0.64–2.58]	1.31	1.51 [0.72–3.16]
Full-time	Reference	Reference	Reference	Reference
Overall p-value for work type	*0.537*	***0.005***	*0.144*	***0.003***
Having children aged 16 years or younger				
Yes	Reference	Reference	Reference	Reference
No	0.56 [0.29–1.08]	0.69 [0.43–1.11]	**0.48 [0.24–0.98]**	0.73 [0.44–1.21]

4. Discussion

This study shows a very high confidence in childhood vaccination in the general Norwegian population. This suggests that the Norwegian childhood immunisation programme is effective in communication on the benefits of vaccination in a period of increased global vaccine hesitancy. Despite the fact that one fifths of Norwegian parents expressed doubts, this did not prevent them to have their child(ren) vaccinated. We identified two subgroups expressing slightly lower confidence in vaccination, those with lower education and those unemployed, which need further investigation.

The very good confidence in childhood vaccination is likely the result of the organisation of the childhood immunisation programme, taking place within low threshold child health centres and school health services where nurses (not physicians) are qualifying children for vaccinations and administering them. These nurses have easy direct access to medical advisors working at the Norwegian Institute of Public Health (NIPH) and to good quality and regularly updated internet resources [3]. The trust of parents in these government resources is good, as has been documented in a previous study [10]. Otherwise, NIPH monitors and proactively manages traditional, digital and social media. This includes professionals being available for media interviews and answering the social media population's questions about vaccines and vaccinations. That the media can have substantial impact on the confidence in vaccination and thereby on the vaccine uptake, has been seen in Denmark by the substantial decline in HPV vaccine uptake after negative media attention [14]. The above mentioned communication efforts may prevent the dissemination of false information and thereby prevents anecdotal information rather than evidence-based information to become the most important source for decision-making, as described before for those refusing vaccination [20]. The high confidence in childhood vaccination is reassured by the high vaccination coverage measured by SYSVAK (coverage of measles-containing vaccine among 2 year olds was 96% in 2018 [21] and 97% in 2019 [5]). A recent multinational study has indicated that the vaccine confidence is very variable across countries, with some countries reporting decreasing confidence [19]. The recent multinational measles outbreak additionally indicates that decreased confidence can lead to re-emergence of vaccine preventable diseases [22]. It remains therefore important to early detect signals of decreased vaccine confidence.

Our finding that one fifth of parents of children in vaccination age expressed doubts is similar to what was observed in the cross-sectional study in 2009 [10]. This means that the proportion of parents with doubt had not increased, despite the fact that the influenza pandemic and the introduction of HPV vaccination in the childhood immunisation programme have caused societal discussions. The vaccination coverage of HPV measured by SYSVAK among 16 year old girls was 88% in 2018 [21] and 89% in 2019 [5]. Our respondents mainly expressed doubts regarding safety and effectiveness of vaccines. We are, nevertheless, somewhat uncertain about what lies in the concept of "doubt": is there real uncertainty about vaccination or is there healthy scepticism about something unknown? The study does not answer this. In 2009, the fear for side effects and uncertainty for the longer term were reported as main reasons for the doubts [11]. Targeted communication about safety of childhood vaccination may diminish doubts and improve confidence in the childhood immunisation programme.

Our results indicate that lower education level and unemployment were associated with slightly lower confidence in childhood vaccination compared to other subgroups. Better educated persons are more likely to understand public health messages and access reliable information on the safety and effectiveness of vaccines provided by the Norwegian public institutions. Several previous investigations have shown that socio-economic factors play an important role in vaccine confidence. Authors have highlighted associations between vaccine confidence and mother's age, ethnicity, income, education level and the number of children in a household [23–26]. The effect of socioeconomic status can vary by country or region, and large discrepancies are especially seen between developed and developing countries. On one hand, systematic reviews of published literature [24–26], and multinational, large-scale surveys [19,27] have indicated that in most countries higher socioeconomic status, defined by higher educational level or income, is positively influencing vaccine confidence and vaccine uptake. On the other hand, single studies have found contradictory evidence. A survey of determinants of seasonal influenza vaccine uptake in 11 countries have shown that in different countries, socio-economic status was either increasing or decreasing vaccine compliance [23]. In the Netherlands, one investigation found out that higher level of education was associated with increased vaccine hesitancy [28]. However a more recent study pointed out that not accepting vaccines was related with lower education [29]. A recent review on context specific causes of vaccine hesitancy in different settings examined the impact of parental education's level on vaccine hesitancy and yielded conflicting results. Studies in China, Lebanon, Israel, Bangladesh and USA identified higher education as a potential barrier, whereas studies in Greece, The Netherlands, Nigeria and Pakistan identified it as a promoter of vaccination [25]; just as we saw in our study. Authors have also stressed the influence of ethnicity on vaccine compliance [24,26]. To conclude, the socio-economic determinants of vaccine confidence are complex and context-dependent and need more targeted investigations within each country, taking into account the increasing multicultural societies.

This study has some limitations. First, the limited sample of the Norwegian population targeted by the surveys (n = 2000 per survey), hinders identification of small pockets of groups opposing vaccination for various reasons. Investigation of this phenomenon would require a dedicated study with oversampling of risk populations, for example certain ethnic or religious minorities. Second, this survey was not specifically directed to study confidence in vaccination, but was part of a questionnaire on travel-related behaviours. This did not allow for a comprehensive investigation of determinants of confidence in vaccinations, as we could only include a few questions on vaccine confidence. However, since vaccination can be a sensitive issue for some, selective non-response of those that are negative towards vaccination may occur when a study is focussed on vaccination [29]. Because this study was part of a behavioural study called the "travel and holiday study", such selective non-response was less likely. The fact that the proportion of parents reported to have vaccinated their children (96%) corresponds very well with the vaccine coverage measured by the immunisation registry [21,30] and may indicate that this study is representative for the Norwegian population.

5. Conclusion

Overall, there was high confidence in vaccination in the general population in Norway. Those reporting least confidence were among those with a lower level of education and the unemployed. To maintain high confidence in childhood vaccination, we recommend maintaining the well-informed system with easily accessible vaccinations in child health centres and school health services. Communication on safety of childhood vaccination may diminish some doubts and improve confidence in the childhood immunisation programme even more. Surveillance in vaccine confidence should continue and should be supplemented with targeted studies on subgroups who are less confident, express doubts and/or oppose vaccination. Those studies should inform communication strategies tailored to subgroups.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Declaration of Competing Interest

The authors report no conflicts of interests.
All authors attest they meet the ICMJE criteria for authorship.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2020.05.011.

References

[1] Anderson RM, May RM. Immunisation and herd immunity. Lancet 1990;335:641–5.
[2] Norwegian Institute of Public Health. Childhood Immunisation Programme. When will your child be offered vaccines? 2020.
[3] Trogstad L, Ung G, Cappelen I, Haugen IL, Feiring B. The Norwegian immunisation register – SYSVAK. Eurosurveillance 2012:17.
[4] Norwegian Institute of Public Health. Norwegian Immunisation Registry SYSVAK. 2020.
[5] Norwegian Institute of Public Health. High coverage for the Childhood Immunisation Programme in Norway. Oslo2020.
[6] McPhillips H, Marcuse EK. Vaccine safety. Curr Probl Pediatr. 2001;31:91–121.
[7] Chen RT. Safety of vaccines. In: Stanley A, Plotkin WAO, editors. Vaccines. Philadelphia (PA): WB Saunders; 1999. p. 1144–63.
[8] Nokleby H, Bergsaker MA. [Adverse events after vaccination]. Tidsskr Nor Laegeforen. 2006;126:2541-4.
[9] Rygg M. Skepticism against vaccination–paradox of preventive work [In Norwegian]. Tidsskr Nor Laegeforen. 2006;126:2933.
[10] Stefanoff P, Mamelund SE, Robinson M, Netterlid E, Tuells J, Bergsaker MA, et al. Tracking parental attitudes on vaccination across European countries:

The Vaccine Safety, Attitudes, Training and Communication Project (VACSATC). Vaccine 2010;28:5731–7.
[11] Stålcrantz J, Mamelund SE, Bergsaker MA, Muniz HP. Norwegian parents attitudes to vaccines are positive [In Norwegian]. Tidsskrift for helsesøstre. 2011;2:32–5.
[12] Heier MS, Gautvik KM, Wannag E, Bronder KH, Midtlyng E, Kamaleri Y, et al. Incidence of narcolepsy in Norwegian children and adolescents after vaccination against H1N1 influenza A. Sleep Med. 2013;14:867–71.
[13] Gil Cuesta J, Aavitsland P, Englund H, Gudlaugsson O, Hauge SH, Lyytikainen O, et al. Pandemic vaccination strategies and influenza severe outcomes during the influenza A(H1N1)pdm09 pandemic and the post-pandemic influenza season: the Nordic experience. Euro Surveill. 2016;21.
[14] Hansen PR, Schmidtblaicher M, Brewer NT. Resilience of HPV vaccine uptake in Denmark: decline and recovery. Vaccine 2020;38:1842–8.
[15] Vainio K, Steen TW, Arnesen TM, Ronning K, Anestad G, Dudman S. Measles virus genotyping an important tool in measles outbreak investigation in Norway, 2011. Euro Surveill. 2012;17.
[16] Schmid D, Holzmann H, Abele S, Kasper S, Konig S, Meusburger S, et al. An ongoing multi-state outbreak of measles linked to non-immune anthroposophic communities in Austria, Germany, and Norway, March-April 2008. Euro Surveill 2008;13.
[17] Holseter C, Statistics Norway. Travel and holiday survey 2017. Documentation report [In Norwegian]. 2018.
[18] Todorovic J, Statistics Norway. Travel and holiday survey 2018. Documentation report [In Norwegian]. 2019.
[19] Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The state of vaccine confidence 2016: global insights through a 67-country survey. EBioMedicine 2016;12:295–301.
[20] Romijnders K, van Seventer SL, Scheltema M, van Osch L, de Vries H, Mollema L. A deliberate choice? Exploring factors related to informed decision-making about childhood vaccination among acceptors, refusers, and partial acceptors. Vaccine 2019;37:5637–44.
[21] Norwegian Institute of Public Health. Report for 2018: childhood vaccination programme in Norway [in Norwegian]. 2019.
[22] European Centre for Diseases Prevention and Control. Risk assessment: Who is at risk for measles in the EU/EEA? Identifying susceptible groups to close immunity gaps towards measles elimination 2009.
[23] Endrich MM, Blank PR, Szucs TD. Influenza vaccination uptake and socioeconomic determinants in 11 European countries. Vaccine 2009;27:4018–24.
[24] Tabacchi G, Costantino C, Napoli G, Marchese V, Cracchiolo M, Casuccio A, et al. Determinants of European parents' decision on the vaccination of their children against measles, mumps and rubella: A systematic review and meta-analysis. Hum Vaccin Immunother 2016;12:1909–23.
[25] Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine 2014;32:2150–9.
[26] Falagas ME, Zarkadoulia E. Factors associated with suboptimal compliance to vaccinations in children in developed countries: a systematic review. Curr Med Res Opin 2008;24:1719–41.
[27] Hadjipanayis A, van Esso D, Del Torso S, Dornbusch HJ, Michailidou K, Minicuci N, et al. Vaccine confidence among parents: Large scale study in eighteen European countries. Vaccine 2020;38:1505–12.
[28] Hak E, Schonbeck Y, De Melker H, Van Essen GA, Sanders EA. Negative attitude of highly educated parents and health care workers towards future vaccinations in the Dutch childhood vaccination program. Vaccine 2005;23:3103–7.
[29] Mollema L, National Institute for Public Health and the Environment. PIENTER 2-project: second research project on the protection against infectious diseases offered by the national immunization programme in the Netherlands. 2009.
[30] Norwegian Institute of Public Health. Continued high uptake for the Childhood Immunisation Programme in Norway 2019.