

# Effectiveness of digital technologies at improving vaccine uptake and series completion: A systematic review and meta-analysis of randomized controlled trials

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# Disclosure Statement

- I have no affiliation (financial or otherwise) with a pharmaceutical, medical device or communications organization.
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- This manuscript is under review at *Vaccine*



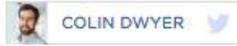


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## Amid Spike In Measles Cases, Health Officials Warn Of 'Losing Decades Of Progress'

November 30, 2018 · 2:35 PM ET



A medical worker holds a measles-rubella vaccine at a health station in Banda Aceh, Indonesia.  
*Chaideer Mahyuddin/AFP/Getty Images*

If you take the long view, international health organizations have much to be encouraged about when it comes to the global fight against measles. From 2000 to 2017, for instance, the annual number of measles-related deaths dropped 80 percent — from a toll of over half a million to just under 110,000 last year.

But lurking inside those statistics, [published Thursday](#) by the World Health Organization and the Centers for Disease Control and Prevention, are some far less rosy numbers. Specifically, what's been going on recently.

The report found that cases of the highly contagious disease spiked by more than 30 percent from 2016 to 2017. The WHO and CDC say there were 170,000 officially

## Measles outbreak raging in Europe could be brought to U.S., doctors warn

“People are dying from measles. This was unbelievable five or 10 years ago.”



# The mHealth market will account for more than **\$28 billion** in 2018

Despite barriers relating to regulation, patient acceptance and privacy concerns, further growth is estimated at a rate of **approximately 30 percent over the next three years**



# Using Mobile Apps to Communicate Vaccination Records: A City-wide Evaluation with A National Immunization App, Maternal Child Registry and Public Health Authorities

Katherine M. Atkinson, Ziad El-Khatib, Geoffrey Barnum, Cameron Bell, Marie-Claude Turcotte, Malia S.Q. Murphy, Mari Teitelbaum, Pranesh Chakraborty, Lucie Laflamme and Kumanan Wilson

**Abstract**  
Medicine is experiencing a paradigm shift, where patients are increasingly involved in the management of their health. We created a mobile app which permitted parents reporting of immunization status to public health authorities as well as data utility for public health surveillance. The app was used for a period from April 27, 2015, to April 18, 2016. We describe app use as a proxy for feasibility and acceptability as well as data utility for public health surveillance. The app was used by 2,853 unique children's records were tracked during the period. Our findings suggest that reporting is feasible and acceptable.

## Health Data and Privacy in the Digital Era

**VIEWPOINT**  
Lawrence G. Gostin, JD  
O'Neill Institute for National and Global Health Law, Georgetown University, Washington, DC  
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In 2010, the social networking site Facebook launched a platform allowing private companies to request users' permission to access personal data. Few users were aware of the platform, which was integrated into Facebook's terms of service. In 2014, Cambridge Analytica, a UK-based political consulting firm, developed a data-harvesting app. That app prompted Facebook users to provide psychological profiles, including responses such as "I get upset easily" and "I have frequent mood-swings" as part of a "research project."

The Facebook platform allowed users to share their friends' data as well, enabling Cambridge Analytica to access tens of millions of personal profiles, identifying voters' political preferences. The controversy revealed risks to identifiable health data posed by social media and web services companies. Facebook suspended a project that aimed to link data about users' medical conditions with information about their social networks.

Individuals often reveal detailed, sensitive health information online. Through wearable devices, social media posts, traceable web searches, and online patient communities, users generate large volumes of

Individuals' health data are now solicited, aggregated, and largely unregulated. Federal and state laws, such as HIPAA, safeguarding data in clinical settings, health insurance, and research do not govern most internet health data.<sup>1</sup> Thus, private firms can effectively assemble consumer and patients based on profiles gathered from tracked user behavior, data purchased from other sources, and predictive analytics. Currently, major gaps and inconsistencies exist in health information privacy safeguards.

## COMMENTARY

# Mobile cell phone technology puts the future of health care in our hands

Kumanan Wilson MD MSc

■ Cite as: CMAJ 2018 April 3;190:E378-9. doi: 10.1503/cmaj.170432  
See related article at www.cmaj.ca/lookup/doi/10.1503/cmaj.170432

The digital revolution has affected virtually every aspect of our lives, and health is no exception. This is particularly evident in the burgeoning area of mobile health (mHealth). A subset of the overall digital health market, which is expected to exceed half a trillion dollars in revenue by 2025,<sup>1</sup> mHealth refers to the use of cell phone technology to deliver health care. A linked research paper reporting on the effectiveness of a smartphone camera functioning as a de facto photoplethysmograph to evaluate the adequacy of collateral circulation in patients scheduled for cardiac catheterization

### KEY POINTS

- The advent of smartphone technology and mobile applications has increased the potential impact and scope of mobile health (mHealth) dramatically, but the challenges of bringing this technology into wider practice are substantial.
- Although downloads of smartphone applications are declining in general, health application purchases are increasing.

HUMAN VACCINES & IMMUNOTHERAPEUTICS  
<https://doi.org/10.1080/21645515.2018.1539604>

## RESEARCH PAPER

# Healthcare provider perspectives on the uptake of the human papillomavirus vaccine among newcomers to Canada: a qualitative study

Taylor Rubens-Augustson<sup>a,b</sup>, Lindsay A. Wilson<sup>a,c</sup>, Malia S.Q. Murphy<sup>a</sup>, Cindy Jardine<sup>a,c</sup>, Kevin Pottie<sup>a,d,e</sup>, Charles Hui<sup>f</sup>, Martin Stafström<sup>b</sup>, and Kumanan Wilson<sup>a,d</sup>

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### EXPERT REVIEWS

## Opportunities for utilizing new technologies to increase vaccine confidence

Kumanan Wilson<sup>1,4</sup>, Katherine Atkinson<sup>1,4</sup>

The emergence of new digital technologies has "disrupted" traditional vaccine information in the internet, social media, digital detection of vaccine hesitancy, and providing a mechanism for the anti-vaccine community has leveraged the benefits of information and communication technologies. Mobile apps offer an important opportunity to identify and address concerns in a



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## Strategies through mobile or mobile enhanced on systems

Shelley L. Deeks<sup>1,2</sup>, Natasha S. Grayson<sup>1,2,3</sup>

It is critical to improving the quality and evaluating the ongoing success of immunization systems is challenged by a myriad of factors including the heterogeneity of individuals, new vaccine development, use of multiple products, and increasingly fragmented information systems. Other opportunities presented by mobile technologies that enhance immunization systems include mobile reporting of adverse events following immunization, bidirectional communication between individuals and public health officials, ensuring privacy of data, access, and equity concerns, obtaining consent and

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KEYWORDS  
human papillomavirus; HPV; immunization; vaccination; newcomers; healthcare providers; qualitative methods

## PRACTICE TOOL ■ PEER-REVIEWED

# CANImmunize: A digital tool to help patients manage their immunizations

Sherilyn K. D. Houle, BSP, PhD; Katherine Atkinson, BSc; Michelle Paradis, BA; Kumanan Wilson, MD, MSc, FRCPC

A PERSON'S IMMUNIZATION HISTORY IS ESSENTIAL to health care providers to determine whether they are protected against vaccine-preventable diseases and to public health officials to ensure adequate vaccine uptake. As pharmacists increasingly offer immunization services across Canada, it is vital that they know an individual's immunization status.

- Personalized immunization forecaster: Users can create immunization records for all members of their family on their devices (Figure 1).

AT THE INTERSECTION OF HEALTH, HEALTH CARE, AND POLICY

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### Using Mobile Technology To Overcome Jurisdictional Challenges To A Coordinated Immunization Policy

November 14th, 2014



by Kumanan Wilson, Katherine Atkinson, and Jennifer Keelan

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On March 20, 2014, the Government of Canada and the federal Minister of Health announced the release of *ImmunizeCanada (ImmunizeCA)*, a smart phone application (app) designed to both provide accurate information on immunization for Canadians and allow them to track their and their family's

Digital technologies have the potential to help address both suboptimal vaccine uptake and series completion.

However, the effectiveness of pushing information and reminders to patients through digital technologies to address vaccination is not known.

The aim of this study is to determine if digital push interventions are effective in increasing vaccine uptake and series completion compared to non-digital interventions.

# Methods

Inclusion Criteria: Randomized Controlled Trials (RCTs)

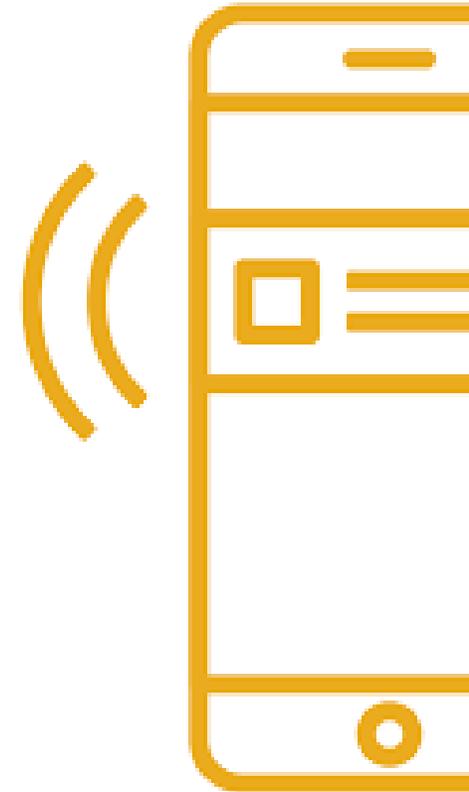
**Population:** Adults, including pregnant women and parents of children or adolescents who are were eligible for vaccination

**Intervention:** Digital-push

**Comparison:** Non-digital Pull

**Outcome:** Vaccine uptake or series completion.

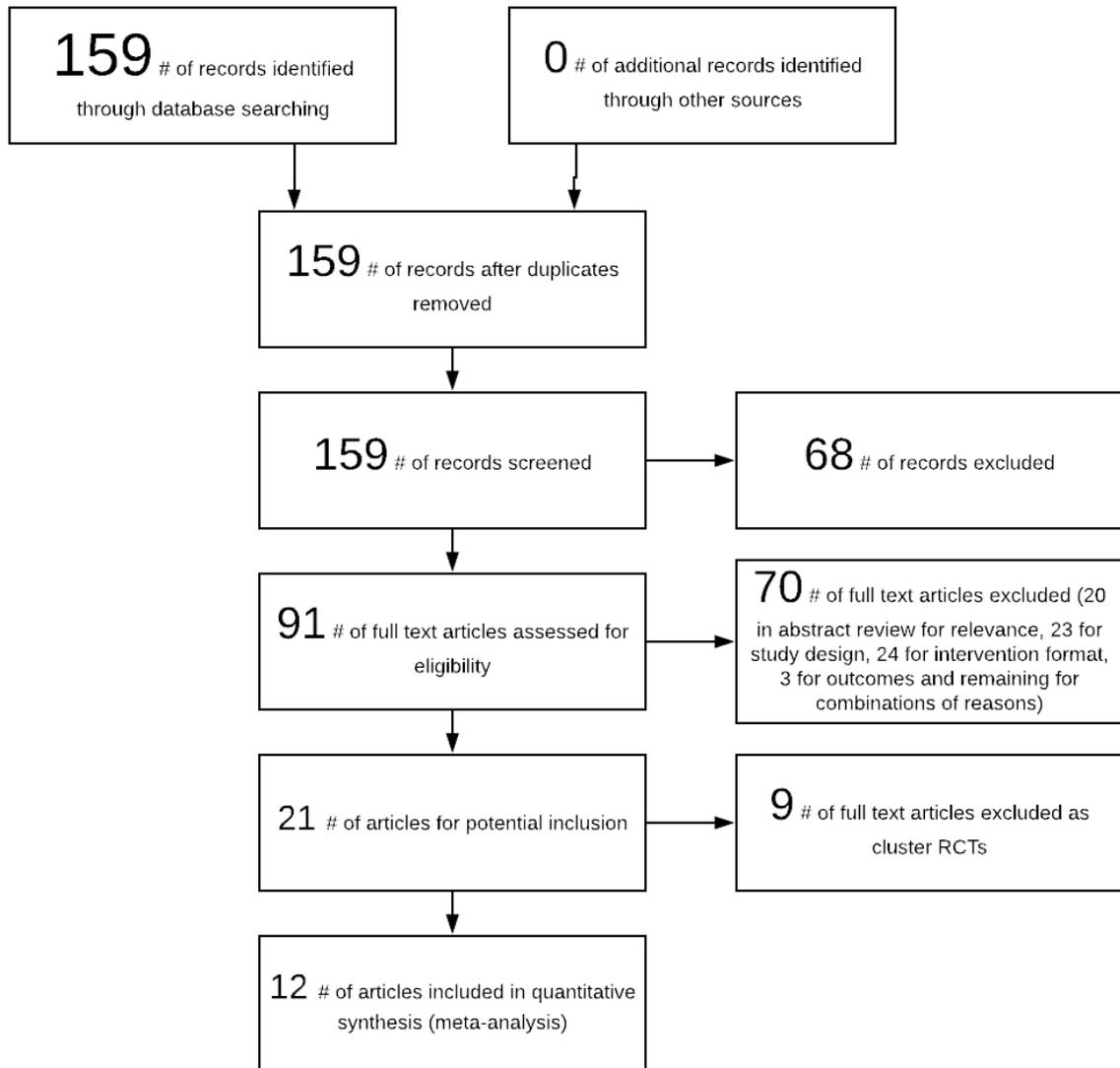
We estimated summary effect sizes, heterogeneity using the  $\chi^2$  test and quantified using the  $I^2$  statistic. Where heterogeneity remained significant, we conducted subgroup analyses. We assessed risk of bias, certainty of evidence and publication bias.



The search identified 159 manuscripts, with 12 manuscripts representing 14 empirical studies published meeting inclusion criteria.

The 14 studies were between 2012 and 2016 with a total of 26,493 participants. All but 3 studies were conducted in the United States of America (USA).

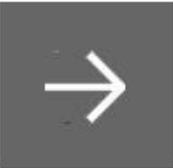
4 studies focused on influenza vaccination, three on pediatric immunizations, 2 on pneumococcal, and the remainder of Hib, MCV4 or Tdap or receipt of any eligible vaccination during the study period.





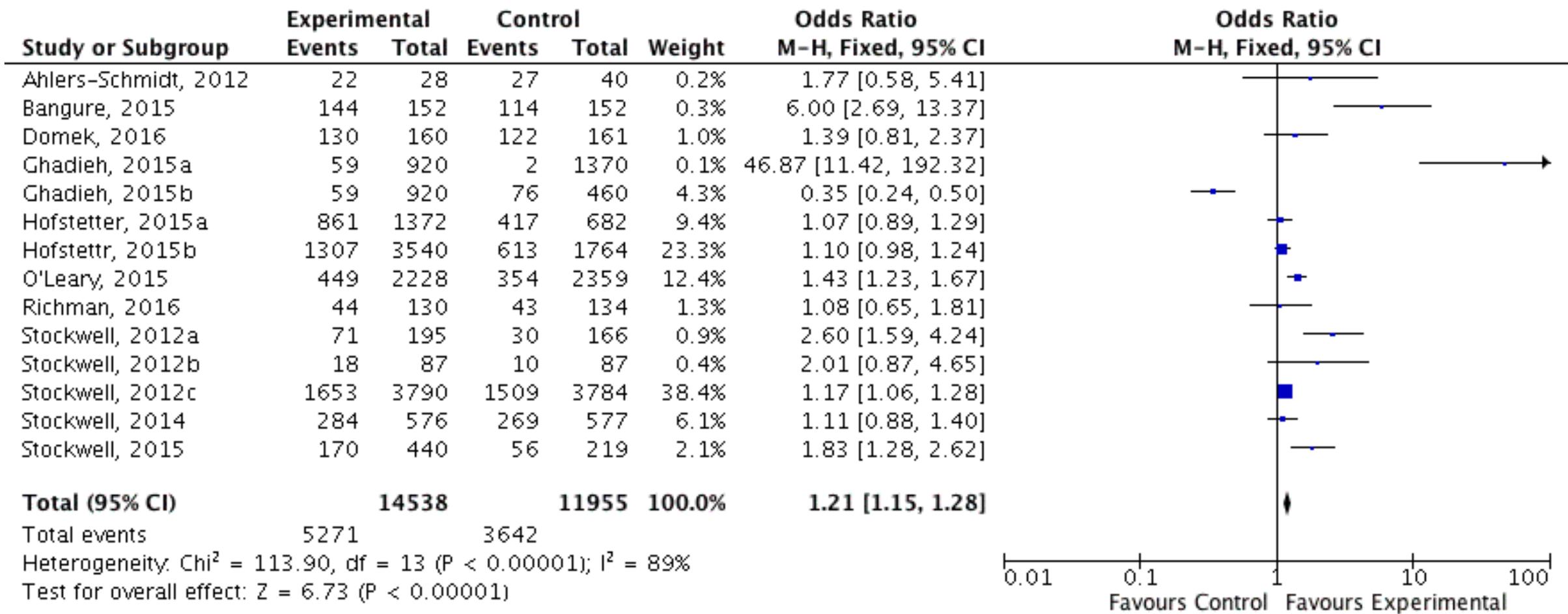
## RIM BlackBerry Bold

While the RIM BlackBerry Bold took its own sweet time getting here, the smartphone was worth the wait. Its half-VGA



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Examining all 14 studies, there was a 1.21[1.15, 1.29] increased odds of participants being vaccinated or completing the vaccination series with digital push interventions compared to non-digital interventions. The I<sup>2</sup> was 89%.

When evaluating by outcome, digital push interventions compared to non-digital interventions for vaccine uptake show an increased odds of 1.20[1.13,1.27] and an increased odds of 1.73[1.27,2.37] for series completion.

# Risk of Bias

Strong evidence of heterogeneity was observed ( $i^2 = 89\%$ ,  $P < 0.0000001$ )

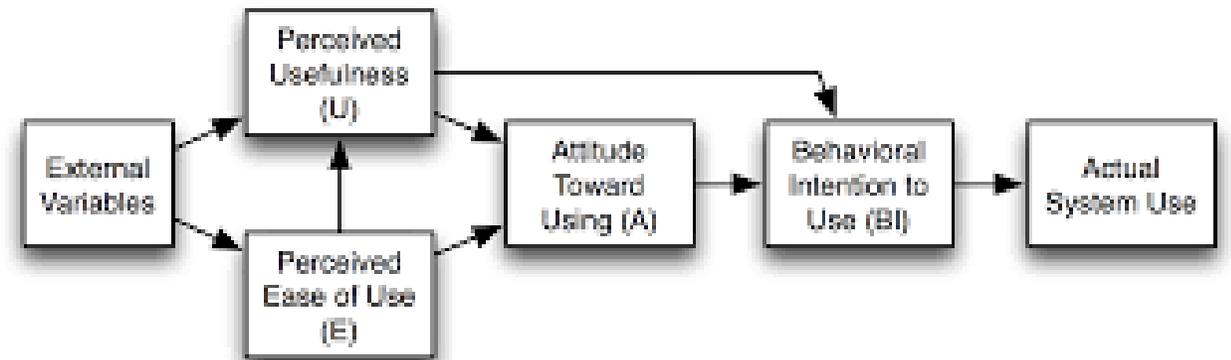
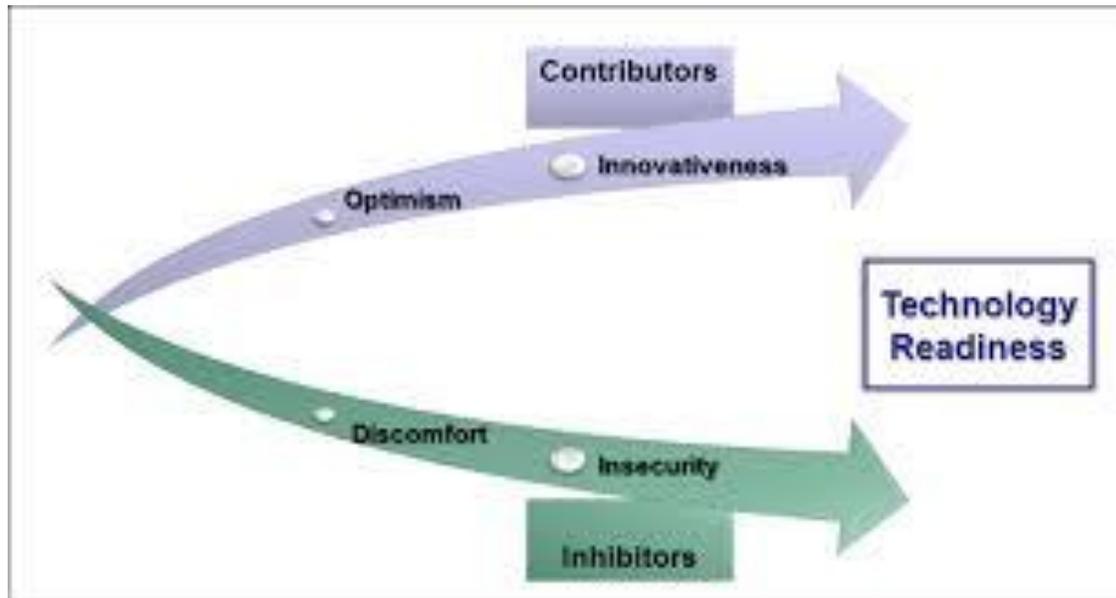
The funnel plot did not show visual evidence of asymmetry

For “Series Completion” and “Vaccine Uptake”, the certainty of evidence was assessed to be very low and moderate, respectively

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Ahlers-Schmidt, 2012	+	+	+	?	-	+	-
Bangure, 2015	+	-	-	-	?	+	+
Domek, 2016	+	+	+	+	-	+	+
Ghadieh, 2015a	+	+	+	?	+	+	+
Ghadieh, 2015b	+	+	+	?	+	+	+
Hofstetter, 2015a	+	+	+	+	?	+	+
Hofstetter, 2015b	+	+	+	+	?	+	+
O'Leary, 2015	+	-	+	?	+	+	+
Richman, 2016	?	+	+	?	?	?	-
Stockwell, 2012a	+	+	+	?	+	?	+
Stockwell, 2012b	+	+	+	?	+	+	+
Stockwell, 2012c	+	+	+	+	-	+	+
Stockwell, 2014	+	+	+	+	?	+	+
Stockwell, 2015	+	+	+	+	?	+	+

# Discussion

Studies have not captured /measured people's attitudes or propensity towards technology



# Discussion

- How can future work better capture the interaction between attitudes towards technology/vaccination?
- How does this impact opportunities to reduce inequalities in vaccination?



## Interventions to reduce inequalities in vaccine uptake in children and adolescents: a systematic review.

Crocker-Buque T<sup>1</sup>, Edelstein M<sup>2</sup>, Mounier-Jack S<sup>1</sup>.

### Author information

#### Abstract

**BACKGROUND:** In high-income countries, substantial differences exist in vaccine uptake relating to socioeconomic group, geographic location and religious belief. This paper updates a 2009 systematic review on effective intervention uptake inequalities in light of new technologies applied to vaccination and new vaccine programmes (eg, human papillomavirus for adolescents).

**METHODS:** We searched MEDLINE, Embase, ASSIA, The Campbell Collaboration, CINAHL, The Cochrane Database of Systematic Reviews, Eppi Centre, Eric and PsychINFO for intervention, cohort or ecological studies conducted at primary/secondary schools, children and young people from birth to 19 years in OECD countries, with vaccine uptake or coverage as outcomes and 2015.

**RESULTS:** The 41 included studies evaluated complex multicomponent interventions (n=16), reminder/recall systems (n=18), outreach programmes (n=3) or computer-based interventions (n=2). Complex, locally designed interventions demonstrated the best evidence for effectiveness in reducing inequalities in deprived, urban, ethnically diverse communities. There is some evidence that postal and telephone reminders are effective, however, evidence remains mixed for text-message reminders, although these may be more effective in adolescents. Interventions that escalated in intensity appeared particularly effective. Computer-based interventions were not effective. Few studies targeted an inequality specifically, although several reported differential effects by the ethnic group.

**CONCLUSIONS:** Locally designed, multicomponent interventions should be used in urban, ethnically diverse, deprived populations. Some evidence is emerging for text-message reminders, particularly in adolescents. Further research should be conducted in the UK and Europe with a focus on reducing specific inequalities.

## The impacts of email reminder/recall on adolescent influenza vaccination.

Dombkowski KJ<sup>1</sup>, Cowan AE<sup>2</sup>, Reeves SL<sup>2</sup>, Foley MR<sup>2</sup>, Dempsey AF<sup>3</sup>.

### Author information

#### Abstract

**BACKGROUND:** We sought to: (1) explore the feasibility of using email for seasonal influenza vaccination reminders to parents of adolescents and (2) assess influenza vaccination rates among adolescents whose parents were randomized to either receive or not receive email reminders.

**METHODS:** Email addresses were obtained for parents of patients 10-18years from 4 practices in Michigan. Addresses were randomized to either receive email reminders, or not. Reminder messages were sent during October 2012-March 2013 (Season 1) and October 2013-March 2014 (Season 2). Vaccination status was determined 60days following the last email reminder for each season using the statewide Michigan Care Improvement Registry (MCIR); per protocol bivariate and multivariate logistic regression analyses were conducted to evaluate reminder notification.

**RESULTS:** After email cleaning, testing, and matching with MCIR, approximately half of email addresses (2348 of 5312 in Season 1; 3457 of 6549 in Season 2) were randomized. Bivariate analyses found that influenza vaccination within 60days after notification date was similar among those notified (34%) versus not notified (29%) in both Season 1 (p=0.06) and Season 2 (39% vs. 37%, p=0.20). However, multivariate models adjusted for season, site, and receipt of notification in two seasons found a higher likelihood of influenza vaccination among children that received notification (aOR=1.28, 95% CI=1.09, 1.51); in addition, differences in influenza vaccination were also observed between practice sites (range: p=0.15 to p<0.001).

**CONCLUSIONS:** We found that practice-based email influenza vaccine reminders to parents of adolescents are feasible, but not without complications. Our study demonstrates that email reminders from practices can yield increases in influenza vaccination rates among adolescents. Practices should consider email as an option for influenza reminders and establish business practices for collecting and maintaining patient email addresses. This study is registered at [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov) id #NCT01732315.

# Conclusion

- Overall, digital push technologies had a modest, positive impact on vaccine uptake and series completion which supports the idea that digital technologies could be a useful adjunct in improving vaccination rates.
- As the use of digital devices becomes nearly ubiquitous this may serve as a more efficient method than traditional approaches



Thank you!

