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REVIEW

Enabling Vaccine Uptake: Strategies for the Public Health Sector

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Abstract

Safe and effective vaccines have been instrumental in controlling and mitigating some of the most contagious and devastating diseases throughout history, ranging from smallpox, polio and diphtheria to measles, flu and coronavirus disease 2019 (COVID-19). Despite their proven success, vaccination rates often fall short of the World Health Organisation's recommendations, facing persistent challenges. This review explores strategies to enhance vaccine uptake, with a particular focus on the UK context, by examining potential barriers, effective interventions and the vital role of various stakeholders. Boosting vaccine uptake requires a comprehensive approach that tackles issues such as vaccine hesitancy, improves accessibility, builds public trust, and utilises effective communication. By implementing targeted strategies, public bodies, scientists and healthcare professionals can work together to improve vaccination rates and safeguard communities against preventable diseases. Continuous evaluation and adaptation of these strategies are crucial to ensure their effectiveness and relevance in addressing the evolving challenges of vaccine uptake.

Key words: childhood vaccination; misinformation; vaccine hesitancy; herd immunity; public health

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Introduction

Vaccines are arguably one of the most impactful medical interventions ever, protecting against debilitating and often fatal infections that were once common, and thereby saving millions of lives (Li et al, 2021). Vaccines work by training the immune system on how to fight infectious organisms and develop the required level of immunity without the risk of a full-blown infection first. In many cases, vaccines can entirely protect from developing an infection and passing it on to others. In other cases, they can greatly alleviate symptoms and prevent serious illness and death. Depending on the type, some vaccines such as the childhood vaccine against measles, mumps and rubella (MMR) may require two or three 'boosters' to ensure full immunity is achieved—without which the individual would be under-vaccinated and still at risk of infection. Similarly, with a rapidly mutating pathogen

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like the flu virus, existing vaccine-induced immunity may not be sufficient to recognise and fight a newer strain, therefore necessitating seasonal booster vaccines. This review explores strategies to enhance vaccine uptake, with a particular focus on the UK context, by examining potential barriers, effective interventions and the vital role of various stakeholders.

Today, most countries have comprehensive vaccination schedules in place, targeting individuals at an elevated risk of serious disease or death, such as the young, the elderly and those with underlying health conditions (Table 1). Vaccines now protect babies and children against many detrimental infections, such as diphtheria, meningitis and polio. It is not just childhood vaccines that are of utmost relevance for public health. Infections by respiratory syncytial virus (RSV) and flu are responsible for numerous hospitalisations during the winter, especially amongst vulnerable groups such as the elderly and the very young. Coronavirus disease 2019 (COVID-19) is not seasonal driving considerable peaks of hospitalisations throughout the year, which is why, in the UK, the most vulnerable are offered a spring booster (Table 1). From autumn 2024, RSV vaccines will be introduced in the UK for pregnant women and people between the ages of 75 to 79. Annual boosters that are designed to target the prevalent strains of flu and COVID-19 are now being offered to more vulnerable groups including people with underlying health conditions.

Despite the progress in vaccine availability, efficacy and safety, vaccination rates in the UK and other industrialised nations are declining, particularly for childhood vaccines, leading to a resurgence of diseases that had almost been eradicated, such as whooping cough, mumps and measles (NAO, 2019). While the COVID-19 pandemic disrupted vaccine provision temporarily in some areas, leading to suboptimal vaccination rates (Dalton et al, 2023), there has been a further drop in vaccine confidence and uptake since then (Siani and Tranter, 2022). As new vaccines are constantly being developed, against both emerging and existing infectious diseases, and more recently against cancers including the exciting potential of personalised treatments (Lin et al, 2022), it is now of paramount importance to ensure that trust in, and acceptance of, available and new vaccines is high.

Understanding Herd Immunity

The impacts of low vaccine uptake are far-reaching, placing unvaccinated individuals at risk and endangering others. High vaccination rates are essential for achieving herd immunity, which protects those who have not yet been or cannot be vaccinated, such as individuals with certain medical conditions. The fewer susceptible individuals there are in a population, the lower the likelihood of an outbreak, benefiting the entire community with a reduced risk of infection. The threshold for herd immunity varies depending on how severe the disease is, how rapidly it spreads and how susceptible the population is. For highly contagious diseases such as measles, around 95% of the population must be immune to achieve herd immunity. In contrast, for diseases like whooping cough or polio that are less contagious a threshold of 80–85% is sufficient. Worryingly, the coverage rate for both recom-

Table 1. Currently recommended vaccinations in the United Kingdom as of September 2024.

Age	Vaccine
Babies and children[1]	
8 weeks	6-in-1 Rotavirus MenB
12 weeks	6-in-1 (second dose) Pneumococcal Rotavirus (second dose)
16 weeks	6-in-1 (third dose) MenB (second dose)
1 year	Hib/MenC MenB (third dose) MMR Pneumococcal (second dose)
2–15 years	Flu (every year)[4]
3 years and 4 months	MMR (second dose) 4-in-1 pre-school booster
12–13 years	HPV
14 years	MenACWY Td/IPV (3-in-1 teenage booster)
Adults[2]	
During pregnancy	Flu COVID-19 RSV Whooping cough
65 years	COVID-19 (autumn booster) Flu (every year) Pneumococcal Shingles[3]

mended doses of the MMR vaccine at age 5 is currently 84.5% for England, and as low as 60% in some areas of London (Harker, 2024). These rates fall short of the 95% target set by the World Health Organisation, leaving up to 3 million children in the UK unprotected from measles (DHSC, 2024). It is worth remembering that prior to the introduction of the measles vaccine in 1968, England and Wales reported around 500,000 measles cases and up to 100 deaths per year. While deaths from measles are now rare in the UK, there were still 136,000 deaths globally in 2022 (WHO, 2024), identifying measles as a severe and potentially fatal disease.

Table 1. Continued.

Age	Vaccine
70–79 years	Shingles
75 years	COVID-19 (spring booster)
75–79 years	RSV

Note: Information from the NHS website is licensed under the Open Government Licence v3.0. [1] Hepatitis B vaccine at birth, 4 weeks and 12 months recommended for babies born to mothers who have hepatitis B. BCG tuberculosis (TB) vaccine at around 4 weeks recommended for children born in areas with high numbers of TB cases, or whose parents or grandparents were born in a country with many cases of TB. COVID-19 vaccine recommended for children from 6 months with a weakened immune system. Yearly flu vaccine recommended for children from 6 months with long-term health conditions. [2] People from certain at-risk groups may be recommended to receive a chickenpox, COVID-19, flu, hepatitis A, hepatitis B, MenACWY, MenB, pneumococcal, and/or shingles vaccine, depending on underlying health conditions. Check the NHS guidance for more details. [3] For people who turned 65 on or after 1 September 2023. [4] Yearly flu vaccine recommended for children from 6 months to 17 years old with long-term health conditions. 4-in-1, tetanus, diphtheria, polio, whooping cough; 6-in-1, tetanus, diphtheria, polio, whooping cough, hepatitis B; COVID-19, coronavirus disease 2019; Hib, *Haemophilus influenzae* type b; HPV, human papillomavirus; MenACWY, group A, C, W and Y meningococcal; MenB, group B meningococcal; MenC, group C meningococcal; MMR, measles, mumps, and rubella; RSV, respiratory syncytial virus; Td/IPV, tetanus, diphtheria, polio.

Which Groups Are Less Likely to Take Up Vaccines?

Ethnic Minorities and those From Lower Socioeconomic Groups

Certain demographics are less likely to take up vaccines although this can vary regionally. Although ethnic minorities and those from lower socioeconomic backgrounds were disproportionately affected by COVID-19 with higher rates of infection, hospitalisation and death, vaccine uptake or intent to receive a vaccine was comparatively low. Black or South Asian ethnicity, religious orthodoxy, deprivation, disability, English language proficiency, household tenure, young age and educational levels were all factors that negatively affected vaccination uptake during the COVID-19 pandemic (Dolby et al, 2022). Inequality has also been demonstrated within the UK vaccination programme, where children with mothers from some ethnic minorities were found to be particularly vulnerable to undervaccination (Zhang et al, 2023).

Healthcare Professionals

Another important group to consider are healthcare professionals who may have their own reservations about vaccines. Indeed, healthcare professional hesitancy is thought to have contributed to a substantial decrease in recommendations for most vaccinations (Dudley et al, 2024). A systematic review of vaccine hesitancy amongst healthcare professionals exposed differences across countries, with nurses generally considering vaccines less safe than general practitioners (Kaur et al, 2023). This was reflected in a study in Wales that showed that medical and dental staff, and Allied Health Practitioners such as occupational therapists were more likely to get vaccinated, compared to nursing and midwifery staff (Bedston et al, 2022).

Hesitancy regarding vaccines also varies depending on the type of vaccine, with newer mRNA vaccines raising more concerns than longer-established vaccines (Leong et al, 2022).

Factors Influencing Vaccine Uptake

Factors influencing vaccine uptake include accessibility, prior negative healthcare experiences, mistrust of organisations or advocacy of alternative healthcare, and vaccine hesitancy (Fig. 1).

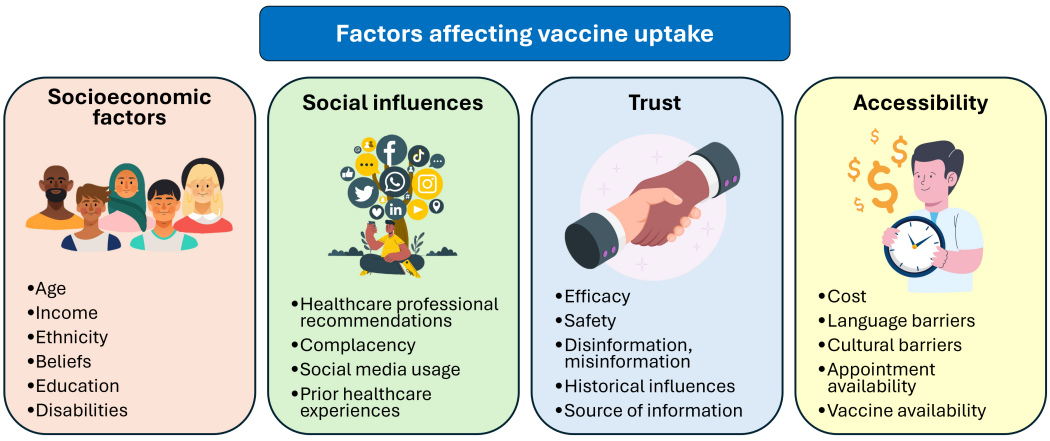

Fig. 1. Factors affecting vaccine uptake. Many issues impact vaccine uptake and the intent to vaccinate including people's backgrounds (socioeconomic factors) and their social influences. Trust in the underlying science, healthcare and large organisations such as pharma and how accessible vaccine information is, their cost as well as the ease and convenience of getting vaccines are all strong drivers impeding vaccine uptake. Figure drawn in Microsoft PowerPoint 365 (Microsoft, Windows 11 Education, Redmond, WA, USA) using assets from Freepik (Málaga, Spain).

The reasons for these diverse factors reducing vaccine uptake are multi-faceted and are summarised by the '5 Cs'—Confidence, Complacency, Convenience, Communication and Context (Fig. 2) (MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015; Razai et al, 2021). The 'Confidence' aspect considers fears around the safety and efficacy of vaccination and the possibility of side effects versus the risk of the actual diseases. This is exemplified by concerns about how much

faster many vaccines can now be developed compared to the past as well as a general mistrust of newer technologies like mRNA vaccines and genetic engineering that may be less familiar to people without a scientific background. 'Confidence' also relies on trust in the institutions which manufacture vaccines and circulate information such as pharmaceutical agencies ('big pharma'), the government, public health institutions, healthcare professionals and scientists. For example, many of the groups known to have had poorer vaccine uptake for example, during the COVID-19 pandemic, including Black or South Asian ethnic groups (Dolby et al, 2022), have historic mistrust in public institutions. There were also concerns over the safety and efficacy of the vaccine development process. This lack of "Confidence" is widespread, with surveys from 113 countries revealing that trust in public health institutions and 'conspiracy mentality' are the strongest predictors of vaccine hesitancy, while trust in government is a somewhat less robust but nevertheless significant predictor (Jennings et al, 2023). The frequent under-representation of, and lack of transparent data on, ethnic minorities within clinical trials further contributes to concerns about confidence and trust (Salari et al, 2022).

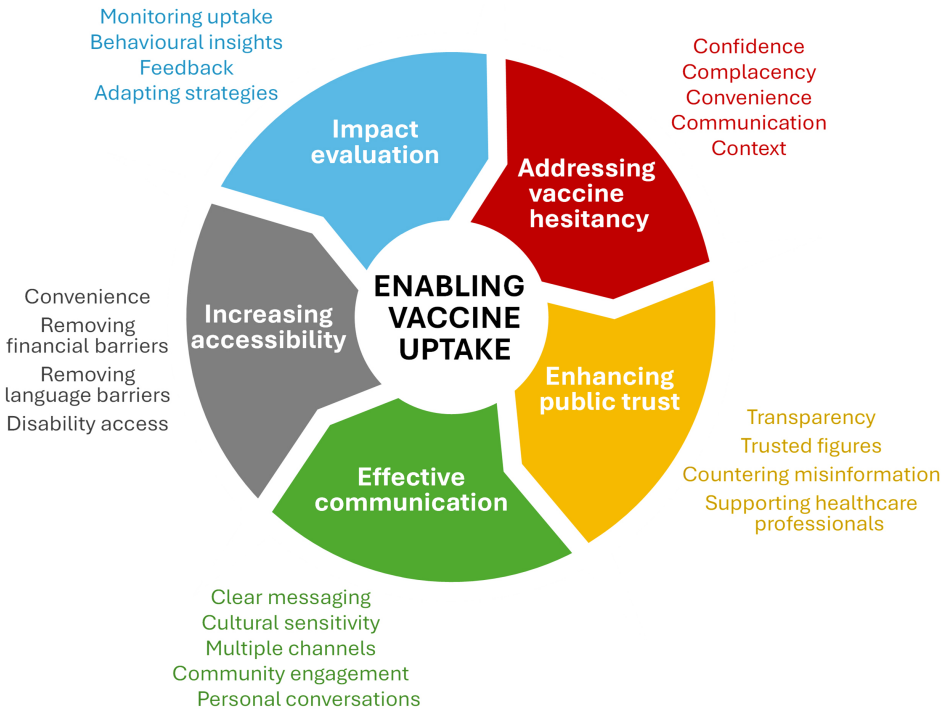

Fig. 2. Enabling vaccine uptake. Interdependent measurements are required to tackle vaccine hesitancy, enhance vaccine uptake and maintain high vaccination rates in modern society. Figure drawn in Microsoft PowerPoint 365 (Microsoft, Windows 11 Education, version 23H2, Redmond, WA, USA).

Historically, 'Complacency' surrounding the severity of eradicated or seasonal diseases has always been prevalent, and misunderstanding of disease risk versus vaccine risk causes people to question the necessity of vaccinations. This is perhaps epitomised by the discourse around the severity of measles that impacts MMR uptake (Toure et al, 2014), or around COVID-19 (Liu et al, 2024), and the concerns

about the safety of mRNA vaccines. 'Convenience' encompasses a wide range of factors affecting vaccine uptake, including accessibility and availability, work time conflicts, quality of service and affordability of vaccines. 'Communication' considers how accessible services and information are. Many people in the UK do not have English as their first language; the 2021 census revealed that over 1 million people in England and Wales (1.8% of residents) could speak neither English nor Welsh well or at all (ONS, 2022). Another issue is ease of access such as location or timings of vaccines. In a society where information and booking systems are increasingly online, it is worth noting that many people are digitally illiterate or lack access to the appropriate technology. 'Context' considers cultural sensitivities and needs. Not addressing the reasons underlying vaccine uncertainty in particular risks leaving people vulnerable to misinformation and disinformation.

'Context' together with 'Communication' was evident during the COVID-19 pandemic, with perceptions that there was a lack of reliable information or trusted messengers that were representative of people's cultures (Shearn and Krockow, 2023). Ineffective communication can also cause 'vaccine fatigue' resulting in inertia towards information about vaccines. It is therefore important to ensure that healthcare information is appropriate, accurate and accessible, especially during booster campaigns which are at risk of 'Complacency' about the risk of infection (Su et al, 2022).

Poor communication can also enhance the likelihood of people resorting to unguided online searches and inadvertently being exposed to vaccine misinformation, which may further impede vaccine uptake. Notably, usage of social media, which may not have clearly signposted accurate information, negatively correlates with vaccination intent, with frequent discussions of negative information surrounding vaccine development, safety, efficacy, necessity and conspiracy theories (Cascini et al, 2022).

Building Confidence and Trust in Vaccinations

Tackling Inaccurate Information and Enhancing Confidence

Misinformation refers to the sharing of inaccurate information and may be unintentional. In striking contrast, disinformation alludes to purposefully creating and sharing inaccurate information. Whilst both can be damaging to vaccine confidence, disinformation is more concerning as it is done with malicious intent. Fortunately, relatively few people deliberately create and amplify misleading content (the 'disinformation dozen') (Nogara et al, 2022). However, the technological and financial resources these people have at their disposal, combined with the way social media algorithms tend to amplify content that boosts 'engagement', means they exert a disproportionate impact on the public discourse. Notably, self-proclaimed 'experts' who use titles and jargon to seemingly sound authoritative to the lay public whilst peddling disinformation can be amongst the most damaging (Harris et al, 2023). Yet, despite the danger of vaccine disinformation and its damaging effect on the roll-out of the COVID-19 vaccines, it has been suggested that the so-called 'anti-vax' movement is not a significant factor in the present decline in childhood

vaccination rates. In fact, granting public attention to 'anti-vaxxers' may even hinder efforts to curb vaccine hesitancy (Edelstein et al, 2020). Raising the profile of anti-vaccination groups and messages and drawing attention to myths can in fact inadvertently increase concerns and reduce willingness to vaccinate (Nyhan and Reifler, 2015; Nyhan et al, 2014).

The ability of the public to recognise and challenge misinformation and disinformation, particularly on the internet, is a key factor in maintaining trust in vaccination (Fig. 2). Media literacy to successfully challenge inaccurate information can be tackled by adopting approaches used in Finland with school children. Here, students are encouraged to consider the source of the information, how reliable the source is, and whether there are financial incentives for the authors such as adverts or offers of 'alternative' cures (Kupiainen, 2019). There may also be tighter sanctions on misleading content online due to tighter regulations of social media platforms, such as via the Online Safety Act and measures in the EU (EU Digital Services Act, 2024), although time will be needed to assess their impact.

Addressing Convenience by Enhancing Accessibility and Availability of Vaccines

Overall, confidence in childhood vaccination remains relatively high in the UK, where the major barrier appears to be accessibility (Fig. 2). Delivery of childhood vaccines through schools is standard in the UK for some childhood vaccines such as flu boosters (UKHSA, 2024a). This can help working parents ensure their children get crucial vaccines without having to take time off, thereby enhancing convenience. All eligible children will be vaccinated unless parents or guardians choose to opt them out. The situation can be more complex in other countries that may have different opt-out policies including objecting on religious or personal grounds.

A decline in vaccination uptake is more likely to be due to the reorganisation of health services and the increasing proportion of the population who face health system barriers, including reduced access to health practitioners and appointments (Dudley et al, 2024; Jennings et al, 2023; Loiacono et al, 2020; Skirrow et al, 2024). Accessibility of services varies largely across the UK, even within cities, and may contribute to the high degree of regional disparity in vaccination uptake, particularly in London, which is ethnically and culturally more diverse than most other parts of the UK (NAO, 2019).

The UK does not charge most people for routine vaccinations including boosters. However, the removal of this direct cost does not mitigate cost accessibility, as appointments are often during working hours, and so cause an indirect loss of income through taking children or themselves to vaccination appointments. Over the COVID-19 pandemic, clinic hours were extended, as were the numbers and types of premises which could carry out immunisations, with many evening and weekend appointments available. Indeed, qualitative evaluation of COVID-19 vaccine delivery in London showed the value of flexible booking systems and convenient, safe and familiar vaccination sites (Halvorsrud et al, 2023). Such strategies should be considered for the future for both adult and childhood vaccinations. The use of pharmacists to give routine childhood vaccinations is currently being piloted in

NorthWest England, which should give wider accessibility to vaccines, and hopefully increase uptake (NHS News, 2024). The NHS vaccination strategy also aims to join up vaccination offers for families to need fewer appointments, which could be an important step in tackling convenience (NHS, 2024).

Communication is important for appointments. The NHS vaccination strategy (NHS, 2024) has detailed plans to ensure that accessing vaccination is simple and convenient, building on the digital National Booking Service that was instrumental during the pandemic, with adequate communication about vaccination appointments that were cost-effective and appropriate. Invitations, reminders and escalation of contact are highly recommended in the guidelines of the National Institute for Health and Care Excellence for vaccine uptake in the general population, along with making service organisations accessible to local needs (NICE, 2022).

The Key Role of Healthcare Professionals in Addressing Communication and Context

The source of information about vaccine safety and efficacy is fundamental, with healthcare professionals and public health institutions widely regarded as one of the most trusted providers of information (Dudley et al, 2024; Kaur et al, 2023; Lazarus et al, 2024). Positive recommendations and discussions can decrease vaccine hesitancy around childhood vaccinations and enhance flu booster uptake, especially in ethnic minorities, men and younger parents (Loiacono et al, 2020; UKHSA, 2024b). Healthcare professionals need to be aware of the severity of diseases, side effects from the vaccines and vaccine effectiveness, and be able to communicate this information to increase confidence and reduce complacency. Regularly updated online resources for healthcare professionals tackling potential concerns need to be available, and training in vaccine discussions should be developed (Fig. 2).

Emphasis should be put on giving healthcare professionals adequate time to access relevant information, whether through personal study or workplace training in the latest guidelines and recommendations, thereby preventing outdated information from fuelling vaccine hesitancy. Healthcare professionals need additional time to effectively discuss vaccines with service users, emphasising recommendations, and more accessible resources to give to patients and their carers or next-of-kin. This includes but is not limited to general practitioner appointments where increased workloads have diminished the time and frequency available for patient interactions, leading to lower vaccination rates compared to scenarios with more frequent appointments per patient (Edelstein et al, 2020).

Communication regarding the need for, science of and value of vaccinations is critical. This is echoed in the literature on climate change advocacy. A recent study on changing people's perception about climate change demonstrated the need for conversations that are relevant to the individual person and their lived experience to ensure a lasting shift in opinion, a strategy which is likely to be applicable to be impactful for vaccine messaging (Soliman, 2024). Who delivers vaccine communication is crucial, and impactful approaches are discussed below.

The Role of Researchers in Vaccine Communication

In addition to healthcare professionals, basic and clinical researchers play a key role in communication about vaccines and addressing some of the issues connected with context. Researchers use public outreach to provide accurate and accessible information to address potential concerns about vaccines. In the UK, the British Society for Immunology (BSI) contributes significantly by coordinating and leading nationwide efforts to enhance public understanding, support informed decision-making, and ultimately improve public health (Aquino et al, 2023). With respect to vaccines this is achieved through multilingual fact sheets, vaccination guides and interactive content; public campaigns with public health bodies, charities, academic institutions and media; training of science communicators and vaccine ambassadors; and events for researchers, healthcare professionals and members of the public as a forum for learning and discussion.

Tailoring Immunisation Programmes

The WHO has published guidance on supporting countries to understand barriers to high vaccine uptake in the form of tailoring immunisation programmes (Fig. 2). These programmes are designed to provide insights into the barriers that specific populations face, formulate interventions, and evaluate results, leading to equitable vaccination uptake regardless of income, age, ethnicity or religion. Much work was done by the UK government, professional bodies and charities over the COVID-19 pandemic to ensure that those unvaccinated and under-vaccinated parts of the population were reached and accessibility barriers removed (Race Disparity Unit, 2021). This included the introduction of community champions hosting round tables with local businesses, volunteers and faith leaders. The use of trusted figures from different communities to establish lasting relationships, and positive messaging in accessible formats (Nordin et al, 2020) can help with tackling context, communication and confidence. The effectiveness of such a strategy is exemplified by organisations such as 'Muslim Doctors Cymru' in Wales. Established by volunteer healthcare professionals to address concerns about COVID-19 vaccines, the group's cultural diversity and academic expertise enabled them to communicate public health messages in a variety of minority languages, and successfully set up pop-up vaccine centres in mosques and other trusted community settings.

Continuing with these existing outreach programmes, and establishing new ones, tailored to solving the specific issues identified within populations or contexts in the form of tailoring immunisation programmes, will be invaluable to the future dissemination of information and to ensure the accessibility of vaccines and the reduction of health inequalities across communities. The new NHS vaccination plan (NHS, 2024) aims to consider tailored outreach for those who are more hesitant to build trust and confidence as well as considering flexibility in locations of vaccination services. As tailoring immunisation programmes must be context-dependent (Skirrow et al, 2021), it will be important to evaluate and share what practices work best in what settings, for which groups and for which vaccines.

Conclusion

The present article covers central issues that contribute to poor vaccine uptake, the demographics least likely to take vaccines and practical steps to address vaccine accessibility and trust. We propose five interdependent areas that require attention to enable and maintain vaccine uptake. The individual steps within these areas relate to addressing vaccine hesitancy, enhancing public trust, effective communication, increasing accessibility and evaluating and adapting strategies. Healthcare professionals play a critical role as trusted messengers in these areas and are well-placed to address vaccine uptake. However, support is needed to ensure they are empowered to do so. The continuing evolution of modern vaccines for a range of diseases including cancer shows the growing importance of these valued tools for our health. It is imperative we work together to address vaccine hesitancy and enhance uptake to improve health for all.

Key Points

- Public health institutions should provide concise information on vaccines and vaccination for dissemination to healthcare professionals and the wider public.
- Structural barriers in the health service should be removed, such as easing the booking of healthcare appointments by providing vaccine services in local communities.
- Healthcare professionals should be supported in media literacy to tackle misinformation and disinformation and be provided with appropriate tools to enhance their ability to address concerns about vaccines.
- Information regarding different types of vaccines should include cultural contexts such as whether vaccines contain animal products so that alternatives can be considered.
- Tailoring Immunisation Programmes and community outreach programmes should be developed to enhance vaccine uptake in underserved or hard-to-reach communities. Evaluation of such programmes will be critical.

Availability of Data and Materials

All the data of this study are included in this article.

Author Contributions

SC and ME conceived the work. SC, KE, and ME drafted the manuscript. RL, JD, and KE conducted the research under the supervision of SC and ME. All authors contributed to important editorial changes in the manuscript and read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest.

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