



Vaccination adherence: Review and proposed model



Asma A. Abahussin^a, Ahmed I. Albarrak^{b,*}

^a Biomedical Technology Department, College of Applied Medical Sciences, King Saud University, P.O. Box 10219, Riyadh 11433, Saudi Arabia

^b Health Informatics, Research Chair of Health Informatics and Health Promotion, College of Medicine, King Saud University, Riyadh, P.O. Box 63709, Riyadh 11526, Saudi Arabia

Received 27 June 2016; received in revised form 10 August 2016; accepted 6 September 2016

KEYWORDS

Vaccine;
Application;
Design;
Adherence;
Child;
Reminder

Summary

Background: The prevalence of childhood vaccine-preventable diseases can be significantly reduced through adherence to confirmed vaccination schedules. However, many barriers to vaccination compliance exist, including a lack of awareness regarding the importance of vaccines, missing due dates, and fear of complications from vaccinations. The aim of this study is to review the existing tools and publications regarding vaccination adherence, and to propose a design for a vaccination adherence application (app) for smartphones.

Methods: Android and iOS apps designed for vaccination reminders have been reviewed to examine six elements: educational factor; customizing features; reminder tools; peer education facilitations; feedback, and the language of apps' interface and content. The literature from PubMed has been reviewed for studies addressing reminder systems or tools including apps.

Results: The study has revealed insufficient ($n=6$) technology-based interventions for increasing childhood vaccination rates by reminding parents in comparison to the fast growth in technology, out of which are two publications discussed mobile apps. Ten apps have been found in apps stores; only one out of them was designed for the Saudi vaccination schedule in Arabic language with some weaknesses. The study proposed a design for a vaccination reminder app that includes a number of features in order to overcome the limitations discussed in the studied reminders, apps, and systems. The design supports the Arabic language and the Saudi

* Corresponding author at: Health Informatics, Chairman, Medical Informatics and E-learning, College of Medicine, King Saud University, P.O. Box 63709, Riyadh 11526, Saudi Arabia. Fax: +966 14690798.

E-mail addresses: asmabahussin@ksu.edu.sa (A.A. Abahussin), albarrak@ksu.edu.sa (A.I. Albarrak).

vaccination schedule; parental education including peer education; a variety of reminder methods, and the capability to track vaccinations and refer to the app as a personal health record.

Conclusion: The study discussed a design for a vaccination reminder app that satisfies the specific requirements for better compliance to children's immunization schedules based on reviewing the existing apps and publications. The proposed design includes element to educate parents and answer their concerns about vaccines. It involves their peers and can encourage the exchange of experiences and overcome vaccine fears. In addition, it could form a convenient child personal health record.

© 2016 Published by Elsevier Limited on behalf of King Saud Bin Abdulaziz University for Health Sciences.

Introduction

Adherence to national immunization schedules for children is essential to protect them from vaccine preventable diseases (VPD). However, the World Health Organization (WHO) has estimated that 1.5 millions of children are dying annually from VPD [1], indicating that compliance to the recommended vaccinations schedule is a challenge for health care systems. The main parental barriers to vaccination include confusion and difficulty in tracking vaccination schedules; lack of awareness regarding the importance of vaccines, missing due dates, and fear of vaccinations' complications and side effects [2–4]. In addition, it has been revealed that 32.9% and 26.6% of the reasons of infants missing vaccinations were due to prior reminders not being given to parents, and parents' forgetfulness respectively [5]. Several proposed solutions to these problems have been discussed in the literature from different aspects in order to increase the immunization coverage rate. For example, it has been found that patient reminders and recall systems are effective in improving immunization rates [6]. Many studies have considered different types of traditional patient reminding approaches, such as mailing and nurse home visits, in addition to discussing some strategies for educating patients about vaccines [2–4,7–13].

Technology and the new media could be effectively utilized to achieve better compliance with children immunization schedules. In fact, it has been found that one in four parents prefer using new technologies for vaccination reminders [14]. However, insufficient evidence is available on the use of social networks, email communication and smartphone applications to support adherence to children vaccination. This has been indicated by a systemic review study published in 2015 that reviewed nineteen interventions applying new media for increasing vaccine uptake and

immunization coverage [15]. The review study covered studies that investigated the role of: text messaging, smart-phone applications, YouTube videos, Facebook, targeted websites and portals, software for physicians and health professionals, and email communication. The included studies were summarized and critically appraised on the effectiveness of the interventions to promote vaccination uptake and increase vaccination coverage. It is evident from the results of this study that text messaging, immunization campaign websites, patient-held web-based portals, and computerized reminders increase immunization rates. On the other hand, not enough evidence was found for using smartphone applications in this field.

The aim of this study is to review the existing tools and publications regarding vaccinations adherence, and to propose a design for vaccinations adherence application (app) for smartphones.

Methodology

The online app marketplaces for the two most commonly used smartphone operating systems (Android and iOS) were searched using the search terms "vaccine", "vaccination reminder", "vaccine reminder" and "immunization reminder". The search was conducted between the 14th and 20th of October 2015. The apps were included in the present review if they were designed for parents' use to remember and adhere to the children's main vaccination schedule.

PubMed was searched between the 5th and 10th of November 2015 for literature published between 2005 and 2015 using the search terms "vaccination reminder", "immunization coverage rate", "vaccine reminder", "immunization reminder". The search was for publications in the last ten years because the evolution of social media and apps almost started during this period. Articles

were included in the review if they considered using any form of technology to enhance the immunization coverage rate against any type of vaccine, and should be intended to remind parents or patients to have the vaccines.

Based on reviewing the literature and the apps, the design for the vaccination reminder application was proposed.

Analysis

The selected apps that met the inclusion criteria were downloaded and reviewed to examine six elements, which are explained in [Table 1](#). Some of the elements were specified based on reviewing the literature and others based on personal knowledge and experience. As mentioned earlier, family education and reminders could contribute towards better vaccination adherence. Also, a peer education environment is desirable in such apps where users can exchange information with others. The elements of customization as well as language are essential for fulfilling the user's preference and attracting the user to the app. Moreover, it is necessary as a service provider to communicate with the clients and derive feedback to improve the app.

We found that the included articles can be classified into three categories for further analysis: review articles; articles that addressed using and

Table 1 The elements to be examined in the reviewed apps.

Element	Explanation
Educational factor	The app provides education on vaccines. In order to ease the assessment of the app regarding this aspect, the coding in Table A1 , in the appendix, was used
Customizing feature	The app can be customized to the Saudi national vaccination schedule
Reminding methods	The methods used by the app to remind users about their children's due vaccines
Peer education	The app provides social support and offers peer's education through, for example, a chatting tool where users can exchange information and learn from each other's experience
Feedback	The app provides a method for obtaining direct comments from users
Language	Language of app's interface and content

Table 2 Aspects to be specified in the reviewed studies addressing new reminder systems.

Aspects	Explanation
Model	The study represents a model for a tool
Application	The study signifies a functioning tool
Study	The study addresses evaluation of a tool
Educational factor	The tool addressed in the study provides education on vaccines. In order to ease the assessment of the tool regarding this aspect, the coding in Table A1 , in the appendix, was used
Reminding methods	The methods used by the tool to remind users about their children's due vaccines
Follow up	The tool facilitates tracking the vaccines schedule
Peer education	The tool provides social support and offers peer's education through, for example, a chatting tool where users can exchange information and learn from each other's experience
Language	Language of tool's interface and content
Intended for children	The tool is intended for children's main vaccination schedule reminders

assessing basic reminder systems or tools such as short message (SMS), phone calls or e-mails; and studies that have addressed a new reminder system or tools. Studies in the latter group were further analyzed to specify a number of aspects detailed in [Table 2](#).

Results

Only ten apps from both Apple's apps store and Google play store met the identified criteria and have been included in the review. [Table 3](#) shows the results of evaluating the six elements, explained in [Table 1](#), in the selected ten apps. These results are summarized in [Fig. 1](#).

The literature search yielded 214 abstracts. Initially, 72 abstracts were selected based on the inclusion criteria and reviewed in detail. A total of 34 articles were excluded as they address clinical reminders at the point of care ($n=11$), or surveys and reminding strategies ($n=23$). The remaining 38 articles were analyzed into the three categories mentioned earlier as follow: 7 studies focus

Table 3 Results of reviewing the selected apps.

Application Reference	Educational factor	Customizing feature	Reminding methods	Peer education	Feedback	Language
[16]	C & F	No	<ul style="list-style-type: none"> • SMS • Email • Push notifications • Phone alerts 	No	Yes	English
[17]	D	No	Email	No	Yes	English
[18]	B	No	No	No	No	Arabic and English
[19]	A	Yes	SMS	No	No	Arabic and English
[20]	A	No	Push notifications	No	No	English
[21]	A	Yes ^a	No	No	No	English
[22]	A	No	Push notifications	No	Yes	Arabic and English
[23]	C & E	Yes ^a	<ul style="list-style-type: none"> • Push notifications • Calendar alert 	No	No	English
[24]	A	Yes ^a	Push notifications	No	No	English
[25]	D	No	<ul style="list-style-type: none"> • SMS • Email 	No	Yes	English

^a The user can design the schedule manually by adding the required vaccines, identifying the duration between them and the number of shots for each vaccine.

on reviewing the literature [3,26–31]; 25 studies addressed using and assessing basic reminder tools; 6 studies have implemented a new reminder tools. The distribution of the basic reminder tools throughout the 25 studies, noticing that some studies discussed more than one reminder tool, is as follows: 16 text messages reminders [32–47], 5 reminders e-mails [34,35,48–50] and 10 telephone

reminders [34,35,49–56]. Out of which are only three studies examined using text messages for children's vaccination reminding [42,43,45]. The analysis of the six studies addressing new reminder systems is shown in Table 4.

Fig. 2 demonstrates our proposed design for the vaccination reminder app based on analyzing the results of reviewing the selected apps and studies.

Table 4 Result of reviewing studies addressed reminder systems or tools ($n = 6$).

Reference	Model	Application	Study	Educational factor	Reminding methods	Follow-up	Peer education	Language	Intended for children
[57]	No	Yes (app)	Yes	C	SMS	No	Yes	English and Spanish	No
[58]	No	Yes	Yes	A	System's prompt	Yes	No	English	No
[59]	No	Yes (app)	No	B	Calendar alert	Yes	No	English	Yes
[60]	No	Yes	Yes	B	Push notifications	Yes	No	English	No
[61]	No	Yes	Yes	B	Push notifications	Yes	Yes	English	Yes
[62]	No	Yes	Yes	A	SMS	Yes	No	Thai	Yes

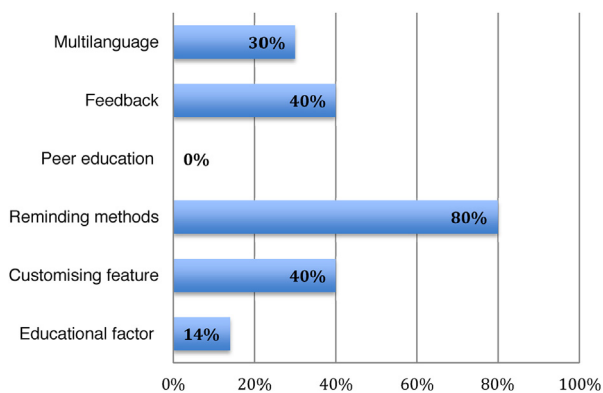


Figure 1 Summarized results of reviewing the selected apps.

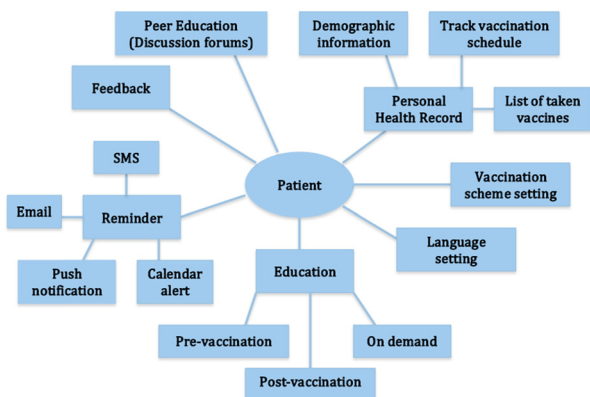


Figure 2 Proposed design for the vaccination reminder app.

Discussion

It has been observed that two main causes of missing children’s vaccinations were prior reminders not being sufficient to parents (32.9%), and parents’ forgetfulness (26.6%) [5]. A review study has indicated that vaccination reminders, in all their forms, are effective in increasing immunization rates in 33 out of 41 studies [63]. In 2011, one in four parents preferred using new technologies for childhood vaccination reminders [14]. This proportion is expected to rise due to the witnessed increasing and continuous usage of smart devices’ apps and social media. Statistics in 2016 revealed that 31% and 27% of the total global population (7.395 billion) are active social media users and active mobile social users respectively. This is with estimated growth of +10% in active social media users and +17% in active mobile social users since 2015. In Saudi Arabia, the active social media users and the active mobile social users represent 35% and 31% respectively from the total population estimated in 2016. Comparing to the statistics of 2015, the growth in usage

is significant (+20% and 25% respectively) [64]. In spite of these facts, the current study found insufficient vaccination reminders utilizing the advanced features in mobile phones’ applications and social media. In the same respect, a study reviewed the used technologies for improving vaccination coverage and revealed that integrating technology into immunization interventions targeting parents is uncommon [30]. As shown in Tables 3 and 4, we found only ten vaccination reminder apps in apps’ stores and only six out of 38 of the selected studies involved implementation of new reminder tools. Only two out of the six studies addressed vaccination reminder mobile apps, whereas one only was designed to help parents to remember their children’s vaccines. The vaccine reminders, found in apps stores and literature, have some limitations based on the reviewed elements.

Reviewing the included vaccination reminder indicated that there is not enough focus on educating parents about vaccinations. In fact, parental reminders and education have been proven to be effective in increasing children’s vaccination uptake. A number of review studies that addressed reminders and educational interventions to improve immunization uptake, reported that providing parents with immunization education and any other form of reminder interventions has a significant effect on increasing children’s immunization rates [27,28,31]. On the other hand, the current study found only 14% of the educational factor is functional in the included apps from apps’ stores as indicted in Fig. 1. Two of the apps provide brief information about vaccinations such as the names of diseases related to the vaccines [16,23]. Such information does not seem adequate enough to answer the parents’ concerns about vaccinations. Information can be valuable if it helps parents to understand their child’s risk from a vaccine-preventable disease, to know that their child is in need of the vaccination, and recognize vaccine efficacy and safety [30]. There are three apps [17,18,25] that provide such information in different ways. In terms of studies addressed new reminders’ tools, some of the studies integrated vaccine education into their reminders by either providing referral links to educational websites (n=3) [59–61] or providing general information about vaccines (n=1) [57].

It has been reported that a quarter of Internet users who search for specific health concerns prefer to connect with others in similar situations and with similar concerns [30]. Fulfilling this preference for reminder systems and apps through facilitating a connection, in any form, between participants to exchange information could potentially contribute

towards improving vaccination coverage and reaching the optimal goal of such tools. However, there was no emphasis on peer education in both included apps and studies. Only two out of the six studies deployed this feature in their reminder systems by enabling users to exchange information and experiences [57,61]. While none of the apps provided a tool for peer education.

Offering at least one reminder method in vaccine reminder apps or systems is essential for fulfilling the aim of such a tool. The results of the present study indicate that one reminder method was applied in each reminder system addressed by the six studies; as shown in Table 4. However, it has been found that applying multiple methods for notifying patients of the need to vaccinate, may contribute towards better vaccine compliance [31]. About 80% of the included apps from apps' stores apply at least one reminding method (Fig. 1), yet only about 37% of them provide more than one method to choose from [16,23,25]. Interestingly, push notifications method is used in almost 62% of the apps, as indicated in Table 3.

Five of the reminder systems addressed by the six studies focus on providing follow up mechanisms for the patients, as shown in Table 4. In other words, the vaccine uptake can be tracked in addition to the vaccines' due dates being recognized. This aspect has been found, according to a review study, to be one of the immunization information systems' features that contribute towards the success of these systems in increasing vaccination rates [28].

The language used for the interface and contents of the reviewed vaccination reminders was mainly English (Tables 3 and 4). Only 30% of the apps from apps' stores [18,19,22] were multi-language and support the Arabic language as shown in Table 3 and Fig. 1. Furthermore, only one (33%) out of these apps was designed for the Saudi national vaccination schedule [19]. However, it has no form of educational elements, only one reminder method, and no feedback tool. This emphasizes the need for functional Arabic apps addressing vaccination reminders for parents in Saudi Arabia and other parents in the Arabic world.

The literature review reveals that the current study is the first review of the available evidence on the use of child vaccine reminder apps and technologies in general. The study has found that the trend of studies ($n=25$) to address vaccine reminders is to examine the effectiveness of the available basic tools as vaccine reminders including SMS, email, or phone calls. Text messages ($n=16$) are the leading studied vaccine reminder tool. Moreover, only three of these studies discuss the effectiveness of basic reminder tools involving

text messages intended for children's main vaccination schedule reminders [42,43,45]. In fact, it has been recognized that text messaging has a significant effect on 71% of non-vaccination related interventions for the paediatric and adolescent population [65]. Interestingly, the field of text messaging for vaccination reminders has been found to be successful in this population [30]. Text messages are considered effective vaccination reminders for a number of reasons that can be summarized according to their main attraction – they reach the intended patients and can be used as reference information [30]. This might explain why parents prefer them compared to postal or phone reminders, as found in a study that has explored parents' preferences for traditional immunization reminders [66].

App proposed design

Based on reviewing the existing apps and publications regarding vaccinations adherence and for better compliance to children immunization schedules, our design for the childhood vaccination reminders app includes a number of features as indicated in Fig. 2. These features overcome the limitations discussed in the studied reminders apps and systems. The design provides elements to educate parents and answer their concerns about vaccines. This includes adequate information about vaccination and the required care for prior and after vaccination. Moreover, the design involves peer education by providing a tool for social media encouraging parents to exchange experiences and overcome vaccine fears. In addition, the design contributes towards solving problems associated with forgetfulness and postponement of due vaccines by offering a variety of reminder tools including SMS, email and others. It could provide a tool for tracking the vaccines schedule and form a convenient child personal health record for future use. The design of the app considers supporting the Arabic language and the Saudi vaccination schedule with customization features. This should fulfil the need for a functional children vaccination reminder for parents in Saudi Arabia and others who follow similar vaccination scheme in other countries. Furthermore, the design offers a feedback tool to enable users to communicate with the developer regarding improving the app.

Future consideration

The design of the vaccination reminder app could be improved in future to consider interconnection

with the healthcare systems. This will contribute into managing the immunization coverage rate around the country and building a database for vaccinated children. In addition, the app with interconnection aspect will facilitate for parents managing issues related to booking appointments for their children vaccination.

Conclusion

The prevalence of childhood vaccine preventable diseases can be significantly reduced through adherence to confirmed vaccinations schedules. However, many barriers to vaccinations compliance exist, including lack of awareness regarding the importance of vaccines, missing due dates, and fear of vaccinations complications. The current study reviewed the existing tools and publications regarding vaccinations adherence, and proposed a design for vaccination adherence app for smartphones. We proposed a design for vaccination reminder app that overcomes limitations discussed in the studied vaccine reminder apps and systems. The design considers supporting parental education including peer education; a variety of reminder methods, and the capability to track vaccinations and refer to the app as a personal health record. The proposed design is tailored for parents in Saudi Arabia and others who follow similar vaccination scheme in other countries. The design should contribute towards better compliance to children immunization schedules.

Funding

No funding sources.

Competing interests

None declared.

Ethical approval

Not required.

Acknowledgement

The project was financially supported by King Saud University, Deanship of Scientific Research, through the research group project No. 73214. This research

did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix.

Table A1 Coding for assessing educational factor.

Code	Educational factor
A	No education
B	Referral link to an educational website
C	General and brief information about vaccines
D	Detailed information about vaccines such as number of doses, appropriate age and period between doses
E	Frequently asked questions about immunizations
F	Information about tracking the child's health in general

References

- [1] WHO. The World Health Organization. Immunization; 2015. <http://www.who.int/gho/immunization/en/> [accessed 17.12.15].
- [2] Esposito S, Principi N, Cornaglia G. Barriers to the vaccination of children and adolescents and possible solutions. *Clin Microbiol Infect* 2014;20(Suppl 5):25–31.
- [3] 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(6):1719–41.
- [4] Schmitt HJ, Booy R, Aston R, Van Damme P, Schumacher RF, Campins M, et al. How to optimise the coverage rate of infant and adult immunisations in Europe. *BMC Med* 2007;5:11.
- [5] Patel TA, Pandit NB. Why infants miss vaccination during routine immunization sessions? Study in a rural area of Anand District, Gujarat. *Indian J Public Health* 2011;55(4):321–3.
- [6] Jacobson Vann JC, Szilagyi P. Patient reminder and patient recall systems to improve immunization rates. *Cochrane Database Syst Rev* 2005;(3):CD003941.
- [7] Dombkowski KJ, Cowan AE, Potter RC, Dong S, Kolasa M, Clark SJ. Statewide pandemic influenza vaccination reminders for children with chronic conditions. *Am J Public Health* 2014;104(1):e39–44.
- [8] Humiston SG, Serwint JR, Szilagyi PG, Vincelli PA, Dhepyasuwan N, Rand CM, et al. Increasing adolescent immunization rates in primary care: strategies physicians use and would consider implementing. *Clin Pediatr (Phila)* 2013;52(8):710–20.
- [9] Morgan JL, Baggari SR, Chung W, Ritch J, McIntire DD, Sheffield JS. Association of a best-practice alert and prenatal administration with tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccination rates. *Obstet Gynecol* 2015;126(2):333–7.

- [10] Sherman MJ, Raker CA, Phipps MG. Improving influenza vaccination rates in pregnant women. *J Reprod Med* 2012;57(9–10):371–6.
- [11] Shultz CG, Malouin JM, Green LA, Plegue M, Greenberg GM. A systems approach to improving TDAP immunization within 5 community-based family practice settings: working differently (and better) by transforming the structure and process of care. *Am J Public Health* 2015;105(10):1990–7.
- [12] Sobota AE, Kavanagh PL, Adams WG, McClure E, Farrell D, Sprinz PG. Improvement in influenza vaccination rates in a pediatric sickle cell disease clinic. *Pediatr Blood Cancer* 2015;62(4):654–7.
- [13] Szilagyi PG, Serwint JR, Humiston SG, Rand CM, Schaffer S, Vincelli P, et al. Effect of provider prompts on adolescent immunization rates: a randomized trial. *Acad Pediatr* 2015;15(2):149–57.
- [14] Clark SJ, Butchart A, Kennedy A, Dombkowski KJ. Parents' experiences with and preferences for immunization reminder/recall technologies. *Pediatrics* 2011;128(5):e1100–5.
- [15] Odone A, Ferrari A, Spagnoli F, Visciarelli S, Shefer A, Pasquarella C, et al. Effectiveness of interventions that apply new media to improve vaccine uptake and vaccine coverage. *Hum Vaccines Immunother* 2015;11(1):72–82.
- [16] Vaccination Reminder. Developed by letsnurture. https://play.google.com/store/apps/details?id=com.letsnurture.vaccination_reminder&hl=en [accessed 16.10.15].
- [17] Vaccine Reminder. Developed by pediatric oncology organization. <https://play.google.com/store/apps/details?id=pedcall.VacReminder&hl=en> [accessed 14.10.15].
- [18] VACCINATIONS REMINDER. Developed by ADPoly (Ministry of Health in UAE). <https://play.google.com/store/apps/details?id=com.health.vaccinationsscheduler&hl=en> [accessed 15.10.15].
- [19] MOH – Vaccinations. Developed by Ministry of Health in KSA. <https://play.google.com/store/apps/details?id=sa.gov.moh.eservices.vaccination&hl=en> [accessed 17.10.15].
- [20] Child Vaccine. Developed by IEMS GLOBAL. <https://itunes.apple.com/gb/app/child-vaccine/id721186522?mt=8> [accessed 19.10.15].
- [21] Vaccines Tracker Lite. Developed by Asif Khalyani. <https://itunes.apple.com/gb/app/vaccines-tracker-lite/id492836186?mt=8> [accessed 15.10.15].
- [22] Vaccine. Developed by Isys Kuwait. <https://itunes.apple.com/kw/app/vaccine/id755310884?mt=8> [accessed 18.10.15].
- [23] Vaccins. Developed by Yasmes (the Moroccan Ministry of Health). <https://play.google.com/store/apps/details?id=com.yasmez.jelba&hl=en> [accessed 16.10.15].
- [24] Vaccinise. Vaccine Reminder – Developed by 246Droids. <https://play.google.com/store/apps/details?id=com.arrcom.vaccination&hl=en> [accessed 15.10.15].
- [25] IAP Immunization. Developed by ITIndustries.com (India). <https://play.google.com/store/apps/details?id=com.iap&hl=en> [accessed 14.10.15].
- [26] Niccolai LM, Hansen CE. Practice- and community-based interventions to increase human papillomavirus vaccine coverage: a systematic review. *JAMA Pediatr* 2015;169(7):686–92.
- [27] Harvey H, Reissland N, Mason J. Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: a systematic review and meta-analysis. *Vaccine* 2015;33(25):2862–80.
- [28] Force CPST. Recommendation for use of immunization information systems to increase vaccination rates. *J Public Health Manag Pract* 2015;21(3):249–52.
- [29] Groom H, Hopkins DP, Pabst LJ, Murphy Morgan J, Patel M, Calonge N, et al. Immunization information systems to increase vaccination rates: a community guide systematic review. *J Public Health Manag Pract* 2015;21(3):227–48.
- [30] Stockwell MS, Fiks AG. Utilizing health information technology to improve vaccine communication and coverage. *Hum Vaccines Immunother* 2013;9(8):1802–11.
- [31] Jones Cooper SN, Walton-Moss B. Using reminder/recall systems to improve influenza immunization rates in children with asthma. *J Pediatr Health Care* 2013;27(5):327–33.
- [32] McIver R, Dyda A, McNulty AM, Knight V, Wand HC, Guy RJ. Text message reminders do not improve hepatitis B vaccination rates in an Australian sexual health setting. *J Am Med Assoc* 2015.
- [33] Hofstetter AM, DuRivage N, Vargas CY, Camargo S, Vawdrey DK, Fisher A, et al. Text message reminders for timely routine MMR vaccination: a randomized controlled trial. *Vaccine* 2015;33(43):5741–6.
- [34] Ghadieh AS, Hamadeh GN, Mahmassani DM, Lakkis NA. The effect of various types of patients' reminders on the uptake of pneumococcal vaccine in adults: a randomized controlled trial. *Vaccine* 2015;33(43):5868–72.
- [35] Morris J, Wang W, Wang L, Peddecord KM, Sawyer MH. Comparison of reminder methods in selected adolescents with records in an immunization registry. *J Adolesc Health* 2015;56(5 Suppl):S27–32.
- [36] Rand CM, Brill H, Albertin C, Humiston SG, Schaffer S, Shone LP, et al. Effectiveness of centralized text message reminders on human papillomavirus immunization coverage for publicly insured adolescents. *J Adolesc Health* 2015;56(5 Suppl):S17–20.
- [37] Stockwell MS, Hofstetter AM, DuRivage N, Barrett A, Fernandez N, Vargas CY, et al. Text message reminders for second dose of influenza vaccine: a randomized controlled trial. *Pediatrics* 2015;135(1):e83–91.
- [38] Kharbada EO. Helping mothers to get the message about influenza: are texts the future for increased immunization? *Expert Rev Vaccines* 2015;14(3):333–5.
- [39] Herrett E, van Staa T, Free C, Smeeth L. Text messaging reminders for influenza vaccine in primary care: protocol for a cluster randomised controlled trial (TXT4FLUJAB). *BMJ Open* 2014;4(5):e004633.
- [40] Stockwell MS, Westhoff C, Kharbada EO, Vargas CY, Camargo S, Vawdrey DK, et al. Influenza vaccine text message reminders for urban, low-income pregnant women: a randomized controlled trial. *Am J Public Health* 2014;104(Suppl 1):e7–12.
- [41] Matheson EC, Derouin A, Gagliano M, Thompson JA, Blood-Siegfried J. Increasing HPV vaccination series completion rates via text message reminders. *J Pediatr Health Care* 2014;28(4):e35–9.
- [42] Hofstetter AM, Vargas CY, Kennedy A, Kitayama K, Stockwell MS. Parental and provider preferences and concerns regarding text message reminder/recall for early childhood vaccinations. *Prev Med* 2013;57(2):75–80.
- [43] Wakadha H, Chandir S, Were EV, Rubin A, Obor D, Levine OS, et al. The feasibility of using mobile-phone based SMS reminders and conditional cash transfers to improve timely immunization in rural Kenya. *Vaccine* 2013;31(6):987–93.
- [44] Szilagyi PG, Adams WG. Text messaging: a new tool for improving preventive services. *JAMA* 2012;307(16):1748–9.
- [45] Stockwell MS, Kharbada EO, Martinez RA, Lara M, Vawdrey D, Natarajan K, et al. Text4Health: impact of text message reminder-recalls for pediatric and adolescent immunizations. *Am J Public Health* 2012;102(2):e15–21.
- [46] Stockwell MS, Kharbada EO, Martinez RA, Vargas CY, Vawdrey DK, Camargo S. Effect of a text messaging intervention

- on influenza vaccination in an urban, low-income pediatric and adolescent population: a randomized controlled trial. *JAMA* 2012;307(16):1702–8.
- [47] Kharbanda EO, Stockwell MS, Fox HW, Andres R, Lara M, Rickert VI. Text message reminders to promote human papillomavirus vaccination. *Vaccine* 2011;29(14):2537–41.
- [48] Harris JG, Maletta KI, Ren B, Olson JC. Improving pneumococcal vaccination in pediatric rheumatology patients. *Pediatrics* 2015.
- [49] Szilagyi PG, Humiston SG, Gallivan S, Albertin C, Sandler M, Blumkin A. Effectiveness of a citywide patient immunization navigator program on improving adolescent immunizations and preventive care visit rates. *Arch Pediatr Adolesc Med* 2011;165(6):547–53.
- [50] Minor DS, Eubanks JT, Butler Jr KR, Wofford MR, Penman AD, Replogle WH. Improving influenza vaccination rates by targeting individuals not seeking early seasonal vaccination. *Am J Med* 2010;123(11):1031–5.
- [51] Shoup JA, Madrid C, Koehler C, Lamb C, Ellis J, Ritzwoller DP, et al. Effectiveness and cost of influenza vaccine reminders for adults with asthma or chronic obstructive pulmonary disease. *Am J Manag Care* 2015;21(7):e405–13.
- [52] Urkin J, Skaliarsky I, Karbi S, Peled R. Parental opinions and level of knowledge regarding influenza immunization for high risk children: Follow-up on two reminder methods. *Minerva Pediatr* 2015.
- [53] Cecinati V, Esposito S, Scicchitano B, Delvecchio GC, Amato D, Pelucchi C, et al. Effectiveness of recall systems for improving influenza vaccination coverage in children with oncohematological malignancies. *Hum Vaccines* 2010;6(2):194–7.
- [54] Esposito S, Pelucchi C, Tel F, Chiarelli G, Sabatini C, Semino M, et al. Factors conditioning effectiveness of a reminder/recall system to improve influenza vaccination in asthmatic children. *Vaccine* 2009;27(5):633–5.
- [55] Winston CA, Mims AD, Leatherwood KA. Increasing pneumococcal vaccination in managed care through telephone outreach. *Am J Manag Care* 2007;13(10):581–8.
- [56] Britto MT, Schoettker PJ, Pandzik GM, Weiland J, Mandel KE. Improving influenza immunisation for high-risk children and adolescents. *Qual Saf Health Care* 2007;16(5):363–8.
- [57] Jordan ET, Bushar JA, Kendrick JS, Johnson P, Wang J. Encouraging influenza vaccination among Text4baby pregnant women and mothers. *Am J Prev Med* 2015;49(4):563–72.
- [58] Ruffin IVth MT, Plegue MA, Rockwell PG, Young AP, Patel DA, Yeazel MW. Impact of an electronic health record (EHR) reminder on human papillomavirus (HPV) vaccine initiation and timely completion. *J Am Board Fam Med* 2015;28(3):324–33.
- [59] Atkinson KM, Ducharme R, Westeinde J, Wilson SE, Deeks SL, Pascali D, et al. Vaccination attitudes and mobile readiness: a survey of expectant and new mothers. *Hum Vaccines Immunother* 2015;11(4):1039–45.
- [60] Mayne S, Karavite D, Grundmeier RW, Localio R, Feemster K, DeBartolo E, et al. The implementation and acceptability of an HPV vaccination decision support system directed at both clinicians and families. *AMIA Annu Symp Proc* 2012;2012:616–24.
- [61] Peck JL, Stanton M, Reynolds GE. Smartphone preventive health care: parental use of an immunization reminder system. *J Pediatr Health Care* 2014;28(1):35–42.
- [62] Kaewkungwal J, Singhasivanon P, Khamsiriwatchara A, Sawang S, Meankaew P, Wechsart A. Application of smart phone in “Better Border Healthcare Program”: a module for mother and child care. *BMC Med Inform Decis Mak* 2010;10:69.
- [63] Szilagyi PG, Bordley C, Vann JC, Chelminski A, Kraus RM, Margolis PA, et al. Effect of patient reminder/recall interventions on immunization rates: a review. *JAMA* 2000;284(14):1820–7.
- [64] WeAreSocial. Special reports digital in 2016; 2016. <http://wearesocial.com/special-reports/digital-in-2016> [accessed 02.06.16].
- [65] Militello LK, Kelly SA, Melnyk BM. Systematic review of text-messaging interventions to promote healthy behaviors in pediatric and adolescent populations: implications for clinical practice and research. *Worldviews Evid Based Nurs* 2012;9(2):66–77.
- [66] Kharbanda EO, Stockwell MS, Fox HW, Rickert VI. Text4Health: a qualitative evaluation of parental readiness for text message immunization reminders. *Am J Public Health* 2009;99(12):2176–8.

Available online at www.sciencedirect.com

ScienceDirect