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Public Health Interest of Vaccination Through Community Pharmacies: A Literature Review

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ABSTRACT

Objective: This work has reviewed the scientific literature to evaluate the impact of vaccination through community pharmacies. **Methods:** A literature search was performed on the PubMed database, using the 2 MeSH search terms "pharmacist" and "vaccination". One hundred and eighty-four articles were screened based on various inclusion and exclusion criteria. **Results:** Analyzed studies showed an impact and potential benefits from pharmacy-based vaccination. Pharmacy-based vaccination can significantly increase vaccination coverage as pharmacists can overcome many barriers to vaccination, such as lack of access to physician's offices and appointment scheduling. Vaccination is also less expensive in pharmacies than in traditional vaccination services. **Conclusion:** Pharmacy-based vaccination allows an immunization target to be reached sooner and at a lower cost.

***Keywords**: Community pharmacist; Pharmacy; Vaccination*

INTRODUCTION

The Covid-19 pandemic demonstrates how infectious diseases can be a critical social and economic burden to the population, health care services, and society [1,2]. Vaccination has been shown to be essential in effectively decreasing mortality and morbidity [1,3]. It has also helped to stem the global economic crisis, reduce the burden on health care, provide relief to many sectors such as catering, travel, leisure, and much more [1].

Vaccination is the most cost-effective, and low-risk preventive measure [4–7]. It significantly reduces infectious disease rates, hospitalizations, and health care costs [2,8]. It prevents 2-3 million deaths per year worldwide [6,9,10] and can even successfully eradicate disease, as in the case of smallpox, when vaccination coverage is high enough [11–13].

Vaccination has an excellent benefit-cost ratio proportional to the rate of vaccination [14]. It also allows an increase in productivity of populations [1,12,14–17] and a decrease in absenteeism from work [1,12,14]. For example,

influenza is estimated to cause 45% of days absent from work among adults [14]. Other benefits include fewer lost wages as workers are sick less often and more regularly at work [14], a decline in the risk of hospital-acquired infections [1], a decrease in long-term sequelae such as neurological disorders or physical disabilities from diseases that could have been prevented by vaccination [1,12], an attenuation in disease severity if individuals are infected despite vaccination (e.g. COVID-19) [1], a boost to the activity of the population (e.g. grandparents babysitting grandchildren...) [1], a lower incidence of unpaid leave for the care of sick children for example [1,12], protection for different sectors such as hospitality, travel and leisure [1], a cut in costs related to transportation to access hospitals or physicians [1], improved life expectancy [12,17], a drop in infant mortality [12,17] and less antibiotic resistance through reduced use of these drugs [12,16,17]. Further to this last point, in Ontario, for example, influenza vaccination has diminished the antibiotic prescription rate by 64% [16]. Such a change seems desirable if antibiotic resistance continues to move in the wrong direction, it could ultimately cause millions of deaths each year and cost 100 billion USD by 2050 [17].

However, the success of vaccination programs depends on the extent of vaccination coverage, which must be as high as possible to enable herd immunity [9,18]. In addition, many categories of people cannot be vaccinated because of the risk's vaccination represents for them: the immunocompromised, the elderly and infants, among others [16,18]. It is only when the rate of vaccinated people is high enough that the targeted diseases will no longer circulate, preventing transmission to the weakest in the community [16].

Therefore, it is critical to find ways to increase the rate of people vaccinated and meet vaccination goals. Unfortunately, vaccination rates are often too low, and vaccination programs are underutilized [3,8,9]. For instance, in Poland, the influenza vaccination rate among people over 65 is below 10% [19]. In the United States, influenza vaccination goals among healthy people were not met in 2020 [20]: the vaccination coverage goal was 70% for adults over 18 years of age, but the actual coverage was only 45.4% in 2017 [5].

As a result, many vaccine-preventable diseases still cause significant death, contamination, as well as public finance and health care costs. For example, in the United States, 40,000 to 50,000 people die each year from vaccine-preventable infectious diseases [21], which represents an annual economic burden of 9 billion USD (76% of this burden being due to people over 50 years old) [5]. This burden could increase further over the next 30 years, especially for influenza, pertussis, shingles and pneumococcus. As a result, the United States risks facing one million new deaths per year and an additional cost of 35 to 49 billion USD [19].

Influenza is one of the vaccine-preventable diseases that represents one of the largest burdens on healthcare and the economy from year to year [2,22]. This virus infects 10% of adults and 30% of children each year worldwide [15]. Epidemics are estimated to cause approximately 5 million severe cases and between 290,000 and 650,000 deaths annually [22–24]. In Canada, it has been estimated that a 2.5% increase in influenza vaccination coverage would generate 16 million USD in Canadian health care savings [25]. Unfortunately, many unvaccinated people fall into the at-risk category [26] even though the WHO recommends that vaccination coverage must be high, especially for this category [2,15].

In this context, pharmacists are essential, given their involvement in the vaccine distribution [3]. They are competent health care professionals capable of providing many services [3]. On the front lines of the health care system [3,27] they are accessible, available, and close to the patient [2,9]. In this way, the pharmacist is a public health advocate with an important role to play among other health care professionals [28], who counsels patients in many areas such as smoking cessation, obesity, addictions, vaccination, or infectious diseases [28].
Pharmacist engagement can improve the population's standard of living and reduce the burden on health care. Furthermore, pharmacists are no longer simply box sellers [27] as the profession is evolving towards service provision, counseling, health promotion and patient follow-up.

Vaccination by the dispensing pharmacist is allowed in many countries such as the United States [6,22], Portugal [2], the United Kingdom [2], Australia [22], France [2], Switzerland [29,30], New Zealand [31], Canada [3] or Poland [32]. A recent review [6] synthesized the different acts related to vaccination and the involvement of pharmacists in low-income countries. Our present review aims to bring a new perspective by focusing on the act of vaccination and expanding the geographical scale by not limiting it to low-and middle-income countries. We, therefore, carried out a review of the current literature dealing with the advantages and disadvantages of vaccination by pharmacists.

MATERIAL AND METHODS

A literature search was performed on the PubMed database to survey articles on the impact of vaccination in pharmacies (**Figure 1**). The two terms used to conduct this search were "pharmacist" and "vaccination." These two medical subject heading (MeSH) terms were required to appear either in the title or the abstract of the articles. The search was restricted to articles published from the year 2016 until 2021 to takes COVID-19 into consideration but also goes back a few years before so as not to be specific to COVID-19.

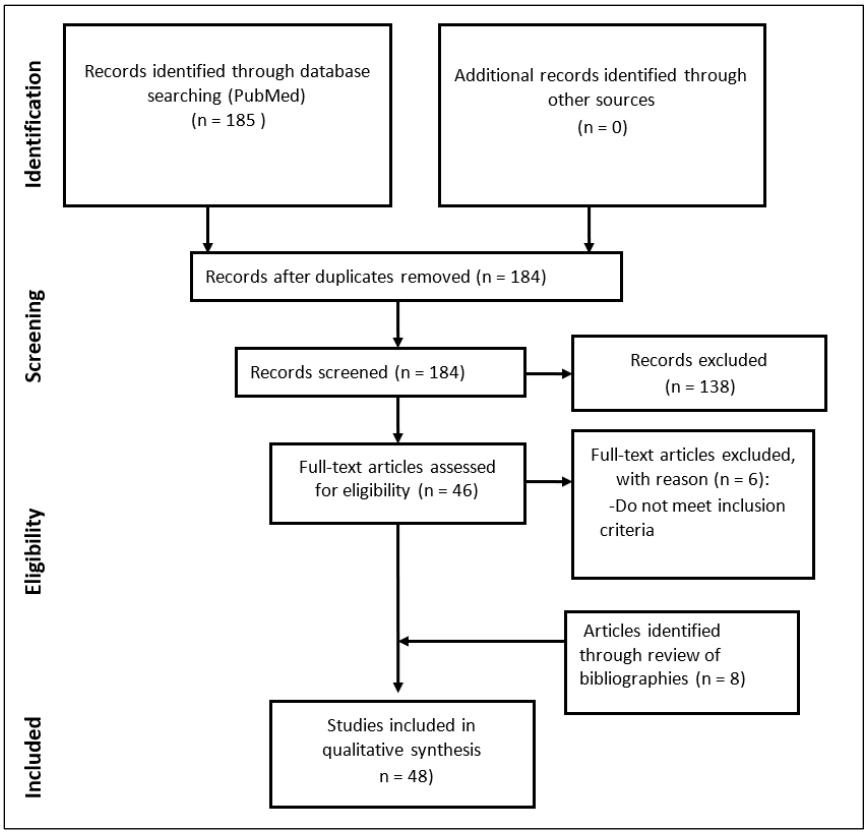

Figure 1. Literature search flow diagram. Numbers in brackets correspond to the number of articles.

The final year was chosen because it witnessed a 440% increase in the number of articles on vaccination by pharmacists compared with previous years. All articles were selected according to the following inclusion criteria: articles or studies on the impact of vaccination by pharmacists in pharmacies open to the public. The scopus database was apprehended at the beginning of the work and not kept because it did not provide any additional impacting article.

Many studies were excluded based on the following exclusion criteria: (1) articles on the interest of the pharmacist as an advocate for vaccination; (2) articles on the interest of the pharmacist as an administrator of vaccines but outside the pharmacy. These items were excluded in order to focus only on pharmacists in their usual place of work, i.e. the pharmacy; (3) articles on the interest of vaccination in the pharmacy for patients with comorbidities. These articles were excluded to retain a general focus on the whole population; (4) articles on the legislative changes necessary for the implementation of vaccination in pharmacies; (5) articles on the evaluation of vaccinator training; (6) articles on clinical trials on sick patients; (7) articles on pharmacy technicians (not pharmacists) as vaccine administrators; (8) articles focusing only on COVID-19 vaccination since the benefit-risk balance of this pandemic could distort the analysis of the pharmacist's interest outside a pandemic situation; (9) articles studying patient or pharmacist perception of vaccination in the pharmacy.

A broader search on economic aspects was also conducted in a second step. This latter review was not intended to synthesize all the available literature but rather to delve into the economic constraints and benefits of vaccination by pharmacists and to assess its economic interest. This review is not systemic because it does not address the risk of bias assessment and the critical appraisal of the included literature.

RESULTS AND DISCUSSION

Despite the burden of infectious diseases, many people do not get vaccinated each year, and vaccination coverage remains too low as some barriers to vaccination exist [5]. A number of hypotheses have been suggested on the causes of poor vaccination rates, namely: inadequate knowledge among the population [9,19,33,34]; the cost of vaccines [7–9,33,34]; the scarcity of trained personnel to vaccinate [9]; the insufficiency of opportunities for patients to understand vaccination [9]; the difficulties in reaching traditional vaccinators [7,34,35]; a narrow window of

opportunity for conventional vaccinators [20,34]; long waiting times for medical appointments [19,33,35]; the fear of side effects and pain [2,19,36]; the lack of patient follow-up by the health care professional [37]; weak promotion of vaccination [35–37]; public misconceptions [8,36] doubts about the effectiveness and usefulness of vaccines [7]; the rareness of regular visits to the physician for much of the population [36]; and the absence of an effective booster system [36].

A way to increase vaccination rates is to allow vaccination by pharmacists [31]. A 2020 meta-analysis of 6 studies, including 3182 participants, reported a 24% increase in vaccination coverage when pharmacists were allowed to administer vaccines to patients [38]. Another meta-analysis of 36 studies from Canada and the United States confirms that vaccination coverage increases when pharmacists are involved in the vaccination process [3,39].

It has also been repeatedly reported that pharmacy-based vaccination significantly boosts vaccination coverage among at-risk individuals and those who rarely get vaccinated in particular [40]. The pharmacist thus stands out as a pillar in vaccination programs and an important asset for public health [40].
The authorization of vaccination in pharmacies does not reduce the role of physicians but instead allows collaboration between these traditional vaccinators and pharmacists. Such synergy allows the largest possible population to be reached and vaccination rates to be raised [41,42]. In parallel, pharmacist activities are evolving toward service delivery and have the potential to expand further [2,3,33,43]

The strengths of pharmacists as vaccinators lie in their accessibility and nationwide presence [40,42–55] their competence and reliability [3,48,50], and the trust that patients place in them [6,41,50]. Pharmacists are frontline health care professionals; they are usually the first professionals to be consulted by patients, so are in very regular contact with the population [5,47,50]. They are close to patients and easily affordable [6,9,31,52]. They can play a role as immunization educators [39,41,53]. Indeed, for vaccination programs to be successful, it is important that patients have a good understanding of vaccination [28]. Pharmacists are available and responsive to patients [37,47,52]. They dispel myths and fears that discourage people from getting vaccinated [2,9,11] and can reach rural populations as well as isolated or underserved populations [50,55]. Pharmacists can easily view patients' vaccine history while in the pharmacy to verify that they are in vaccination order, perform reminders, and prompt patients to get vaccinated if this is not the case [7,20,21,28]. Pharmacists can recognize at-risk individuals who should be vaccinated. Such patients come to the pharmacy regularly, thus allowing pharmacists to remind them that they can get vaccinated and encourage them to do so [28,41,45,56]. Not only do pharmacists foster public awareness and act as effective promoters of vaccination [15,33,44,47], but most of them are also motivated to vaccinate [7]. In addition, they provide fast service with little waiting [19,21,22,47] because most of the time there is no need to make an appointment at a pharmacy unlike at a physician's office [35,47,53,55]. In countries where pharmacy-based vaccination is allowed, it can also be noted that many people get vaccinated by their pharmacists when traditional services are not available. Pharmacies have generally wider opening hours than physician’s offices, so patients can go to the pharmacy at their leisure [15,47,53,55]. For people who are short on time or have no reason to go to the physician, going to the pharmacy is more convenient than making an appointment for a medical visit [6,20,26,30]. Finally, many people do not have a general practitioner at all; this portion of the population can go directly to a pharmacy to get vaccinated [3,30].

Pharmacy-based vaccination can reach a large population, including many people who never take recourse to traditional vaccination services [41,46]. It has been shown that between 6.2% and 23% of patients would not get vaccinated if pharmacy-based vaccination was not authorized despite many of them being at-risk individuals [15,40]. Patients believe that pharmacy-based vaccination is more beneficial than in medical offices and are very satisfied with this service [9,40]. On this account, some patients are willing to get vaccinated by a pharmacist and bring along their children to get also vaccinated [48].

In addition, there is a significant shortage of health professionals worldwide: 7.2 million additional health professionals are needed this year, with the shortage possibly increasing to 15 million by 2030 [6] It is thus of great interest to expand the role of pharmacists to minimize the impact of health professional shortages [6].
Pharmacists already have the required infrastructure [6,48], materials, and equipment to play a key vaccination role. Indeed, they already have refrigerators (to comply with the cold chain [6]) and emergency medical products. Pharmacies also regularly integrate a confidentiality space to allow vaccinations to be administered away from other patients. Therefore, no further investment would be required for this service to be performed in pharmacies [21].

However, information of the public is a prerequisite for pharmacist-administered vaccination to develop effectively. The public may not be aware that pharmacists can vaccinate on their premises [50] and have received adequate training [35]. Finally, pharmacists need to be proactively involved for this service to be truly successful and to benefit the population [38].

It is less expensive to be vaccinated by a pharmacist than a physician as no medical consultation fees are charged at a pharmacy [21,28,54,55]. This point is illustrated by a 2014 study in the United States, which calculated average prices for vaccination (including the

vaccine, administration, dispensing and visits) at pharmacies, physicians' offices, and medical facilities. The average price for influenza vaccination was 29.29 USD at the physician's office, 24.20 USD at medical facilities, and 21.57 USD at pharmacies. For shingles, the average price was 208.72 USD at the physician's office, 209.51 USD at medical facilities, and 168.50 USD at pharmacies. For pneumococcal vaccination, the average price was 65.69 USD at the physician's office, 72.11 USD at medical facilities, and 21.57 USD at pharmacies [21]. It therefore appears that vaccination consistently costs less at pharmacies than at any other vaccination site [21]. Overall, pharmacists provide an opportunity to increase vaccination rates [9,36,51] while being less expensive [9,21] and faster than conventional vaccinators [57].

Vaccination in pharmacies is already authorized in several countries such as the United States, Portugal, the United Kingdom, Australia, New Zealand [31], Estonia [10], Norway [2], France [2], South Africa [6], Poland [32], Canada [8] and Switzerland [29]. **Table 1** presents studies from different countries on the results of vaccination carried out by pharmacists in their pharmacies. Obviously, the expansion of the role of pharmacists in these countries has brought a positive impact on vaccination coverage.

Mandatory training must be completed for pharmacists to vaccinate in each of these countries [6,30,31]. This allows them to be appropriately upskilled and vaccination to be performed safely [6,58]. Therefore, it is sufficient to add a program to students' university curricula and provide training for pharmacists who have already graduated [9].

In countries where vaccination in pharmacies is not yet allowed, it appears that the reasons for non-vaccination by pharmacists are often not rational or else unrelated to public health issues. Rather, the refusal to change is linked to inter-professional problems and a reluctance to transform the sector.

Nevertheless, the success reported in countries allowing vaccination by pharmacists (**Table 1**) demonstrates the genuine interest in pharmacist-led vaccination [2,6,7,42]. Not only does this service provide a significant public health gain through a marked increase in vaccination coverage but save costs too. Among all the articles in this review, no disadvantage of this pharmacy service was identified.

Moreover, vaccination is low risk compared to the multiple benefits it offers. Given that approximately 1.31 anaphylactic shocks occur per million doses of vaccine administered [60], the risk that pharmacists may have to deal with such shock is low, and they, in any case, are trained to deal with this type of situation. A few hours of simple training are sufficient for a pharmacist to be fully qualified and able to vaccinate [6,9,59].

The benefits of pharmacist vaccination can have an even larger impact during winter seasons or epidemics since health care services such as physician's offices are already overburdened at such periods [61].

One study showed that during an epidemic with a reproduction rate of 1.3, pharmacy-based vaccination can prevent 11.9 million cases of symptomatic influenza and between 23,577 and 94,307 deaths. These casualties correspond to 1 billion USD in direct costs, between 4.2 billion USD and 44.4 billion USD in lost productivity, and between 5.2 billion USD and 45.3 billion USD in overall costs [62]. Therefore, vaccination in pharmacies is one of the most obvious ways to increase the rate of vaccination coverage and reach vaccination objectives as quickly as possible.

Another significant advantage of vaccination by pharmacists is that it saves time and money for patients and reimbursement services.

In countries where pharmacy-based vaccination is not yet allowed, the patient must pay for one or two visits to the physician (for the administration and sometimes the prescription) as well as the vaccine at the pharmacist's, which includes the price of the vaccine but also the pharmacist's dispensing fee. Therefore, vaccination by the pharmacist would reduce the cost of vaccination. The patient would no longer have to pay for a medical consultation for the administration, nor the pharmacist's dispensing fee, but only the pharmacist's vaccine administration fee and one medical consultation (if necessary for the prescription). In Switzerland, the price of vaccination in pharmacies is calculated on a basis that includes: (1) costs of the personnel needed to administer the vaccine; (2) the price of the vaccine and the necessary materials; (3) a surcharge for sales, general and administrative costs, and business management costs; (4) 7.7% VAT (value-added tax); and (5) a margin for the beneficiary. These different costs together then make up the price of the vaccination charged by the dispensing pharmacist [62].

Furthermore, the pharmacist may also be authorized to prescribe a vaccine, as is the case in Belgium [65] Prescription, dispensing, and administration of the vaccine could therefore be carried out directly at the pharmacy. Patients would no longer be required to visit the physician to be vaccinated against the flu. The cost of flu vaccination would simply entail the pharmacist's administration fee and the price of the vaccine. Problems heard but not related to this research must be highlighted addressing the clinical outcomes of pharmacy-lead vaccination, including the hospitalization rate, risks and severity of the adverse reactions associated with vaccination under pharmacist-led compared to physician-led.

We suggest that respect of the cold chain underly the critical role of pharmacists in the vaccination. Care must always be taken to store and transport vaccines properly, in temperature-controlled conditions with temperatures ranging from 2°C to 8°C.

Table 1. Results on vaccination by pharmacists in different countries

Country	Results
United Kingdom	Pharmacists have been allowed to vaccinate against influenza since 2002 on a private basis. In 2005, low vaccination coverage led to vaccination authorization in local pharmacies for at-risk people over 65. The rate of people vaccinated is around 75%, the highest rate in Europe [2]. The introduction of pharmacy-based vaccination has been identified as the main reason for increased vaccination coverage [2]. Thanks to the National Health Service (NHS), many patients benefit from fully reimbursed vaccination (over 65s, pregnant women, health professionals, … [23]), but of these, half would still go to pharmacies for vaccination even if this service were not reimbursed [15 45] , for the sake of convenience. Moreover, the coining of a slogan about vaccination in pharmacies, "It's easier in pharmacy," demonstrates the English population's satisfaction with this service [64]. A study of 3500 patients determined that 99% of those vaccinated in pharmacies consider the vaccination service as very good. In addition, 20% would not have been vaccinated if it were not possible in pharmacies [45]. In Wales, when pharmacy-based vaccination was authorized, the number of flu vaccines administered increased by 34,670 (from 1,568 to 36,238 vaccines) and nearly 60% of these vaccines were given to people over 65 years of age [23]. Pharmacists also reach many younger at-risk individuals with fairly low vaccination rates [51].
France	An experiment was launched in 2017 to test influenza vaccination in pharmacies by pharmacists. Proving highly successful, it led to the general authorization of flu vaccination in pharmacies in 2018 [2]. Pharmacists in the Franche-Comté region furthermore have a broad tendency to approve vaccination in their pharmacies as long as mandatory training exists (for students as well as practicing pharmacists) [52].
Australia	Half of the patients vaccinated by their pharmacists were not vaccinated in the previous year [22]. One in 5 patients would not have been vaccinated if this pharmacy-based service were not authorized [22]. One in 7 patients reported that they had never previously received a flu shot [22]. In 2015, less than 1% of patients suffered minor reactions following their vaccinations at a pharmacy, but pharmacists always adequately managed these[8].
United States	It was the first country to authorize vaccination in pharmacies, with the first authorizations granted in 1996 [22]. As a result, pharmacists in all 50 states are currently licensed to vaccinate against diphtheria, tetanus, pertussis, hepatitis A, hepatitis B, pneumococcus, meningococcus, with some also licensed to administer the HPV vaccine [22]. Pharmacy-based vaccination has positively impacted population vaccination coverage, especially for influenza and adult vaccines [6]. Vaccination rates have increased significantly with pharmacy-based vaccination, especially among young adults. Therefore, this type of prevention program seems particularly effective when addressed at young adults rather than older individuals [49]. Pharmacists have a very positive image of in-office vaccination, especially after completing their training [58]. Flu vaccination capacity increased by 25 million doses/week when pharmacists were allowed to administer vaccines [57]. Patients are very satisfied with this pharmacy service: 99% recommend it, and 88.5% feel very comfortable getting vaccinated by a pharmacist [29]. In addition, population vaccination coverage has been shown in the United States to increase when pharmacists are involved in the vaccination process [5]. During the 2014-2015 flu season, 20% of people vaccinated against influenza were vaccinated at a pharmacy [43]. In West Virginia, parents have demonstrated a willingness to go to pharmacies for their children to be vaccinated due to pharmacies' convenience and fairly wide opening hours.
Switzerland	In 2015, vaccination by dispensing pharmacists was authorized in some cantons [10]. As of 2018, more than 1000 pharmacists were trained to administer vaccines in 19 different cantons [30]. Patients are very satisfied with this pharmacy service, with 99% recommending it to their friends and 88.5% feeling very comfortable being vaccinated by a pharmacist [29].
Canada	Approximately 33% of patients vaccinated at pharmacies would not have been vaccinated if this pharmacy service did not exist [21]. 99% of surveys in one study determined that patients are satisfied with this pharmacy service and recommend it to others [21]. 80% of influenza vaccine patients prefer being vaccinated at a pharmacy [47]. In Ontario, when pharmacists began vaccinating as of the 2013-2014 flu season, the rate of people vaccinated increased from 2.6 million to 3.1 million. This rise prevented more than 20,000 cases of influenza, which represented savings of 595 000 USD in health care costs (hospitalization, medical consultation, …). In addition, the re-increase in productivity resulted in savings of 3.5 million USD and the decrease in downtime, savings of 2.7 million USD [25].

Table 1 Cont.	
Estonia	In Estonia, the rate of people vaccinated against the flu was very low for several years. Flu vaccination by pharmacies was then allowed for the first time in 2018 [10]. More than half of the patients vaccinated against influenza by their dispensing pharmacists had never been vaccinated before [10].
Portugal	Administration of the influenza vaccine by dispensing pharmacists has been allowed since the 2008-2009 influenza season. As a result, 36.4% of influenza vaccinations were performed in pharmacies during that season, with the figure rising to almost 50% during the 2011-2012 influenza season [2].
Norway	Pharmacy-based vaccination has been allowed since 2018. The goal of implementing this service is to increase vaccine coverage and decrease antibiotic use [2].

If the cold chain is not maintained, there is a risk that vaccines will degrade and become less effective. This can lead to vaccine failures, with people vaccinated with doses that are not active enough, while under the mistaken belief that they are totally immune. The potential consequences are increased mortality, morbidity, costs, and burden on health care, even going so far as the creation of epidemics.

Unfortunately, healthcare professionals have no means to check whether patients are putting their vaccines in refrigerators quickly enough. When patients wait too long before refrigerating the vaccine after picking it up from the pharmacy, there is the risk of a breach in the cold chain and ensuing vaccine degradation. This risk is also present when patients remove their vaccines from their refrigerators to go to the physician's office to be vaccinated.

These problems can nevertheless be avoided thanks to vaccination in pharmacies. The pharmacist can administer the vaccine while it is at the right temperature to prevent any degradation.

In addition, in pharmacies, refrigerator temperatures are adapted and controlled daily. Therefore, the vaccines are stored safely and adequately until they are administered to the patient. Proper storage by the pharmacist and direct administration to the patient ensure the quality of the injected vaccine.

CONCLUSION

All the articles screened advocate that vaccination in pharmacies significantly increases vaccination coverage because pharmacists can overcome many barriers to vaccination such as lack of access to physician's offices, appointment scheduling, and lack of information among the population.

Vaccination is also less expensive in pharmacies than in traditional vaccination services because fewer costs are involved when the patient goes only to the pharmacist, without also having to consult a physician.

Transition of flu vaccination from the doctor to the pharmacist is almost complete in France but a collaborative model involving all the health professionals is the common practice around the world. Various countries have already authorized this pharmacy-based service, and it has proven to be a great success each time. To the best of our knowledge, no country has reversed its decision to allow vaccination in pharmacies, nor has this service given rise to any disadvantages according to the articles of this review. Finally, it would be interesting to investigate further the advantage offered by sound conservation of vaccines due to more secure maintenance of the cold chain thanks to vaccination in pharmacies.

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Conflict of interest

The author declares that there isn't any conflict of interest regarding the publication of this paper.

Contributions

All authors read and approved the final version of the manuscript.

Supplementary material

Table summarising the included studies can be accessed online through the journal website at https://aprh.journals.ekb.eg/article_296712.html

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