Caregivers' decision-making about childhood seasonal influenza vaccination in three provinces in China

A mixed-methods study

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DECLARATION

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4. ABSTRACT

Yearly seasonal influenza vaccination for children 6 months to 5 years of age is recommended by the World Health Organization. However, the uptake of influenza vaccine among preschool children aged (usually ≤ 6 years old) was hardly satisfactory.
This PhD study aimed to identify and characterize the factors that influence the decision-making process of caregivers with regards to childhood (6-60 months) influenza vaccination in China and help inform the development of behavioural change intervention to promote the childhood influenza vaccination in China.
To conduct this program of research, I employed a mixed-methods approach throughout the study phases, which included: 1) systematic literature reviews on influencing factors of childhood influenza vaccination, 2) quantitative analyses of large-scale population data on determinants of childhood influenza vaccination in three provinces in China, 3) qualitative analyses to explore the reasons for caregivers' perception about influenza and vaccines, and how caregivers perceive and understand the communication on influenza vaccine, and finally 4) a mixed-methods evaluation to explore the influencing factors of healthcare workers' recommendation for non-EPI vaccines in China.
The systematic reviews identified factors influencing caregivers' decision on childhood influenza vaccination. Using the survey data, caregivers' confidence in the influenza vaccine, positive influence from healthcare workers, family members, or friends and access to vaccination service were found to be associated with childhood vaccine acceptance. Some caregivers confused the common cold with influenza and thought that vaccines are not effective in preventing the constantly mutating virus. Therefore, targeted efforts should be made to address caregivers' misperception about influenza and influenza vaccine. Additionally, the communication about vaccines between caregivers and professional information sources, such as healthcare workers, is inadequate. The multi-level ecosystem around non-EPI vaccination should be improved to optimize the communication between healthcare workers and the public.

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Supplement 2.4. Appraisal – quantitative (Cross sectional study: Distribution, administration and response, and Coding and analysis)

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ACRONYMS AND ABBREVIATIONS

BSMI	Basic Social Medical Insurance
BSMIUE	Basic Social Medical Insurance for Urban Employees
BSMIUR	Basic Social Medical Insurance for Urban Residents
CDC	Centre for Disease Control and Prevention
CHC	Community Healthcare Centre
CIs	Confidence intervals
EPIC	Evidence to Policy pathway to Immunisation in China
EPI	Expanded Program of Immunisation
GISRS	Global influenza surveillance and response system
HBM	Health Belief Model
HCWs	Healthcare workers
HFMD	Hand-foot-and-mouth disease
ICU	Intensive care unit
IIV	Inactivated Influenza Vaccine
KAP	Knowledge, Attitude, and Practices
LAIV	Live attenuated influenza vaccine
LSHTM	London School of Hygiene and Tropical Medicine
MERS-CoV	Middle East respiratory syndrome coronavirus
MSA	Medical Savings Account
NHC	The National Health Commission
NIAC	The National Immunization Advisory Committee
NIP	National Immunisation Program
NPIs	Nonpharmacologic interventions
NRCMI	New Rural Cooperative Medical Insurance for Rural Residents
ORs	Odds Ratios
PHE	Public Health England
POV	Point of Vaccination
RdRP	RNA-dependent RNA polymerase
SAGE	Strategic Advisory Group on Experts
SARI	Severe acute respiratory infection
SARS-CoV	Severe Acute respiratory syndrome coronavirus
SEM	Socio-Ecological Model
SEU	Subjectively expected utility theory
TPB	Theory of Planned Behaviour
UNICEF	The United Nations Children's Emergency Fund
VSPs	Vaccination service providers
WHO	World Health Organization

ZMDP	Zero mark-up drug policy

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CHAPTER ONE: INTRODUCTION

1.1 Background

Influenza is an acute viral respiratory infection that circulates every year [1]. It is highly contagious, and the hallmark of infection is abrupt onset of fever, cough, chills or sweats, myalgias, and malaise [2]. Influenza infection can also lead to a wide range of non-respiratory complications in some cases — affecting the heart, central nervous system and other organ systems [3]. In children, influenza is one of the commonest causes of acute respiratory illness. It causes great disease burden among children below 5 years of age, with an estimated 870,000 hospitalizations and 10,200 deaths per year worldwide [4]. To reduce the influenza-related disease burden in the community, yearly seasonal influenza vaccination for children 6 months to 5 years of age is recommended by the World Health Organization (WHO) [5].

In China, the influenza vaccine is recommended but not paid for by the Expanded Program of Immunisation (EPI) [6]. The uptake of influenza vaccine among preschool children aged (usually ≤ 6 years old) was not ideal. Data collected between 2009 and 2012 indicate that influenza vaccination uptake among children <5 years living in five provinces, including Beijing municipality, Shandong, Hunan, Henan, and Sichuan provinces was about 26.4% [7].

Multiple factors are associated with hesitancy around childhood influenza vaccination. The World Health Organization Strategic Advisory Group on Experts (SAGE) on Immunisation developed the Vaccine Hesitancy Determinants Matrix with influencing factors grouped of individuals' vaccination decisions in three categories: contextual, individual and group and vaccine/vaccination-specific influences [8].

This PhD study aimed to investigate the influencing factors of caregivers' decision-making on influenza vaccination for children, to inform an evidence-based and context appropriate intervention to promote childhood influenza vaccination in mainland China. Specifically, this study included four aims: 1) evidence synthesis through systematic reviews on factors influencing childhood influenza vaccination; 2) quantitative data analyses on the association between childhood influenza vaccination and caregivers' perceptions of influenza and influenza vaccine, access to vaccination service, emotions and various information sources; 3) qualitative analyses on the decision-making process of caregivers regarding childhood influenza vaccination in children, figure out how caregivers' perception about the disease and vaccine are formed and how communication with the information sources influences their decision, and finally; 4) a mixed-methods

study to frame the determinants of healthcare workers' recommendation for non-EPI vaccines in China. This study has contributed to the field of childhood influenza vaccination acceptance by not only focusing on caregivers' views on illness and vaccines, but also investigating the barriers to promote influenza vaccination from the perspective of healthcare workers (HCWs).

This chapter provides an introduction to the thesis. It outlines the basis for this research with respect to the fields of childhood influenza vaccination, the objectives, and the research methods.

1.2 The background to the research

1.2.1 The disease burden of influenza

Influenza is an acute infectious viral respiratory disease. There are 4 types of seasonal influenza viruses, types A, B, C and D. Influenza A and B viruses circulate and cause seasonal epidemics of disease [2]. The viruses spread easily, through droplets containing viruses (infectious droplets) produced by an infected person's coughing and sneezing, or by hands and fomites contaminated with influenza viruses. Illness is normally characterized by fever, cough, headache, muscle and joint pain, malaise, sore throat, and a runny nose – symptoms that have an abrupt onset and can last for more than 2 weeks [1]. Although influenza is self-limiting and most people recover within a week without the need for further medical attention, influenza can lead to severe illness, hospitalization, and death, especially in older adults, infants, pregnant women, overweight individuals, and individuals with chronic medical conditions [9].

Every year there are estimated 3 to 5 million cases of severe illness and 290,000–650,000 respiratory deaths worldwide [10]. In China, the overall influenza-associated outpatient burden was also substantial, with a total of 3.4 million persons medically consulted a medical practitioner on an annual basis because of influenza viruses [11]. Influenza also causes substantial morbidity and mortality. Systematic review shows that the pooled rates of influenza-associated all-cause mortality rate was 14.33 per 100,000 persons [12]. One study also estimated that an annual mean of 88,100 influenza-associated excess respiratory deaths occurred in China from 2010 to 2015 [13].

Although influenza is often regarded as an illness of the elderly population due to the highest influenza-related excess mortality among persons over 65 years of age, ample evidence indicates that the burden of influenza is also substantial in children. Children have the highest rates of infection in the community during epidemics. It causes great disease burden among children below 5 years of age, with an estimated 870,000

hospitalizations and 10,200 deaths per year worldwide [2, 3]. In China, Influenza-associated severe acute respiratory infection (SARI) mostly affected children aged <5 years (2,021 hospitalizations per 100,000 during 2010–2011 flu season and 2,349 per 100,000 during 2011–2012) in Jingzhou, central China [14]. Another study estimated annual influenza-associated SARI hospitalization rates per 1,000 children aged <5 years ranged from 4 in the 2012-2013 flu season to 16 in the 2011-2012 season in Suzhou, east China [15]. In addition, influenza infections in children can lead to higher outpatient and emergency care costs, as well as caregivers' absenteeism, which further contributes to indirect health costs. A study in Suzhou showed that caregivers of children infected with influenza missed 1.4 days of work [16].

1.2.2 Influenza vaccine

Influenza viruses are susceptible to antigenic variation due to the misincorporation of nucleotides by the viral RNA-dependent RNA polymerase (RdRP) during genome replication and the segmented nature of their genomes [17]. Antigenic variation is generally classified as antigenic drift or shift [18]. The surface of the virion envelope is covered with proteins hemagglutinin (HA), neuraminidase (NA), and matrix. Antigenic drift is associated with the gradual accumulation of nucleotide mutations and amino acid substitutions in the HA and NA surface glycoproteins, which periodically results in the emergence of new antigenic variants [19]**.** Antigenic shift refers to the significant changes in the HA or NA proteins that create novel influenza subtype [20].

Influenza viruses continually evolve, allowing them to evade immune memory responses and infect individuals previously exposed to similar virus strains. Hence, annual influenza vaccination is recommended to prevent and control seasonal influenza virus infections [10]. Multiple formulations of the influenza vaccine are available, including Inactivated Influenza Vaccine (IIV), Live attenuated influenza vaccine (LAIV) and recombinant influenza vaccine. According to the components of the vaccine, influenza vaccines can also be divided into trivalent and quadrivalent influenza vaccines. WHO, through the WHO global influenza surveillance and response system (GISRS), monitors influenza activity globally, recommends seasonal influenza vaccine compositions twice a year for the Northern and Southern hemisphere influenza seasons, guides countries to choose vaccine formulations, to help mitigate the consequences of the epidemic [21]. Strong clinical evidence has demonstrated the efficacy of the influenza vaccine [22]. Annual influenza vaccination is recommended for all people six months and older who do not have contraindications [5]. Meanwhile, vaccination efforts should target people at increased risk of complicated or severe influenza and those who care for or live with high-risk individuals, including health care professionals, including: 1) pregnant women at any

stage of pregnancy; 2) children aged between 6 months to 5 years; 3) elderly individuals (aged more than 65 years); 4) individuals with chronic medical conditions;5) health-care workers [10]. In addition to the above groups, the Chinese Centre for Disease Control and Prevention (CDC) also added the following groups of people to its list of high-risk groups for the 2022-2023 influenza season, including: 1) participants and security personnel of large-scale events; 2) vulnerable population and employees in nursing homes, long-term care facilities, welfare homes; 3) people in high-priority places (e.g., kindergartens, primary and secondary schools, and prison); 4) family members and caregivers of infants under 6 months of age; 5) elderly individuals aged between 60-65 years [23].

1.2.3 Vaccine delivery system in China and reimbursement policies for influenza vaccination

Mainland China initiated its national expanded program on immunisation (EPI) in 1978. Currently 14 vaccines against 15 vaccine-preventable diseases (Text Box 1) [24], referred as Category I, are provided to children free of charge and required for school enrolment. Category II Vaccines, including oral rotavirus vaccine, Hepatitis A vaccine, seasonal influenza vaccine and others, are available to citizens at a cost [25].

Although annual seasonal influenza epidemics represent a major disease burden, Influenza vaccination is not included on the National Immunisation Program (NIP) in China. Eliminating or reducing out-of-pocket expenses for vaccination can significantly promote influenza vaccine uptake [26-30]. Currently, over 40% of countries include seasonal influenza vaccination on their National Immunisation Program, including most countries across Europe, North and South America, and some countries in African, South-East Asia, and the West Pacific Region [31-34].

In China, Influenza vaccination in some regions is reimbursed fully or partially by the local Government Financial Department (Finance-reimbursed vaccination), or Basic Social Medical Insurance (BSMI) [6]. Fully finance-reimbursed vaccination policy is confined to around 6 million persons, mainly the elderly, school children and health-care workers in 5 cities, including Beijing, Dongli district in Tianjin, Karamay in Xinjiang province, Shenzhen in Guangdong province and Xinxiang in Henan province [35].

BSMI-reimbursement policy is further broken down into 3 subgroups: (1) vaccination reimbursed by New Rural Cooperative Medical Insurance for Rural Residents (NRCMI); (2) BSMI-proportional-reimbursed vaccination, which is proportionally reimbursed by Basic Social Medical Insurance for Urban Employees (BSMIUE), and/or Basic Social Medical Insurance for Urban Residents (BSMIUR); (3) vaccination reimbursed by the surplus fund of individual card of Medical Savings Account (MSA) of BSMIUE.

BSMI-reimbursed policy covers around 116 million and reimbursed fully or partially the influenza vaccination for insured persons. Although BSMI-reimbursed policy covered more people, it only focused on the insured persons irrespective of medical status. This mismatch could create unequal access to vaccination for high-risk groups [35].

Text box 1: Category I and II vaccines in China

Category I Vaccines (14 vaccines against 15 diseases, paid by government)	**Category II Vaccines*** (Paid out of pocket by recipients, the list gives some examples)
Domestic Hepatitis B vaccine	Imported Hepatitis B Vaccine
BCG vaccine	Seasonal influenza vaccine
Polio vaccine	HPV vaccine
DPT vaccine	Rabies vaccine
Diphtheria-tetanus vaccine	Pneumonia vaccine
Measles vaccine	Oral rotavirus vaccine
Hepatitis A vaccine	Hepatitis A vaccine
Group A Meningococcal vaccine	HIB vaccine
Group A+C Meningococcal vaccine	Varicella vaccine
Encephalitis B vaccine	Hib vaccine
MMR vaccine	Live attenuated MMR vaccine
HFRS (Hantavirus) vaccine*	
Anthrax vaccine*	
Leptospirosis vaccine*	

* Category I vaccines are mainly routine vaccines for children, HFRS (Hantavirus) vaccine, Anthrax vaccine and Leptospirosis vaccine are for high-risk population

* Category II vaccines listed in the table are the common ones, not complete

1.2.4 Childhood influenza vaccination in China and COVID-19

Influenza vaccination for children could bring about substantial health benefits not only to children themselves but also to persons in other age groups. However, in China, the national influenza vaccination coverage for all ages is only 1.9% in 2014 [35], and data collected in 2009-2012 indicates that influenza vaccination uptake among children < 5 years living in five provinces in mainland China was about 26.4% [7]. Several factors contribute to this low coverage. In addition to the seasonal influenza vaccine not being included in the national Expanded Program on Immunisation (EPI), and needs to be paid for out of pocket, caregivers' (i.e., parents, and guardians) awareness of risk, knowledge, attitudes and beliefs on vaccination behaviour were significantly associated with childhood influenza vaccination [36-38].

More importantly, the COVID-19 pandemic, which has had an unparalleled impact on the health of people worldwide [39], may also affected public perception and attitudes toward influenza vaccines. The COVID-19 contagion initially emerged in Wuhan, Hubei Province, China on December 8, 2019, when a cluster of patients with pneumonia-like symptoms were reported from Wuhan [40, 41]. Subsequently, the discovery of a previously undescribed coronavirus, was obtained from samples of the respiratory system of some of these patients, which differed from all known coronaviruses including severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) [42, 43]. This new infectious agent is named as SARS-CoV-2 [44]. Studies indicated that SARS-CoV-2 is transmitted between people through respiratory droplets, contact routes and even fecal contamination [45-50]. The clinical spectrum of SARS-CoV-2 infection ranges from asymptomatic infection, mild upper respiratory tract illness, to severe viral pneumonia with respiratory failure and death [51]. In addition to respiratory involvement, the virus can induce systemic inflammation, affecting other organ systems, including the gastrointestinal, cardiovascular, hematological, renal, musculoskeletal, and endocrine system [51].

Wuhan city was the centre of the initial SARS-CoV-2 outbreak. Meanwhile, the coincidence of the outbreak of SARS-CoV-2 and Chunyun, a large-scale migration for the Chinese Lunar New Year holiday starting from January 10, 2020, contributed to the spread of the virus to every province in mainland China [52, 53]. As of March 3, 2020, a total of 80,151 cases were confirmed in mainland China [54]. International travel between Wuhan and other cities across Asia, Europe and North America, facilitated the global spread of SARS-CoV-2 and onward transmissions [55-57], with the epicentre shifting to the Middle East, Europe and North America [58-63]. The WHO declared COVID-19 a pandemic on

March 11, 2020 [64]. By the end of February 2023, the total number of confirmed cases globally had passed 600 million, including more than 6 million reported deaths [54].

As a previously unknown disease, effective pharmaceutical treatment options were not expected to be available for months [65]. Therefore, nonpharmacologic interventions (NPIs) remained central for management of COVID-19 [66-68]. Three major groups of NPIs have been implemented to slow the spread and reduce the size of the epidemic across China [69]. First, travel restrictions were put in place across the country to prevent further spread of the virus [70]. Early isolation of patients and quarantine of exposed persons comprised the second group of NPIs, including improving the screening, identification, diagnosis, isolation, reporting, and contact tracing of suspected ill persons and confirmed cases [69]. Third, contact restrictions and social distancing measures, including cancellation of mass gatherings and stay-at-home orders, school and workplace closures, together with personal preventive actions, such as regular handwashing, and wearing face masks, were used to reduce the community transmission [71, 72].

The implementation of these NPIs coincided with a rapid decline in the number of new cases across China [73]. By April 8, 2020, the number of infected people reported to be infected was reduced to 0 [74]. China then has entered a normalization stage of prevention and control [75]. In this stage, the goal of epidemic prevention and control is early detection, treatment of confirmed cases and close contacts, and resolutely preventing sustained community transmission [75]. Specific measures include the implementation of temperature detection in public places, strengthening screening in fever outpatient, identifying close contacts in a timely manner, taking measures such as canceling public gathering and lockdown when necessary to cut off transmission routes and treating patients with mild symptoms timely [76]. The implementation of the above measures successfully contained dozens of outbreaks with local transmission caused by imported SARS-CoV-2 [77]. However, as the highly transmissible Delta variant was becoming the dominant strain [78], China adopted a new strategy called “Dynamic COVID-zero” from August 2021, which was a transitional strategy adopted after a successful containment strategy [79]. The core is to quickly find, control, and cure infected people in each cluster outbreak within a specific geographic region to minimize the impact of the epidemic on the economy, society, and people’s normal lives. New technologies like big data analysis were applied to help epidemic prevention staff find the close contacts in the “golden response time” (within 24 hours after each outbreak) [80].

Maintaining a low infection rate in the general population throughout the pandemic provided China time to mass immunise the population against SARS-CoV-2. On April 2020, there were more than 100 COVID-19 vaccine candidates in laboratory or preclinical

studies [81]. At the end of 2020, COVID-19 vaccines were approved for emergency use for key population groups at high risk of occupational exposure, including community workers, health workers and those at risk of overseas infection and in essential positions of maintaining basic society operation [82]. With the updated evidence from clinical trials of COVID-19 vaccines and the increase in vaccine supply, vaccination expanded to the public with a priority order of the 18-59 age group, individuals aged over 60 or with health conditions, the 12-17 age group and the 3-11 age group [83]. To achieved mass vaccination, China adopted a whole-of-society approach, including government engagement, the collaboration of multiple systems and departments, and large-scale vaccination mobilization [83]. As of April 18, 2022, nearly 92% of the population had received the full primary schedule of the COVID-19 vaccination [84].

However, vaccine-induced immunity was insufficient to prevent outbreaks caused by the SARS-CoV-2 Omicron variant. First reported in South Africa, SARS-CoV-2 Omicron variant rapidly replaced previous strains and became the dominant strain globally given its high transmissibility and immune escape properties [85, 86]. From March 1 to April 22, 2022, more than 500,000 local Omicron infections have been reported in almost all provinces across China, with most (about 93%) occurring in Shanghai, one of the largest metropolitan area with a population of over 24 million [87]. To contain the highly infectious and immune evasive Omicron variant, strict public health measures were taken, such as large scale viral nucleic acid and antigen screening, quarantine of infected cases and close contacts in shelter hospitals and hotels, respectively, and lockdown of districts with severe outbreak [88].

Shanghai's great efforts led to very promising results. The number of newly infected cases, after peaking at 27,605 on April 13, 2022, dropped to 4,466 cases, as of May 4, 2022 [88]. On June 1, 2022, the Shanghai government declared the end of the city-wide lockdown [89].

Although strict NPIs were sufficient to control community spread, it is important to stress that city-wide lockdown brought great inconvenience to local citizens in their daily lives and was socially and economically costly and impractical in the long term [87]. In view of the declining mortality rate in COVID-19 and the development of herd immunity, China announced that it would relax restrictions to alleviate the negative impact of mass lockdowns in December 2022 [90], which resulted in a significant surge in cases [91]. This study was conducted from September to November 2021, during which time sporadic COVID-19 outbreaks were well contained due to the implementation of NPI, and before the surge in cases once restrictions were relaxed.

It is important to emphasize that the COVID-19 pandemic also likely affected public perceptions and attitudes toward influenza vaccination as it did in other countries [92]. Though the COVID-19 virus and influenza are vastly different pathogens, there are important areas of overlap [93]. For example, both viruses are primarily transmitted by respiratory droplets, and the majority of COVID-19 patients present with Influenza-Like Illness [94]. Meanwhile, the adoption of NPIs also had a good prevention effect on influenza. Study have shown decreased influenza incidence in 2020 (January through May) after adoption of NPIs as compared with prior seasons [95]. Changing risk of influenza and the similarities in transmission patterns and symptoms of SARS-CoV-2 and influenza virus could affect public's risk perceptions of influenza infection and their decisions about influenza vaccination. Therefore, it's necessary to understand how public perceptions of influenza changed during COVID-19.

1.3 Research objective

To identify and characterize the factors that influence the decision-making process of caregivers with regards to childhood (6-60 months) influenza vaccination in three provinces (Guangdong, Anhui, Shaanxi) in mainland China.

1.4 Research questions

On the basis of the research gaps mentioned above, the following research questions were investigated:

1. Question 1: What are the non-clinical determinants of caregivers' decision making about childhood influenza vaccination? (Aim 1, chapter two)

2. Question 2: What is the uptake level of influenza vaccination among children (6-60 months) in the 2020-2021 flu season in the China? (Aim 2, chapter three)

3. Question 3: What are the factors influencing caregivers' decisions around childhood influenza vaccination in the 2020-2021 flu season? (Aim 2, chapter three)

4. Question 4: How are caregivers' perception about influenza disease and influenza vaccine formed? (Aim 3, chapter four)

5. Question 5: How does the communication from different information sources influence caregivers' decisions about childhood influenza vaccination? (Aim 3, chapter four)

6. Question 6: How do healthcare workers (HCWs) recommend non-EPI vaccines to caregivers in China? (Aim 4, chapter five)

7. Question 7: What are the potential determinants of HCWs' recommendation for non-EPI vaccines in China? (Aim 4, chapter five)

1.5 Research aims

The research questions are addressed through four interlinked aims:

1. Aim 1 - Conducting systematic literature reviews identifying influencing factors on caregivers' decision on childhood influenza vaccination. (Chapters two)

2. Aim 2 –Conducting quantitative data analyses in assessing the association between individual perceptions, access to influenza vaccination, emotion of caregivers and various information sources and childhood influenza vaccination. (Chapters three)

3. Aim 3 - Conducting qualitative data analyses in investigating out how caregivers' perception about the disease and vaccine are formed and how communication with the information sources influences their decision. (Chapter four)

4. Aim 4 - Conducting a mixed-methods study combining a cross-sectional survey and key informant interviews in framing the potential determinants of HCWs' recommendation for non-EPI vaccines in China. (Chapter five)

1.6 Theoretical framing and research methods

Here I summarize theories for investigating individual health behaviours and present a short overview of the objectives and methods used in each part of PhD research.

1.6.1 Theoretical models applied to caregivers' decision-making about childhood influenza vaccination

At the early stages in the development of decision theory, the model of rational behaviour, also known as subjectively expected utility theory (SEU), drew on theoretical and empirical contributions from economics and mathematics. SEU-type theories assume that people will assess the utility of outcome of alternatives and weight it by the probability of its occurrence, and final decision will be arrived through the integration of all the information [96, 97].

Three SEU-type health behaviour models have been applied in the field of parent and caregiver decision-making on vaccines. These are: 1) the Knowledge, Attitude, and Practices (KAP) model; 2) the Health Belief Model (HBM) and 3) the Theory of Planned Behaviour (TPB).

The ‘Knowledge, Attitude, and Practices’ (KAP) model is based on Bandura’s Social Learning Theory [98]. According to this theory, people are active information processors, and develop hypotheses on the outcome of the behaviour based on their observations. The result of the mediational processes guides their future action. The KAP theory divides the change of human health behaviour into three continuous processes: acquiring knowledge, generating attitude and shaping practice. Previous studies have applied the KAP theory to explore chronic disease management among patients and the prevention behaviour around infectious diseases among the public [99-102]. The model was also used to explore caregivers' decision making on influenza vaccination for children [103-105].

Compared with the KAP model, the ‘Health Belief Model’ (HBM) is more widely used to study vaccination behaviour [36, 106-115]. The HBM was developed in the 1950s and then extended by Leventhal to explain variations in adherence to treatment [116]. It proposes that whether to take preventive health action or not depends on individuals’ trade-off between perceived threat of the disease, perceived benefits of preventive action and barriers to preventive action which are set in motion by cues to action including internal (e.g., self-perception of bodily states) and external (e.g., mass media campaigns, advice from others, or illness of family member or friend).

The ‘Theory of Planned Behaviour’ also has been applied to investigate vaccination behaviour [117, 118]. It considers the attitudes (positive, negative or neutral) and subjective norms (perceived social pressure to perform or not perform the behaviour referring to the significant influence from relevant groups or individuals such as family members and friends on individual's behaviour) and perceived behavioural control (degree of sense of control they feel when they expect to take a certain action) [119].

These theories are useful to understand why individuals engage in certain health behaviours such as vaccination. However, they also have the following limitations. Firstly, these theories contain constructs related to perceptions and attitudes about diseases and vaccines, but not sufficient to explain how the potential factors influence individual decision on vaccine. During the timeline from the initial awareness, gradual formation of perceptions, to the final decision and behaviour, individuals could actively or passively learn other information about vaccines and vaccination. Individuals’ vaccination behaviours are closely linked to the information they receive or seek around vaccination. In today’s communication environment, the rapid proliferation of health information on the Internet has resulted in individual Internet health information seeking becoming more pervasive [120, 121]. Increasingly fragmented information with different information sources and quality are spread to people easily, with the development of internet and social media [122]. The emotional narrative format of misinformation could make it more

influential than statistical or scientific information. In addition, it is important to highlight that although the general population are encouraged to participate in shared-decision making in relation to their own health, together with their doctors [123], they still rely on experts to assess the risks of disease for them in many cases as they may not possess the necessary skills to evaluate received information [124-127]. Many studies have shown that HCWs are the most trustworthy health information sources for the public and communication between HCWs and the public is considered to be the cornerstone of maintaining the public's confidence in vaccinations [128-130]. Existing studies mainly investigate whether the public's vaccination decisions are influenced by HCWs through questionnaires, such as asking respondents whether they have received recommendation on vaccination from doctors, which is important, but cannot help us to deeply understand the nature of communication and interaction between the individuals and HCWs [108-110, 113, 131]. Therefore, to better inform the development of interventions to improve the caregivers' vaccination willingness, it is necessary to investigate how well the information given by HCWs is received and the interplay between HCWs advice and other information sources in influencing vaccine decisions.

Secondly, making decisions in the real world isn't just a matter of weighing risks against benefits based on accurate scientific information, but multi-stage and mixed with non-rational evaluation. The SEU-type theories emphasize the importance of cognitive evaluation and the knowledge or prior contact with the disease, while studies have shown people make decisions not only based on rational risk assessment, but also take mental shortcuts to make decisions which are not based on based on knowledge and objective information and could lead to cognitive biases in the representation of risks. According to Slovic, two important and independent modes for processing information exist, one is a cognitive system, by which, information will be inferred and rational argumentation will be following to help the differentiation process; the other is an emotional system which has been described as "primary, instantaneous, not yielding to wilful control and difficult to change with rational argumentation", it can help us think quickly through a complex and uncertain situation [132]. Although both systems operate in parallel, it is easier for individuals to rely on the latter to make decisions. Previous research on other health behaviours has shown that individuals are irrational when making choices about their own health. Taking antibiotic use for example, many hold the misconception that an antibiotic is a Xiaoyanyao (literally means anti-inflammatory drug in Chinese), and prompt people to self-medicate with antibiotics for prophylaxis, which contribute to the massive misuse of antibiotics [133]. In addition, studies have shown that individuals can also be highly influenced by emotions such as regret and anxiety they expect as a result of certain decisions [134, 135]. Existing research on caregivers' vaccine decisions focus on their

perceptions and attitudes toward disease and vaccines, not how they process information [36, 104, 107, 109, 112, 136]. The further in-depth interview could help us understand the role of irrational evaluation in decision-making on vaccination.

Thirdly, vaccination behaviour cannot be explained by a single factor but is instead the consequence of a multitude of psychological, social, and contextual factors. Therefore, the access to vaccination service needs to be considered to develop a comprehensive understanding of factors influencing decision-making related to vaccination. Access summarizes a set of specific areas of fit between the public and the health care system. According to Penchansk, access includes the following dimensions: availability, accessibility, accommodation, affordability, and acceptability, respectively referring volume and type of medical service, the location of supply, prices of medical service ,the manner in which the supply resources are organized to accept patients, and patients' attitudes about personal and practice characteristics of providers [137]. Existing studies only investigated the above individual dimensions, and subsequent studies need to take all five dimensions into account [109, 131, 138].

1.6.2 Vaccine Hesitancy Determinants Matrix

Vaccination behaviours are influenced by a wide diversity of factors. According to the Vaccine Hesitancy Determinants Matrix developed by the WHO SAGE working group, the determinants of vaccine hesitancy are grouped in three categories: contextual, individual and group and vaccine/vaccination-specific influences (Text Box 2)[139, 140]. Contextual influences include political, religious, cultural, or socio-economic factors as well as the communication and media environment. Individual and social group influences comprise beliefs, attitudes and motivations about health and vaccination, personal experiences with health systems and vaccination, as well as perceived risks and benefits of vaccination. Finally, vaccine and vaccination-specific issues relate to scientific risk-benefit assessments, mode of administration or delivery of vaccination, costs, or reliability of vaccine supply.

Compared with the SEU-type theories, the vaccine hesitancy matrix is more comprehensive. Besides the cognitive evaluation of the health risks, the matrix also emphasizes individuals' limited ability to process statistics or health literacy, and the impact of communication through different information sources. In addition, the vaccine hesitancy matrix also highlights factors related to the vaccine delivery system and vaccination services, which include vaccination costs, relevant policies, reliability of the supply of vaccines and vaccination equipment, geographic access, design of vaccination

program, mode of delivery, and personal, family and community members' experience with vaccination.

However, this model has its limitations. Namely, while it lists the various factors which influence vaccine hesitancy, it does not clarify the relationship between them, for example, the impact of health information on health decision-making. The factors need to be considered in light of the processes and influences around decision making.

Text box 2. Three categories and specific factors in Vaccine Hesitancy Determinants Matrix.

Contextual influences Influences arising due to historic, socio-cultural, environmental, health system/institutional, economic or political factors	a. Communication and media environment b. Influential leaders, immunisation program gatekeepers and anti- or pro-vaccination lobbies c. Historical influences d. Religion/culture/gender/socio-economic e. Politics/policies f. Geographic barriers g. Perception of the pharmaceutical industry
Individual and group influences Influences arising from personal perception of the vaccine or influences of the social/peer environment	a. Personal, family and/or community members' experience with vaccination, including pain b. Beliefs, attitudes about health and prevention c. Knowledge/awareness d. Health system and providers – trust and personal experience

Vaccine/vaccination – specific issues Directly related to vaccine or vaccination	e. Risk/benefit (perceived, heuristic) f. Immunisation as a social norm vs. not needed/harmful a. Risk/benefit (epidemiological and scientific evidence) b. Introduction of a new vaccine or new formulation or a new recommendation for an existing vaccine c. Mode of administration d. Design of vaccination program/Mode of delivery (e.g., routine program or mass vaccination campaign) e. Reliability and/or source of supply of vaccine and/or vaccination equipment f. Vaccination schedule g. Costs h. The strength of the recommendation and/or knowledge base and/or attitude of healthcare professionals

1.6.3 The Social-Ecological Model

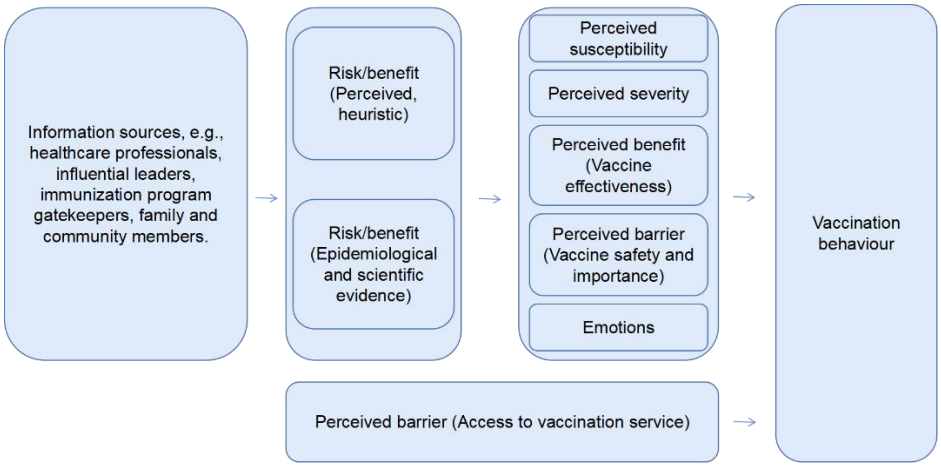
The Socio-Ecological Model (SEM) is a theoretical model for understanding the interactive effects of individual and social environmental factors that identify behavioural and institutional leverage points as well as intermediaries for promoting healthy behaviours [141]. In this model, patterned behaviour is the outcome of interest and is viewed as being determined by five sub-ecosystems, which are intrapersonal, interpersonal, institutional, community, and policy [142].

1.6.4 Conceptual framework research

To better inform the study on caregivers' decision on childhood influenza vaccination, I reorganized the factors in the Vaccine Hesitancy Determinants Matrix. First, I classified the range of information sources in the matrix, including influential leaders, immunization program gatekeepers and anti-- or pro-vaccination lobbies family and/or community members, immunization program gatekeepers and anti-- or pro-vaccination lobbies family and community members, health systems and providers. Health information sources influence individual perceptions of disease risk and vaccine risks or benefits, which are essential to the understanding of vaccine acceptance.

Using the HBM constructs, I explored individual perceived susceptibility and severity of disease risk and disease consequence. Perceived benefits and barriers relate to perceived effectiveness, safety, and importance of vaccines. In addition, I also classified the Vaccine Hesitancy Determinants Matrix factors related to access of vaccination services, including policies, geographic barriers, introduction of a new vaccine, new formula or a new recommendation for an existing vaccine, design of vaccination program/mode of delivery, reliability and/or source of supply of vaccine and/or vaccination equipment, vacation schedule and costs. Emotions were also added as factor in influencing decision-making. (Figure 1). The model was employed to guide the literature review (reported in chapter two), quantitative data analyses (reported in chapters three) and qualitative data analyses (reported in chapter four).

Figure 1: The framework of determinants of childhood influenza vaccination (Adapted from the Vaccine Hesitancy Determinants Matrix)



A systematic literature review was conducted to landscape what factors have been studied to be associated with caregivers' decision on childhood influenza vaccination. Alongside the literature review, I conducted one cross-sectional survey in Shenzhen megacity in Guangdong province, Anhui province, and Shaanxi province, located in Eastern, Central, and Western China, respectively. The main target populations of this survey were caregivers of children < 6 years old. I conducted descriptive analysis on the childhood influenza vaccination behaviour in 2020-2021 influenza season. Then, guided by the conceptual framework (presented in Figure 1), I explored factors influencing caregivers' decisions regarding influenza vaccination for their children. Results from these analyses were used to inform socio-demographic priorities of target population and components for potential intervention. In this study, I found that caregivers' confidence in the importance, safety and effectiveness of influenza vaccine was significantly associated with childhood vaccine acceptance. Meanwhile, caregivers are less likely to consider influenza vaccines as being effective and important. Also, poor access to influenza vaccination services, including conflicts between caregivers' availability and vaccination service schedules and inconvenient transportation to the vaccination site, is negatively associated with childhood influenza vaccination. Positive recommendations from HCWs to caregivers, was significantly associated with childhood influenza vaccination. However, only a few caregivers reported positive recommendations from HCWs.

To better understand caregiver's decision-making process regarding childhood influenza vaccination during the COVID-19 pandemic, I concurrently conducted a qualitative analysis, as part of the cross-sectional study, and interviewed caregivers purposively sampled according to their children's influenza vaccination status in the 2020-2021 flu season. I choose qualitative approach because it could access authentic accounts of subjective experiences and is ideal to develop a better understanding of the process of childhood influenza vaccination decision-making among caregivers. Key areas explored in this part included caregivers' perception of the disease and the vaccine, information sources and influencers in relation to influenza vaccination, and communication with professional information sources to help understand not only the reasons for caregivers' perception about influenza and vaccines, but also how caregivers perceive and understand the communication on influenza vaccines.

Finally, given the central role and impact of HCWs recommendation on individuals' health decision-making, I conducted a mixed-methods data analyses on the large-scale survey datasets across Shenzhen megacity, Anhui province, and Shaanxi province collected by Fudan University in 2019, to explore factors influencing the communication about vaccination between caregivers and HCWs. The target populations of these surveys were all vaccination service providers (VSPs) in the sampled districts and counties.

Published studies on HCWs' vaccination recommendation are rare. For this part of my study, I used the Social Ecological Model, because the behaviour of medical professionals is not only influenced by their own perception and attitude, but also by institutional regulations and policies. This SEM model could help explain HCWs' recommendation of non-EPI vaccines centred around their own perception and attitude while recognizing multifaceted effects of personal and environmental factors, such as institutional regulations and policies. Results from this study could inform interventions to optimize the communication between HCWs and caregivers. More detailed discussions on the results are included in chapter six.

All participants were informed of the purpose of the study and consented. They were also informed that participation was voluntary and that they could withdraw at any time. The study methods involving use of primary and secondary data were approved locally in China via Fudan University Ethics Committee and the London School of Hygiene and Tropical Medicine (LSHTM) Ethics Committee. The ethics approvals are attached in Appendix.

1.7 Collaborations and partnership

In China, although new vaccines against diseases such as Streptococcus pneumoniae, influenza and human papillomavirus have been introduced, many of these vaccines are not centrally funded and need to be paid out-of-pocket, which makes them inaccessible to poor and vulnerable people. Increasing the range of vaccines fully funded by government would require a large amount of money and manufacturing capacity to supply China's large population. Hence, Chinese central government needs evidence of the potential health benefits, and budget impact in funding new vaccines. In addition, they also need to build public confidence and vaccine acceptance to ensure sufficient public demand, so that local vaccine manufacturers will ensure a reliable and uninterrupted vaccine supply.

The Evidence to Policy pathway to Immunisation in China (EPIC) is a multi-year (2017-2021) Global Health Research Group that brings four British and Chinese public health and academic partners: the LSHTM, Public Health England (PHE), China CDC and Fudan University (Fudan). All four partners are leading institutions in infectious diseases and vaccine research on a global scale.

EPIC aims to help decision-makers in China build a vaccination program that ensures reliable, affordable, equitable and uninterrupted supply of vaccines to the Chinese population. The work of EPIC focuses on the vaccine-preventable diseases and vaccines that are of most interest to decision makers but are not currently centrally funded. There are three key objectives themes: (i) collecting and analysing data about health and economic consequences of vaccine-preventable diseases across different parts of China, such as

testing sero-epidemiological data from mother-child pairs in a county-level city to assess seasonal influenza incidence by subtype, and using notifiable disease data from China CDC in geospatial model to predict geographical distribution of hand-foot-and-mouth disease (HFMD) burden across China, (ii) understanding vaccine supply, demand and decision making among the public, manufacturers and other key stakeholders, including using mixed-methods to investigate the acceptance, perceptions, and hesitancy towards vaccination among public and provider, identifying factors that contribute to reduced uptake of EPI vaccines, and exploring public and provider perspectives on introducing non-EPI vaccines into routine schedule and examine facilitators and barriers that could affect this transition, (iii) using findings from themes (i) and (ii) in mathematical models to project the health and economic impact that vaccine introductions could have, including examining effectiveness and cost-effectiveness of influenza vaccination of young children and older adults, a routine paediatric HFMD and vaccination program, and routine infant pneumococcal conjugate vaccination. In addition, in 2020, to address the infectious disease threat of COVID-19, a new Theme, theme 4, was added to address some of the key issues around mitigating the pandemic in China and in low-and middle-income countries. The main content of theme 4 is to evaluate the non-pharmaceutical interventions for containing and suppressing COVID-19 and the potential impact and cost-effectiveness of COVID-19 vaccination.

My PhD research was situated in EPIC Theme 2.1 which is committed to providing insights into public and HCWs' confidence in vaccination, fundamental for an effective immunisation program. In addition, identifying subgroups with low vaccine confidence and figuring out the reasons underpinning their vaccination decision-making and behaviours was important to inform tailored strategies for addressing concerns and increasing vaccine confidence. This is a mixed-methods study design, which includes primary data collection in the form of two rounds of questionnaire surveys interspersed with the collection of qualitative data. The first survey round was conducted in Guangdong province, Anhui province, and Shaanxi province in January 2019, after a national vaccine crisis, in China. The second round was conducted in the same areas between September - November 2021. To help promote COVID-19 vaccination, we extended the research to investigate the caregivers' and healthcare workers' vaccination intentions, vaccine confidence, willingness to pay, information needs of potential COVID-19 vaccines.

I collaborated closely with Fudan University to gain strong local support, including the financial, social and human capital needed to conduct two rounds of data collection. For Aim 2 and 3, my data collection was integrated into the second round of questionnaire survey and interview. I collected data on potential influencing factors of caregivers' decision on childhood influenza vaccination, including parents' perceptions of influenza

and vaccines, access to vaccination services, and explored the reasons for the formation of caregivers' perceptions, and their communication with professional information sources. In addition, I also investigated the impact of COVID-19 on caregivers' perceptions on influenza and vaccines, and final decisions on childhood influenza vaccination. I was responsible for developing the questionnaire and went to the sampled region with researchers from Fudan for data collection. At the same time, I cleaned the quantitative data and transcribed the recording of the interviews. For Aim 4, Fudan University agreed to share both quantitative and qualitative data collected in the first round on VSP's recommendation behaviour on non-EPI vaccines. Prior to the first-round data collection, I contributed to the study design and questionnaire development. During this PhD, I applied social epidemiological methods for secondary data analyses. The results of this study will be disseminated in the form publications. They will inform evidence-based policy recommendations that strengthen China's national effort to promote childhood influenza vaccination.

CHAPTER TWO

Factors influencing childhood influenza vaccination: a systematic review

In this chapter, I report on a review of the literature to identify non-clinical factors affecting caregivers' decision on childhood influenza vaccination. I conceived the project, developed the literature review design, methods, and conducted analysis independently. I conducted the review in close collaboration with two colleagues (native Chinese speakers) based in Fudan University and London School of Hygiene and Tropical Medicine, respectively. The findings and results have been prepared as a first draft of the manuscript, with comments on drafts from Professors Heidi Larson, Tracey Chantler, Zhiyuan Hou. This manuscript has been submitted to Vaccines for the consideration of publication.

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Surname/Family Name	Han		
Thesis Title	Caregivers' decision-making about childhood seasonal influenza vaccination in three provinces in China: A mixed-methods study		
Primary Supervisor	Professor Heidi Larson		

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SECTION E

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Date	1/9/2024

Supervisor Signature	
Date	1/9/2024

Factors influencing childhood influenza vaccination: a systematic review

Abstract: (1) Background: The coverage of influenza vaccination among children remains low in developing countries to date. This systematic review aims to identify influencing factors around childhood influenza vaccination. (2) Methods: A systematic literature review was conducted and included empirical studies with original data that investigated factors influencing childhood influenza vaccination. We searched MEDLINE, Web of Science, EMBASE, CINAHL Plus, Global health, and PsycINFO, furthermore, in order to include more local studies in China, two Chinese databases (China Knowledge Resource Integrated Database and Chongqing VIP), using a combination of the key terms 'childhood', 'influenza', 'vaccination', and related syntax for all peer-reviewed publications published before December 2019. (3) Results: Thirty studies were included in the analysis. Childhood influenza vaccination was positively associated with caregivers' knowledge of influenza vaccine, positive vaccine attitudes, self-efficacy, perceived susceptibility and severity of influenza, believing in the efficacy of influenza vaccine, the worry of getting sick, healthcare workers' recommendation and previous influenza vaccination experiences. Barriers included safety concerns and side effects of the vaccine, as well as poor access to vaccination services. (4) Conclusions: To improve childhood influenza vaccine uptake, healthcare workers' recommendation is necessary to inform caregivers and increase their understanding of vaccines. Future studies are needed to investigate influencing factors around healthcare workers' vaccine recommendation behaviour and the impact of contextual factors on vaccine acceptance.

1. Introduction

Influenza is a highly infectious respiratory illness characterized by various acute onset of symptoms including fever and cough, and can result in serious complications (e.g., pneumonia, dehydration, and encephalopathy) and even deaths [10]. It causes considerable disease burden in terms of excessive morbidity, mortality, and hospitalization yearly [143]. According to the global annual influenza-associated respiratory deaths register, 290,000–650,000 seasonal influenza-associated respiratory deaths (4.0–8.8 per 100,000 individuals) occurred annually from 1999–2015 [20].

One of the groups particularly vulnerable to influenza infection and illness is young children. [144]. To provide individual protection and reduce transmission across all age groups thereby decreasing the disease burden across the population, the World Health Organization (WHO) recommends that children aged between 6 and 59 months should be vaccinated against influenza annually [145]. Over 40% of countries list seasonal influenza vaccination on their National Immunisation Schedule, including most countries across North and South America, Europe, and some countries in African, South-East Asia, and the West Pacific Region [31-33, 146-149]. But many countries still do not include influenza vaccination in the National Immunisation Program (NIP). For example, in China, seasonal influenza vaccination must be purchased by recipients[24], and the vaccine uptake for the entire population is 1.9%, which is far from satisfactory [35].

Numerous factors contribute to the low influenza vaccination coverage. The WHO Strategic Advisory Group on Experts (SAGE) on vaccine hesitancy proposed in their model that individual/social influences, contextual influences and vaccine and vaccination-specific issues all play a role [139]. In addition to parents' perceptions around vaccines, communication and information sources, access issues, cost, or travel time, all influence vaccine decisions. Hence, these factors should be considered when investigating childhood influenza vaccination. However, previous studies only focused on the factors at the individual level, including knowledge of influenza, awareness of risk, misconceptions regarding vaccine safety and efficacy.

As a result, this systematic review aims to summarize the available evidence in order to identify influencing factors around childhood influenza vaccination. The findings can inform further studies on factors influencing childhood influenza vaccination in developing countries, like China, and finally contribute to country-level policy decisions and improve childhood influenza vaccination uptake.

2. Methods

2.1. Data Sources and Searches

This review aimed to identify determinants for childhood influenza vaccination all over the world. We systematically searched the following databases: MEDLINE, Web of Science, EMBASE, CINAHL Plus, Global health, and PsycINFO, furthermore, in order to include more local studies in China, two Chinese databases (China Knowledge Resource Integrated Database and Chongqing VIP) were also searched. The search strategy is a combination of key terms 'childhood', 'influenza', 'vaccination', and related syntax for all peer-reviewed publications published before November 2019, studies related to childhood influenza vaccination published later was pushed through those databases and included in the review for analysis after being confirmed to meet the criteria.

As a primary outcome of interest, "childhood influenza vaccination" indicated children's flu vaccination status in the latest flu season. Relevant outcomes also included caregivers' intention to vaccinate their children in the upcoming flu season.

2.2. Study Selection

The search strategy is presented in the supplemental file 1. Studies that focused only on knowledge, attitudes and beliefs with regard to childhood influenza vaccination, but do not refer to actual vaccine uptake (or intention) were excluded. For the quantitative component, data from cross-sectional and longitudinal studies, where relevant confounders were accounted for by the study design or analysis, were included. Qualitative studies where methods of data collection and analysis were explicitly reported were eligible for inclusion. Experiments that generated empirical data were included whereas non empirical studies or studies not reporting original data were excluded.

In addition, we conducted manual searches of the reference lists of included studies to identify additional relevant studies. All citations identified were imported to Endnote, and duplicates were deleted. Two reviewers (HKY and LMY) independently screened titles and abstracts to select potentially relevant citations. Articles included in the full text review stage were retrieved and independently scrutinized. Any discrepancies in the process were resolved through discussion with a third reviewer until consensus was reached (see figure 1).

2.3. Data Extraction and Quality Assessment

A standardized form based on Cochrane Review and behavioural theories including the including the 'Knowledge, Attitude, and Practices' model, the Health Belief Model and the theory of Planned Behaviour was developed specifically for this review prior to data extraction. Topics in the form include knowledge and awareness of influenza and influenza vaccines, confidence in the importance, safety, and efficacy of influenza vaccines, perceived susceptibility and severity of influenza, benefits and barriers to influenza vaccination, cue to action and social norm, self-efficacy, and emotions. Data were double extracted by two reviewers (HKY and

LMY). The information extracted included characteristics of the study, methods, target population, sample size, childhood influenza vaccination and associated factors influencing behaviours. Numerical data (numbers or percentages) that reported prevalence and non-medical factors of influenza vaccination were extracted from the quantitative component; themes relevant to factors influencing vaccination behaviours were extracted for the qualitative component. Factors that were examined as the predictors of influenza vaccination uptake among respondents are presented in the results section.

Two reviewers (HKY, LMY) independently assessed the risk of bias in all included studies using predetermined tools and reached consensus through discussion when discrepancies arose. The quantitative studies and quantitative components from mixed-methods studies that met inclusion criteria were assessed by adapted BMJ survey appraisal tools(supplemental file 2.1-2.7)[150]; qualitative studies and the qualitative components from mixed-methods studies were appraised by the Critical Appraisals Skills Program Appraisal Checklists (supplemental file 3)[151]; experiments and mixed-methods studies were appraised by Mixed Methods Appraisal Tool. Quality of studies can be scored as percentage depending on how many set criteria are met by the study being assessed. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guidelines for reporting systematic reviews in structuring the review findings.

2.4. Data Synthesis and Analysis

Researchers grouped variables into categories such as caregivers' knowledge and attitudes. Associations and statistically significant values, where reported, were compiled from studies to present the direction and range of effect of each relevant factor. Findings were narratively synthesized to identify facilitators of and barriers to childhood influenza vaccine.

3.RESULTS

3.1. Search Results and Study Characteristics

Table 1 summarizes the characteristics of the included studies. We identified 30 studies from 8 countries. More than 70% (n = 22) of the studies were conducted in China (n = 18) and USA (n = 4). Data collection in half (n=14) of the included studies was conducted between 2010 to 2014. Most studies (n=24) employed cross-sectional designs. There were 29 quantitative (including 2 experiments) and 1 qualitative study. Twelve studies covered both rural and urban settings. Sixteen focused on actual vaccine uptake, seven on caregivers' intention for childhood influenza vaccination and six on both. Non-biomedical factors influencing childhood influenza vaccination were categorized and analysed according to the factors listed in Table 2, which include knowledge and attitudes towards influenza vaccine, perceptions of influenza and influenza vaccines, cues to action, emotions, individual characteristics, and contextual factors.

Study quality ranged from 19% to 90% with an average score of 62% across all 30 studies (Table 3). The majority of studies did not seek views of consumers on the study design (25), discuss potential response biases (24), and lacked evidence of data dredging (25). In order to provide an overview of the entire literature, no studies were excluded based on their quality.

3.2. Childhood influenza vaccination and caregivers' intention for childhood influenza vaccination

Substantial variations in coverage of childhood influenza vaccination were reported across the studies. Childhood influenza vaccination coverage ranged from 6.6% (in the past flu season) in Pakistan [103] to 96.4% (2013-2014 flu season) in Ansan and Jeonju cities, South Korea [114]. Studies in Hongkong reported higher coverage: 58.9 (in the past flu season)–63.2% (2011-2012 flu season) [112, 118]. Other high-coverage areas included Colorado, USA (50.2% in the past flu season), Texas, USA (65%, 2010-2011 flu season), England (52.8%, 2015–2016 flu season) and Guangzhou city, China (47%, 2012-2013 flu season)[38, 110, 113, 152]. Most studies reported high vaccination intention among caregivers to vaccinate their children against influenza. The highest reported vaccine acceptance was in Ansan and Jeonju cities, South Korea (92.6%) [114], followed by Seoul, South Korea (83.57%) [131].

3.3. Influencing factors of childhood influenza vaccination and caregivers' intention for childhood influenza vaccination

In Supplements 4.1 and 4.2, we summarize the identified factors influencing childhood influenza vaccination and measures (e.g., denominator and numerator) that have been investigated across the studies.

3.3.1 Caregivers' knowledge

Measurements for knowledge and related constructs varied. Among included studies, the majority of the included studies employed single-item questions and summary scores [37, 103, 107, 109, 153, 154]. Caregivers having better knowledge about influenza vaccine were more likely to vaccinate their children (OR = 1.13–2.64) [37, 109, 153]. Better knowledge was also associated with stronger intention to vaccinate their children (OR = 1.74) [107].

Caregivers' awareness of influenza was reported in 4 studies, employing single-item questions for measurements [37, 103, 104, 155] . Only one study showed that caregivers' awareness that "Children should be vaccinated every year" was associated with children's influenza vaccination in the past flu season (OR = 2.34) [37].

3.3.2 Caregivers' attitudes towards influenza vaccines

Caregivers' attitudes toward influenza vaccines, including acceptance of vaccines or willingness to vaccinate children, were reported in eleven studies [103-105, 107, 108, 113, 117, 131, 155-157]. Attitudes varied across studies. In China and England, approximately 53.8% and 50.57% of surveyed caregivers deemed the influenza vaccine necessary, respectively [107, 113]; meanwhile, about 98% of Thai caregivers reported clear intention to vaccinate their children against influenza [104]. Caregivers with higher acceptance or positive attitudes of influenza vaccine were more likely to vaccinate their children (OR = 1.88–7.46)[105, 113, 118]. Patterns were similar for associations between caregivers' attitude of influenza vaccine and their intention to vaccinate their children [107, 113].

Caregivers' self-efficacy in deciding on childhood influenza vaccination was reported in 6 studies, which all employed pre-existing scales for measurement [38, 106, 109, 112, 117, 118]. Multiple studies revealed most caregivers had high level of self-efficacy in taking their children for influenza vaccination. The percentage of parents who said they were able to vaccinate children if they desire to do so no matter how difficult ranged from 79% to 96.3%. High level of self-efficacy was positively associated with caregivers' likelihood to vaccinate their children (OR =2.96)[38], or intention to vaccinate (OR = 1.25) [106].

3.3.2 Caregivers' perceptions of vaccines and emotion

Research frequently explored caregivers' perceptions of the influenza vaccine, which mainly covers four constructs: susceptibility, severity, barriers and benefits. Six studies employed single-item questions to investigate the above part of constructs, such as perceived benefits and barriers [37, 103, 108, 110, 155, 158], and 11 studies employed self-made or pre-existing scales by summary scores of corresponding answers or self-reported scales [36, 38, 106, 107, 109, 112, 113, 115, 118, 131, 156].

Among included studies, the proportion of parents who perceived high susceptibility to influenza varied between 10.4% and 83% [108, 113]. Meanwhile, 12%–82.9% of caregivers believe that influenza was a serious disease [115, 156]. Caregivers perceiving more susceptibility and severity to influenza were more likely to vaccinate their children. Increased likelihood of childhood influenza vaccination was observed amongst caregivers who perceived high infection risk (OR = 4.46) and high disease burden (OR = 1.66) [113]. Caregivers' opinion on the susceptibility (OR =1.44–3.2) and severity (B=1.4) of the disease influenza vaccine prevents also influenced their intention to vaccinate children against influenza [107, 109, 113]. Likewise, believing in vaccine efficacy was often positively associated with caregivers' likelihood to vaccinate their children (OR =1.5–4.56) [37, 112, 113, 118], or intention to vaccinate (OR = 1.22–8.85) [36, 106, 107, 109, 113, 118].

Caregivers' perception of the barriers to vaccination also influenced their decision on childhood influenza vaccination. One reason for not vaccinating was concern about vaccine safety and side effects, as reported by 19.5%–61.1% and 19.9%–89.8% of caregivers, respectively [37, 38, 103, 108-110, 112, 113, 115, 118, 156]. Caregivers expressing more concern about safety (OR = 0.16–0.59) or side effects (OR = 0.17–0.26) were less likely to vaccinate their children [37, 109, 110, 113]. Negative association also existed between caregivers' concern about safety (OR = 0.74, B=-1.78, β=0.35) or side effects (B = -2.02–-0.53) [107, 113, 117]. In addition, the poor access to vaccination services, including the cost of the vaccine (OR = 0.84) unmotivated childhood influenza vaccination [105].

Five studies examined the impact of caregivers' emotions on childhood influenza vaccination decisions [38, 109, 112, 113, 117]. The worry and fear of getting sick supported vaccination decision (OR = 2.31) [38].

3.3.3 Cues to action and social norming

Cues to action and social norming both contain factors related to perceived social pressure from groups or individuals such as family members, friends, and healthcare workers to perform or not perform the behaviour. In addition, individual's health status or the presence of related symptoms were also factors which could mediate an individuals' perception or even decision-making on influenza vaccination. Among included studies, research frequently explored communication about vaccines between caregivers and healthcare workers, family members, , caregivers' perception of others' vaccination behaviour (regarding behaviour done by others as sensible), and self-rated health status of themselves or children. Studies in Singapore, USA, England, and Thailand all indicated that having had a healthcare worker recommend vaccination (OR = 2.8–8.2, PR=1.47–2.47) [104, 108, 110, 113] can increase childhood influenza vaccination. Increased intention to get children vaccinated was also observed amongst caregivers whose health care professionals had recommended vaccination (OR = 1.11) or social influence of family or others (OR = 11.23–21.66) [113, 118].

3.3.4 Caregivers characteristics

Caregivers' decisions regarding childhood influenza vaccination were sometimes influenced by the caregivers' or children's characteristics. Family members' influenza vaccination history was a frequently studied variable.

Caregivers (OR =5.81–9.1) [109, 110, 112], or children's (OR =3.2–15.54) [104, 113] previous influenza vaccination experiences of was associated with greater childhood influenza vaccination or vaccination intention (OR =1.79–4.99) in the current flu season [38, 106, 107, 113, 115, 158]. In addition, caregivers working in enterprises (OR =1.86–3.15) [37, 153], or

hospitals (OR = 2.36) [37], , having a male child (OR =1.45–1.58)[37, 105, 154], and a higher education degree (OR = 3.9) [153]were more likely to vaccinate their children against influenza.

There was less consensus on the effects of other caregivers' demographics on childhood influenza vaccination, including location(rural/urban), household registration status, and income. One study indicated positive vaccine behaviour among caregivers living urban area (OR = 4.89)[159], while another study found caregivers in rural area were more likely to vaccinate their children (OR = 1.82) [154].

3.3.5 Contextual factors

Only one study conducted in Jiangsu province, China, investigated the impact of contextual factors, including vaccination service delivery and the number of vaccinators per capita in the local population on childhood influenza vaccination. The study showed higher frequency of vaccination services (OR = 1.08) and greater number of vaccinators (OR = 1.2) had positive associations with local childhood influenza vaccination, while negative association existed between the availability of vaccination services on weekends and childhood influenza vaccination (OR = 0.88)[159].

4. Discussion

This systematic review summarizes the literature on factors influencing childhood influenza vaccination among a variety of populations from a diverse set of geographical and cultural contexts. The findings reveal a wide range of childhood influenza vaccination coverage (6.6% in Pakistan–96.4% in Ansan & Jeonju cities, South Korea) and caregivers' intention (48% in Seattle, USA– 85.1% in Xiameng city, China) to vaccinate their children. The results indicate that better knowledge of influenza vaccine, positive vaccine attitudes, high level of self-efficacy, perceived high susceptibility and severity of influenza, confidence in the efficacy of influenza vaccination, fear of getting sick, healthcare worker's recommendation and previous influenza vaccination experiences are factors identified as contributing to increased uptake of childhood influenza vaccination. In addition, the main barriers that contributed to caregivers' vaccine hesitancy in the reviewed studies were the fear of the safety and side effects of the vaccine, as well as poor access to vaccination service.

In general, childhood influenza vaccine coverage rates in high-income countries and regions are higher than Low and Low Middle-Income Countries [108, 110, 112-114, 117, 118, 152, 156]. The high vaccination rate may reflect a better vaccination infrastructure and free flu vaccinations in some places. But it is worth noting that even with free flu vaccines being available, vaccination rates in high-income countries and regions are still far from ideal [160]. According to the Vaccine Hesitancy Determinants Matrix, factors that influence vaccination uptake are complex [139]; furthermore, results from a single study depend on the time when the

survey was conducted, the surveyed population, and the geographical region/city that was surveyed. All of these factors add to the difficulty of comparing flu vaccination uptake across regions. Further investigation is required to determine the relative importance of these factors.

Our findings are well aligned with theoretical models of health behaviour, including the Knowledge, Attitude, and Practices (KAP) model, which posits that relevant knowledge and positive attitudes could lead to positive behaviour change[98]. We suggest that health education, and providing adequate, clear, and accessible information to caregivers about influenza infection and vaccine could increase caregiver understanding of vaccines. Despite the high volume of studies, tools used to investigate knowledge levels questionnaires varied. Use of standardized tools for collecting information about respondents' knowledge on influenza viruses and vaccines, like the similar one available for other vaccines [161], could facilitate more consistent data collection and enable researchers to more accurately compare the knowledge level and perceptions among people in different countries and regions across groups.

We found that respondents' perception of their susceptibility to influenza, the severity of influenza, and the benefit derived from effective vaccines was associated with childhood influenza vaccination and vaccination intention. This finding is consistent with previous studies [162]. Additionally, our systematic review identified concerns about vaccine safety and side effects as the main barriers determining caregivers' willingness to vaccinate. Health communication techniques using a variety of media platforms are needed to leverage the positive themes that emerged as encouraging high vaccine uptake, including the rigorous safety process in vaccine development and approval by the drug administration authority entities.

Our results showed a strong consensus on the impact of healthcare workers' (HCWs) recommendation on patient uptake. The importance of healthcare workers as trusted sources of information aligns with previous study [8, 163]. Studies have shown wide variations in vaccine recommendation behaviour among HCWs among countries and region, with low level of recommendation practice in China [164, 165], and high level of that in US and European countries [166-169]. Factors at different levels, including knowledge and confidence in vaccines [168, 169], HCWs' workload, communication skills, financial incentives for recommending vaccines and whether vaccines are free or not, all influence the recommendation behaviour of HCWs [170]. Further research into the factors that influence HCWs' vaccination recommendation practice are needed to optimize the communication between HCWs and the public.

Among caregivers' characteristics, our study has shown that influenza vaccination history is a strong predictor of vaccine acceptance, which is consistent with previous studies [171-173]. As for contextual factors, we found few studies investigating this factor. As the vaccine hesitancy matrix shows, vaccination behaviour is viewed as being affected by multiple levels of

familial, social and cultural influences [140]. The procurement and supply of vaccines, the promotion of vaccines by the health sector and HCWs all could influence individual vaccine decisions. Further research into childhood vaccination behaviour needs to take these factors into account.

The strength of this study is its analysis of research across a range of countries and regions. Our study has several limitations. First, although this study included 12 countries and regions, it may not be representative of global childhood influenza vaccination. There is limited data from low-income countries, which is a barrier to generalizing our findings. Second, most studies utilized self-reported questionnaires as their main data collection method. Inherently, this approach is most suitable at the given time as such studies are measuring the subjective perception of individuals. However, it is important to note that self-reported surveys have a number of limitations including social desirability bias and recall bias [174, 175]. Moreover, caregivers' perception or attitudes to vaccination are influenced by complex factors, including vaccination price and vaccine safety incidents. Finally, the different measures and outcome variables and inconsistent reporting limited the ability to conduct direct statistical comparisons or draw generalizable conclusions on every predictor. In addition, the amount of research which proceeds to publication is limited; studies reporting significant findings are more likely to be published and could potentially introduce bias to our review inclusion.

5.Conclusion

By expanding our knowledge about specific vaccine perception–behaviour associations and factors hindering or contributing to childhood influenza vaccination, this paper may guide the future studies in China and other countries with the similar contexts and guide the interventions development to increase childhood influenza vaccination. The majority of included studies adopt quantitative methods. Only 1 study utilized qualitative methods. Therefore, more qualitative studies are needed to provide insights into the formation of caregivers' attitudes and perception, allowing deeper understanding beyond predetermined quantitative tools. Our study presents the positive association between childhood influenza vaccination and caregivers' knowledge on influenza vaccine, positive vaccine attitudes, perceived high susceptibility and severity of influenza, higher confidence on influenza vaccine. Hence health education is necessary to inform caregivers and increase their understanding of vaccines. Our study indicates recommendations from HCWs may increase childhood influenza vaccination. To better motivate HCWs to recommend influenza vaccines and improve the communication between HCWs and the public around vaccination, further research should investigate influencing factors of HCWs' recommendation behaviour in different countries or regions. In addition, studies on contextual factors, including the procurement and supply of

vaccines, the promotion of vaccines by the health sector are needed to render lessons on how contextual factors drives the public vaccination behaviour.

Table 1. Summary of characteristics of included studies that investigated factors influencing childhood influenza vaccination.

Characteristic	Number of studies	Studies
Total	30	
Language		
Chinese	8	[105, 153-155, 158, 159, 176, 177]
English	22	[36-38, 103, 106-110, 113, 131, 138, 156, 178]
Year of data collection		
2010-2014	14	[38, 106, 109, 110, 112, 114, 117, 118, 131, 156, 157, 178]
2015-later	15	[36, 37, 104, 105, 107, 108, 113, 152-154, 159, 178-180]
NR	1	[103]
Study design		
Quantitative study		
Longitudinal	3	[117, 118, 152]
Cross-sectional	24	[36-38, 103, 106-110, 112, 156, 178]
Experiment	2	[131, 180]
Qualitative study	1	[179]
Study region		
Asia		
China		
Mainland China	12	[36-38, 105, 107, 153-155, 158, 159, 176, 177]
Hongkong	5	[109, 112, 115, 117, 118]
Taiwan	2	[106, 107]
South-Korea	2	[114, 131]
Singapore	1	[108]
Pakistan	1	[103]
Thailand	1	[104]
Europe		
England	1	[113]
North America		
USA	4	[110, 152, 156, 157]
Oceania		
Australia	2	[179, 180]

Urbanicity			
Urban		12	[105, 108, 109, 112, 114, 115, 118, 157, 176, 177, 179, 180]
Rural	0		
Both		12	[36, 37, 104, 106, 107, 113, 117, 152-155, 159]
Unknown		6	[38, 103, 110, 131, 156, 158]
Outcome variable			
Vaccination behaviour		17	[103-105, 108-110, 112, 152-156, 159, 176, 177, 179, 180]
Vaccination intention		7	[36, 106, 107, 115, 131, 157, 158]
Both		6	[37, 38, 113, 114, 117, 118]

Table 2. Factors influencing childhood influenza vaccination.

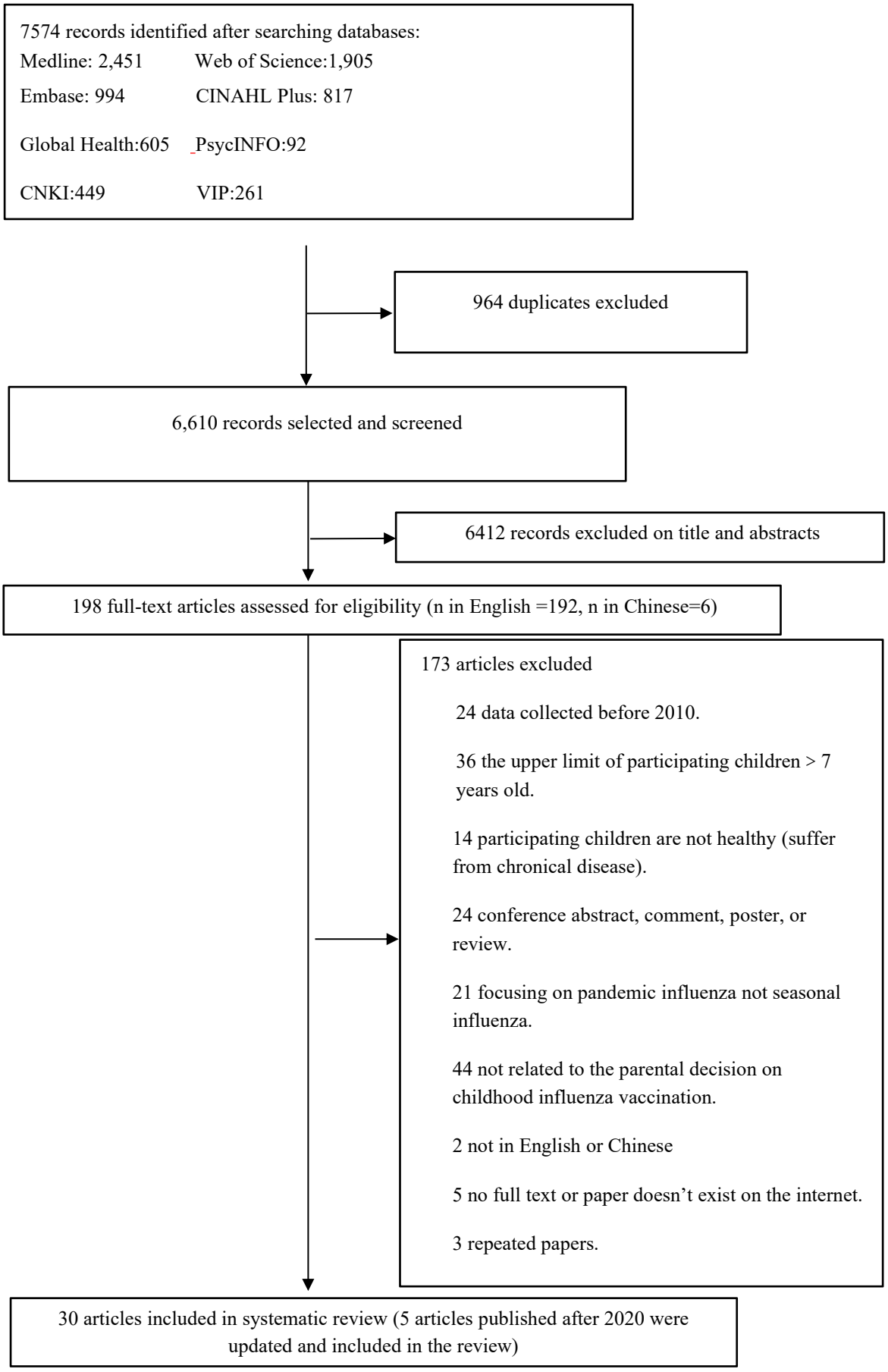
Non-biomedical factors	Application/examples
Knowledge	
Knowledge	The participant's knowledge about the specific infection
Awareness	The participant's awareness of influenza as a health threat on individual or on the society as a whole
Attitudes towards influenza vaccine	
Attitudes towards influenza vaccination behaviours	The participant's attitudes towards childhood influenza vaccination
Self-efficacy	The participant's perception of his/her or others' competence in engaging in vaccinating their children against influenza
Perceptions of influenza and influenza vaccines	
Perceived susceptibility	Self-rated health status
Perceived severity	The participant's assessment/perception of the severity of the situation regarding the infection (e.g. self-diagnosed symptoms experienced)
Perceived benefits	The participant's assessment/perception of the benefit of receiving influenza vaccination (e.g., considering influenza vaccination to boost immunity) (misconceptions)
Perceived barriers	The participant's assessment/perception of barriers to engaging in influenza vaccination (e.g., health insurance and knowledge of current policy)
Norm	Participants' view of how others treat illnesses
Cue to action	
Symptoms	Presence of fever
Information sources	The flow of information exchange between healthcare workers, the public and the media, etc.
Emotion	Moods and positive or negative reactions towards vaccination or non-vaccination, including worry, anxieties, and so on
Individual characteristics	
Age	The age of the participant
Gender	The gender of the participant
Education	The education level of the participant
Income	The household income or monthly allowance of the participant

Vaccination history	Influenza vaccination behaviour of family members during past influenza seasons
Contextual factors	
Location	The rural/urban of residence of the participant
Region	Region of residence of the participant —geographic area or economic development stage
Policy	Health policy or vaccination program that might affect access to influenza vaccine and financial incentives for recommending influenza vaccine of vaccinators
Access	The degree of fit between the user and the vaccination service, including accessibility, availability, acceptability, affordability, and adequacy.

Table 3. Study quality appraisal

Title	Quality appraisal
Xu, L., 2017	65%
Chen, C.H., 2015	74%
Han, Y., 2019	81%
Zeng, Y., 2019	61%
Low, M.S.F., 2017	68%
Lau, J.T.F., 2018	74%
Offutt-Powell, T.N., 2014	74%
Strelitz, B., 2015	71%
Bukhsh, A., 2018	55%
He, L., 2015	74%
Wu, A.M., 2015	71%
Smith, L.E., 2017	71%
Liao, Q., 2016	74%
Hwang, J.H., 2017	65%
Hofstetter, A.M., 2017	55%
Wu, A.M.S., 2020	77%
Lau, J.T.F., 2021	68%
Ye, L., 2019	23%
Li, G., 2020	45%
Yang, W., 2018	52%
Mei, M., 2017	48%
Gao, H., 2014	29%
Chen, X., 2011	19%
Thanee, C., 2021	74%
Wu Y., 2020	45%
Weiwei, L., 2021	32%
Borg, K.,2018	85%
Choi, A.,2017	54%
Rao, S.,2019	86%
Biezen, R., 2018	90%

Figure 1 Flowchart of study identification and selection.



Supplement 1. Search Criteria (using Medline as an example)

Key Terms	Searches
influenza	"Influenza.mp" [Keyword] or "exp Influenza Human/" [Mesh]
vaccination	"exp Influenza Vaccines/" [Mesh] or "vaccine.mp." [Keyword] or "exp Vaccination/" [Mesh] or "vaccination.mp" [Keyword] or "exp Immunisation/" [Mesh] or "immunisation.mp."[Keyword]
decision making	"exp Attitude/" or "attitude.mp." or "view.mp." or "idea.mp." or "opinion.mp. or exp Attitude/" or "exp Decision Making/ or decision.mp." or "exp Choice Behavior/ or choice.mp." or "confidence.mp." or "trust.mp." or "exp Trust/" or "acceptance.mp." or "exp Health Knowledge OR Attitudes OR Practice/ or exp Vaccines/ or hesitancy.mp." or "exp Awareness/ or awareness.mp." or "belief.mp." or "exp Intention/ or intention.mp." or "perception.mp. or exp Perception/" or "barrier.mp." or "facilitator.mp." or "willingness.mp." or "fear.mp. or exp Fear/" or "suspicious.mp." or "exp Vaccination Refusal or refusal.mp." or "delay.mp." or "opposition.mp." or "boycott.mp."
childhood	"caregiver.mp. or exp caregiver/" or "parent.mp. or exp parent/" or "exp parental attitude/ or parental.mp. or exp parental behavior/" or "children.mp. or exp child/"

Supplement 2.1. Appraisal – quantitative (Cross sectional study: Research question and study design)

	Research question and study design			
Title	What information did the researchers seek to obtain?	Appropriateness of questionnaire	Any better existing measures and justification for newly developed measure	Seeking views of consumers on the study design
Xu, L., 2017	To evaluate the level of seasonal influenza vaccination coverage in 2014-15 and 2015-16 seasons among kindergarten children in Xining City, and to explore potential factors	Yes	No	No
Chen, C.H., 2015	To identify health belief constructs that were predictive of the intention to have children vaccinated against influenza.	Yes	Yes	No
Han, Y., 2019	Investigate the determinants of parents' intentions to vaccinate their kindergarten children against seasonal influenza if the free policy were implemented	Yes	Yes	No
Zeng, Y., 2019	Investigate parents' perceptions on influenza vaccina; and to explore potential factors promoting parents to vaccinate their children	Yes	Yes	No
Low, M.S.F., 2017	To estimate influenza vaccine coverage among children aged 6 months to 5 years in Singapore and investigate factors associated with child influenza vaccination.	Yes	Yes	No
Lau, J.T.F., 2018	To investigate prevalence and associated factors of IV among Chinese children aged 12–23 months in Hong Kong	Yes	Yes	No
Offutt-Powell,	To estimate the proportion of children in licensed daycares who were vaccinated against influenza during the 2010–2011	Yes	Yes	No

T.N., 2014	influenza season, and explore the relationship between parental risk perception and influenza vaccination in this population			
Strelitz, B., 2015	To assess the feasibility of administering the PACV modified for influenza vaccination in a PED setting and to determine whether parental PACV scores were associated with receipt of seasonal influenza vaccine.	Yes	Yes	No
Bukhsh, A., 2018	To evaluate the awareness and attitude of general public regarding influenza vaccination in Pakistan	Yes	Yes	No
He, L., 2015	To identify which factors are important for parents' decision on vaccinating their children against seasonal influenza	Yes	Yes	No
Wu, A.M., 2015	To investigate prevalence and associated factors of IV status among Chinese children aged 24–59 months in Hong Kong	Yes	Yes	No
Smith, L.E., 2017	To test whether attitudes towards influenza and the vaccine, together with parental perception of side-effects, were associated with intention to have their child vaccinated in the 2016–2017 season.	Yes	Yes	No
Liao, Q., 2016	To assess influenza vaccination uptake among target children of the Hong Kong 2012/2013 CIVSS and examine psychosocial factors associated with parents' decisions regarding their children's vaccination	Yes	Yes	No
Hwang, J.H., 2017	To characterize parental perception and patterns of action in response to influenza and influenza-like illnesses (ILIs), including vaccination and healthcare use	Yes	Yes	No
Hofstetter,	To examine how clinicians communicate with parents about influenza vaccination and the effect of these communication	Yes	Yes	No

A.M., 2017	behaviour on parental vaccine decision-making			
Wu, A.M.S., 2020	This study aimed to tested three hypotheses based on TPB, that: (1) baseline parental behavioural intention of the child's IV in the next 12 months would predict their actual IV within the 12-month follow-up period; (2) baseline parental attitude, perceived norm, and perceived behavioural control would be associated with baseline parental intention for child's IV, and predict child's actual IV within the follow-up period; (3) the prospective relationships between the three TPB constructs (i.e., baseline parental attitude, perceived norm, and perceived behavioural control) and the child's IV within the follow-up period would be mediated by baseline parental intention.	Yes	Yes	No
Lau, J.T.F., 2021	To investigate the associated factors of parental intention regarding their child's IV (next 12 months) among parents of ever-vaccinated and never-vaccinated children aged 24 to 59 months in Hong Kong	Yes	Yes	No
Ye, L., 2019	This study aimed to investigate the influencing factors of influenza vaccination in children 6-36 months of age	NA	NA	NA
Li, G., 2020	To analyze the influencing factors of influenza vaccination in children under 5 years of age	Yes	Yes	No
Yang, W., 2018	To understand parents' cognition of influenza vaccine, vaccination willingness and influencing factors	Yes	No	No
Mei, M., 2017	To analyze influencing factors of influenza vaccination among children in childcare institutions in Binhai County	Yes	No	No
Gao, H., 2014	To analyze influencing factors of influenza vaccination among	Yes	No	No

	children aged from 6-50 months			
Chen, X., 2011	To investigate Influenza vaccination status and influencing factors of preschool children in Yuzhong District, Chongqing	Yes	No	No
Thanee, C., 2021	To understand the determinants of influenza vaccination in their children	Yes	Yes	No
Wu Y., 2020	To understand preschool children's parents' awareness of influenza and their willingness to get influenza vaccine	Yes	No	No
Weiwei, L., 2021	To analyze the influenza vaccination of preschool children in Nanshan district of Shenzhen city	Yes	No	No

Supplement 2.2. Appraisal – quantitative (Cross sectional study: Validity and reliability, and Format)

	Validity and reliability		Format				
Title	Claims for validity of instrument	Claims for reliability of instrument	Appropriateness of the title of the questionnaire	Appropriateness of the questionnaire format	Non-threatening questions at the beginning of the measure and sensitive ones near the end?	Briefness of the questionnaire	Participants friendliness
Xu, L., 2017	No	No	Yes	Yes	Yes	Yes	Yes
Chen, C.H., 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Han, Y., 2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zeng, Y., 2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Low, M.S.F., 2017	No	No	Yes	Yes	Yes	Yes	Yes
Lau, J.T.F., 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Offutt-Powell, T.N., 2014	Yes	No	Yes	Yes	Yes	Yes	Yes

Strelitz, B., 2015	Yes	No	Yes	Yes	Yes	Yes	Yes
Bukhsh, A., 2018	Yes	No	Yes	Yes	Yes	Yes	Yes
He, L., 2015	Yes	No	Yes	Yes	Yes	Yes	Yes
Wu, A.M., 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Smith, L.E., 2017	Yes	No	Yes	Yes	Yes	Yes	Yes
Liao, Q., 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hwang, J.H., 2017	No	No	Yes	Yes	Yes	Yes	Yes
Hofstetter, A.M., 2017	Yes	No	Yes	Yes	Yes	Yes	Yes
Wu, A.M.S., 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lau, J.T.F., 2021	Yes	No	Yes	Yes	Yes	Yes	Yes
Ye, L., 2019	NA	NA	NA	NA	NA	NA	NA

Li, G., 2020	No	No	Yes	NA	Yes	Yes	Yes
Yang, W., 2018	No	No	Yes	Yes	Yes	Yes	Yes
Mei, M., 2017	Yes	No	Yes	NR	NR	Yes	Yes
Gao, H., 2014	No	Yes	NR	NR	NR	NR	Yes
Chen, X., 2011	No	No	NR	NR	NR	NR	Yes
Thanee, C., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wu Y., 2020	No	No	Yes	Yes	Yes	NR	Yes
Weiwei, L., 2021	No	No	Yes	Yes	Yes	NR	Yes

Supplement 2.3. Appraisal – quantitative (Cross sectional study: Instructions, Piloting, and Sampling)

	Instructions			Piloting			Sampling	
Title	Adequate instructions in questionnaire for completion	Instructions for how to return the questionnaire	Explanation of the research in questionnaire	Was the questionnaire adequately piloted in terms of the method and means of administration, on people who were representative of the study population?	Piloting exercise	Change for instrument after piloting	Representativeness of the sampling frame	Instrument suitable for all participants
Xu, L., 2017	Yes	Yes	Yes	No	NO	NO	Yes	Yes
Chen, C.H., 2015	Yes	NR	Yes	Yes	Questionnaire pretests were performed by 32 recruited respondents with appropriate qualifications from a community health centre in Taipei City during May 24–26, 2011	NR	Yes	Yes
Han, Y.,	Yes	Yes	Yes	No	NA	NA	Yes	Yes

2019								
Zeng, Y., 2019	Yes	NR	Yes	No	NA	NA	Yes	Yes
Low, M.S.F., 2017	Yes	Yes	Yes	No	NA	NA	Yes	Yes
Lau, J.T.F., 2018	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Offutt-Powell, T.N., 2014	Yes	Yes	Yes	No	NA	NA	Yes	Yes
Strelitz, B., 2015	Yes	Yes	Yes	No	NA	NA	Yes	Yes
Bukhsh, A., 2018	Yes	No	Yes	No	NA	NA	No	Yes
He, L., 2015	Yes	Yes	Yes	Yes	A pilot study was conducted in April 2013 to test the length,	Yes	No	Yes

					comprehensibility, content and face acceptability of the questionnaire			
Wu, A.M., 2015	Yes	Yes	Yes	No	NA	NA	Yes	Yes
Smith, L.E., 2017	Yes	Yes	Yes	No	NA	NA	Yes	Yes
Liao, Q., 2016	Yes	NA	Yes	Yes	NR	NR	Yes	Yes
Hwang, J.H., 2017	Yes	Yes	Yes	No	NA	NA	No	Yes
Hofstetter, A.M., 2017	Yes	Yes	NR	No	NA	NA	No	Yes
Wu, A.M.S, 2020	Yes	Yes	Yes	Yes	Yes	NR	Telephone numbers randomly selected from up-to-date local directories	Yes

Lau, J.T.F., 2021	Yes	Yes	Yes	No	NA	NA	Telephone numbers randomly selected from up-to-date local directories	Yes
Ye, L., 2019	NA	NA	NA	NA	NA	NA	NA	NA
Li, G., 2020	Yes	NR	Yes	NO	NA	NA	NO	Yes
Yang, W., 2018	Yes	Yes	Yes	NO	NA	NA	Yes	Yes
Mei, M., 2017	NR	Yes	NR	NO	NA	NA	Yes	Yes
Gao, H., 2014	NR	Yes	NR	NO	NA	NA	No	No
Chen, X., 2011	NR	Yes	NR	NO	NA	NA	No	Yes
Thane, C., 2021	Yes	NR	Yes	Yes	No	NR	Yes	Yes
Wu Y.,	NR	Yes	NR	NO	NA	NA	No	Yes

2020								
Weiwei, L., 2021	NR	NR	NR	NO	NA	NA	No	Yes

Supplement 2.4. Appraisal – quantitative (Cross sectional study: Distribution, administration and response, and Coding and analysis)

	Distribution, administration and response				Coding and analysis		
Title	How was the questionnaire distributed?	How was the questionnaire administered?	Reporting response rates	Discussing potential response biases	Appropriateness of analysis	Measures to maintain the accuracy of the data	Evidence of data dredging
Xu, L., 2017	Researchers recruited parent for each child through teachers, and used a self-administered questionnaire for investigation in the study kindergartens	Researchers recruited parent for each child through teachers, and used a self-administered questionnaire for investigation in the study kindergartens	No	No	Multivariate logistic regression/Yes	Children's immunisation records and checking self-reported vaccination time/Yes	No
Chen, C.H., 2015	Questionnaire was delivered to subjects	NR	Yes	No	Multivariate logistic regression	NR	No
Han, Y., 2019	Questionnaires were delivered to the parents by school physicians.	Researchers deleted all identifying information and kept the questionnaires as restricted data.	Yes	No	Skewed logistic model (Scobit)	Yes	Yes
Zeng, Y., 2019	NR	NR	No	No	Multiple logistic regressions	No	No
Low, M.S.F., 2017	Disseminate	The anonymous, online	Yes	No	Poisson model with	No	No

	information about the study to parents and a link to an online survey	survey questionnaire was developed using Qualtrics software (Qualtrics Labs, Inc.)			robust standard errors		
Lau, J.T.F., 2018	The nurses of the MCHC performed eligibility screening and referred prospective participants to approach interviewers	Anonymous face-to-face interviews of about 15 minutes were administered in a private room	No	No	Multivariate logistic regression analyses	No	No
Offutt-Powell, T.N., 2014	Daycare personnel from participating centres distributed the survey to a parent or primary caregiver who met the eligibility criteria.	Daycare personnel from participating centres distributed the survey to a parent or primary caregiver who met the eligibility criteria	Yes	Yes	Conditional logistic regression	No	No
Strelitz, B., 2015	Researchers administered the PACV survey to the parent in the child's PED exam room.	After obtaining verbal consent from the child's parent, researchers administered the PACV survey to the parent in the child's	Yes	No	Multivariable logistic regression models	No	No

		PED exam room.					
Bukhsh, A., 2018	NR	NR	No	No	Relative importance index (RII)	No	No
He, L., 2015	Each eligible subject was invited to complete a face to- face interview based on a standardized questionnaire.	Each eligible subject was invited to complete a face to-face interview based on a standardized questionnaire.	No	No	Hierarchical logistic regression models	No	No
Wu, A.M., 2015	Telephone survey	Random telephone numbers were selected from up-to-date local telephone directories. selected parent was invited to participate in the study	No	No	Multiple logistic regression	No	No
Smith, L.E., 2017	The market research company Ipsos MORI recruited participants from an existing panel of people willing to take part in internet surveys	The market research company Ipsos MORI recruited participants from an existing panel of people willing to take part in internet surveys	Yes	No	Multivariate logistic regressions	No	No

Liao, Q., 2016	Telephone survey	One eligible subject (mother or father) within a household was invited to complete a telephone interview lasting around 15 min.	Yes	No	Structural equation modeling	No	No
Hwang, J.H., 2017	A trained interviewer conducted the survey	A trained interviewer conducted the survey	Yes	No	$\chi 2$ test	No	No
Hofstetter, A.M., 2017	NR	NR	No	No	Generalized linear mixed models	No	No
Wu, A.M.S., 2020	Telephone survey	NR	Yes	No	Multiple logistic regression	No	No
Lau, J.T.F., 2021	Telephone survey	NR	Yes	No	Multiple logistic regression	No	No
Ye, L., 2019	Through the immunisation prevention management information system of Ningbo city	Through the immunisation prevention management information system of Ningbo city	NA	NA	Multiple logistic regression	NA	No
Li, G., 2020	NR	NR	No	No	Multiple logistic regression	No	No
Yang, W., 2018	NR	NR	No	No	Multiple logistic	No	No

					regression		
Mei, M., 2017	NR	NR	Yes	No	Multiple logistic regression	No	No
Gao, H., 2014	Research team members interviewed the parents of children	Research team members interviewed the parents of children	Yes	No	x2 test	No	No
Chen, X., 2011	NR	NR	No	No	Multiple logistic analysis	No	No
Thanee, C., 2021	NR	NR	Yes	No	Multiple logistic regression	Medical record	No
Wu Y., 2020	Parents of preschool children in POV were invited to fill the questionnaires	Parents of preschool children in POV were invited to fill the questionnaires	NA	No	Multiple logistic regression	No	No
Weiwei, L., 2021	Family members of children in the Maternal and Child Health Hospital of Nanshan District and two kindergartens were invited to fill the questionnaires	Family members of children in the Maternal and Child Health Hospital of Nanshan District and two kindergartens completed the questionnaires	NA	No	T test	No	No

Supplement 2.5. Appraisal – quantitative (Cross sectional study: Results, and Conclusions and discussion)

	Results			Conclusions and discussion	
Title	Reporting all relevant data	Reporting non-significant results	Adequately interpret qualitative results	Appropriate link between the data and conclusions	Placing the findings within the wider body of knowledge in the field
Xu, L., 2017	Yes	Yes	NA	Yes	Yes
Chen, C.H., 2015	Yes	Yes	NA	Yes	Yes
Han, Y., 2019	Yes	Yes	NA	Yes	Yes
Zeng, Y., 2019	Yes	Yes	NA	Yes	Yes
Low, M.S.F., 2017	Yes	Yes	NA	Yes	Yes
Lau, J.T.F., 2018	Yes	Yes	NA	Yes	Yes
Offutt-Powell, T.N., 2014	Yes	Yes	NA	Yes	Yes
Strelitz, B., 2015	Yes	Yes	NA	Yes	Yes
Bukhsh, A., 2018	Yes	Yes	NA	Yes	Yes
He, L., 2015	Yes	Yes	NA	Yes	Yes
Wu, A.M., 2015	Yes	Yes	NA	Yes	Yes
Smith, L.E., 2017	Yes	Yes	NA	Yes	Yes
Liao, Q., 2016	Yes	Yes	NA	Yes	Yes

Hwang, J.H., 2017	Yes	Yes	NA	Yes	Yes
Hofstetter, A.M., 2017	Yes	Yes	NA	Yes	Yes
Wu, A.M.S., 2020	Yes	Yes	NA	Yes	Yes
Lau, J.T.F., 2021	Yes	Yes	NA	Yes	Yes
Ye, L., 2019	No	Yes	NA	Yes	Yes
Li, G., 2020	No	Yes	NA	Yes	Yes
Yang, W., 2018	No	Yes	NA	Yes	Yes
Mei, M., 2017	Yes	Yes	NA	Yes	Yes
Gao, H., 2014	No	No	NA	No	No
Chen, X., 2011	No	No	NA	No	No
Thanee, C., 2021	Yes	Yes	Yes	Yes	Yes
Wu Y., 2020	No	Yes	NA	Yes	Yes
Weiwei, L., 2021	No	No	NA	No	No

Supplement 2.6. Appraisal – quantitative (Experimental study)

Questions	Borg, K.,2018	Choi, A.,2017
Did the study address a clearly focused research question?	Yes	Yes
Was the assignment of participants to interventions randomized?	Yes	NA
Were all participants who entered the study accounted for at its conclusion?	Yes	Yes
Were the participants 'blind' to intervention they were given?	Yes	NA
Were the investigators 'blind' to the intervention they were giving to participants?	Can't tell	Can't tell
Were the people assessing/analyzing outcome/s 'blinded'?	Can't tell	Can't tell
Were the study groups similar at the start of the randomized controlled trial?	Yes	NA
Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?	Yes	NA
Were the effects of intervention reported comprehensively?	Yes	Yes
Was the precision of the estimate of the intervention or treatment effect reported?	Yes	Yes
Do the benefits of the experimental intervention outweigh the harms and costs?	Yes	Yes
Can the results be applied to your local population/in your context?	Yes	Yes
Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?	Yes	Yes

Supplement 2.7. Appraisal – quantitative (Cohort study)

Questions	Rao, S.,2019
Did the study address a clearly focused issue?	Yes
Was the cohort recruited in an acceptable way?	Yes
Was the exposure accurately measured to minimize bias?	Yes
Was the outcome accurately measured to minimize bias?	Yes
Have the authors identified all important confounding factors?	Yes
Have they taken account of the confounding factors in the design and/or analysis?	Yes
Was the follow up of subjects complete enough?	Yes
Was the follow up of subjects long enough?	Yes
What are the results of this study?	Among 126,763 births meeting criteria for inclusion, 50.2% were vaccinated against influenza by two years of age. Children admitted to the NICU receiving oxygen with 72 h of birth were 20% less likely to be vaccinated (RR = 0.8, 95% CI: 0.67–0.96) after adjusting for maternal age, race/ethnicity, education and preterm birth. Conversely, premature births were associated with an increase in influenza vaccination by age two years (RR = 1.1, 95%CI: 1.05,1.15)
How precise are the results?	The results are precise because all the data are from Colorado Birth Registry data and state immunisation data
Do you believe the results?	Yes
Can the results be applied to the local population?	Can't Tell
13. Do the results of this study fit with other available evidence?	Can't Tell
What are the implications	Additional studies are warranted to assess factors associated with early

of this study for practice?	influenza vaccination in children, to help target immunisation strategies of this vulnerable pediatric population.

Supplement 3. Appraisal – qualitative

Questions	Biezen, R., 2018
Was there a clear statement of the aims of the research?	Yes
Is a qualitative methodology appropriate?	Yes
Was the research design appropriate to address the aims of the research?	Yes
Was the recruitment strategy appropriate to the aims of the research?	Yes
Was the data collected in a way that addressed the research issue?	Yes
Has the relationship between Researcher and Participants Been Adequately considered?	NA
Have ethical issues been taken into consideration?	Yes
Was the data analysis sufficiently rigorous?	Yes
Is there a clear statement of findings?	Yes
How valuable is the research?	The finding of this research may facilitate the design of more robust interventions and overcome existing barriers of childhood influenza vaccination.

Supplement 4.1. Factors associated with childhood influenza vaccination.

First Author	Published Year	Setting	City& Country	Outcome variable	Denominator	Numerator	Reported Prevalence	Classification of non-biomedical factors	Factor	Category	ORs
Lili Xu	2017	kindergarten	Xining, Qinghai Province, China	Children's vaccination status	Kindergarten children (aged 2-7 years) (1298)	Children who had been vaccinated for influenza either in 2014–15(148) or 2015–16(154)	11.4% (season 2014–15) &11.9% (season 2015–16)			Housework and other unemployed	Reference
								Caregivers' characteristics	Occupation of mothers	Enterprise staff	1.86(1.15-3.02)
										Farmers and herdsmen	0.4(0.18-0.91)
										Healthcare worker	2.36(1.09-5.14)
								Caregivers' characteristics	Gender(child)	Female	Reference
										Male	1.48(1.09-2.02)
								Knowledge	Knew the dose for children	NO	Reference
										YES	2.14(1.37-3.35)
								Awareness	Children should be vaccinated every year	No	Reference
										Yes	2.34(1.65-3.31)
								Perceived barriers	Vaccination	No	Reference

										is safe for children	Yes	1.69(1.2-2.37)
									Perceived benefits	Vaccine is the most effective way to prevent flu	No	Reference
											Yes	1.5(1.09-2.08)
Mabel S.F. Low	2017	Pre-schools	Singapore	Influenza vaccination history in the past	Pre-school student parents (332)	Parents whose children were vaccinated against influenza in the past (105)	32%		Information sources	Recommended by physician to vaccinate child against influenza	No	Reference
											Yes	PR=2.47 (1.75–3.48)
									Cues to action	Family took pre-travel influenza vaccination	No	Reference
											Yes	PR=1.64 (1.19–2.25)
									Attitudes towards influenza vaccine	Willingness to vaccinate child against influenza		PR=1.59 (1.24–2.04)
									Information sources	Received influenza vaccine information from private GPs	No	Reference
											Yes	PR=1.47 (1.05–2.04)
									Information sources	Received influenza vaccine information	No	Reference
											Yes	PR=0.44 (0.23–

									from television		0.85)
								Perceived barriers	Felt well-informed about influenza vaccine	No	Reference
										Yes	PR=1.44 (1.04–1.99)
Joseph T. F. Lau	2018	Outpatient	Hongkong , China	Influenza vaccination history	Parents of children aged 12–23 months (489)	Parents whose children were vaccinated against influenza in the past (56)	11.5%	Knowledge	Knowledge score about governmental policies and recommendation related to IV	0	Reference
										1~2	0.86 (0.34,2.14)
										3~4	2.64 (1.09,6.40)
								knowledge	Knowledge about influenza vaccine requirement: Children (aged 6 months to less than 6 years) should take up influenza vaccine every year	No / Not sure	Reference
										yes	2.30(1.21,4.38)
								Perceived barriers	Score of safety	0	Reference
										1~2	0.24(0.12,0.47)

										concerns	3~4	0.14(0.06,0.33)
									Information sources	Scores of information sources and seeking for therapeutic purposes decisions	0	Reference
											1~2	1.63(0.76,3.46)
											3~5	7.79(3.45,17.58)
									Norms	Subjective norms	0	Reference
											1~2	4.59(2.34,9.00)
									Caregivers' characteristics: Vaccination history	Family members ever taken up IV in the past year	No / Do not know	Reference
											Yes	6.60(3.60,12.11)
T. N. OFFUTT-POWELL	2014	Daycare centres	Tarrant County, Texas, USA	Influenza vaccination during the current influenza season	Parents of children in the selected daycare centres (124)	Parents' children who received at least one dose of influenza vaccine during the current influenza season (80)		65%	Perceived barriers	Perceived risk of vaccine-related adverse events	Low	Reference
											Moderate	0.37(0.10, 1.3)
											High	0.17(0.03, 0.71)
									Information sources	Physician recommendation†	Not recommended	Reference
											Recommended	8.2(2.7, 30)

									vaccination history	Parental prevention behaviours	Low Moderate High	Reference 1·3 (0·29, 6·2) 9·1 (3·2, 31)
Bonnie Strelitz	2015	Outpatient	Seattle,WA,USA	Acceptance of influenza vaccination	Parents of children (152)	Parents who accepted influenza vaccination for children paediatric emergency department (56)	37%	Attitude & Perceptions	Scores of Parent Attitudes about Childhood Vaccines (PACV) survey	<50 50–100	Reference 6.58 (2.03, 21.38)
Allah Bukhsh	2018	Community	Pakistan	Influenza vaccination in the past	Parents of children (532)	Parents' child who received influenza vaccine in the past (35)	6.6%	Perceived severity	Influenza is a mild disease and does not need vaccination	/	Not applicable
								Perceived benefits	Vaccine is safe and effective measure to protect your child against influenza	/	Not applicable
								Perceived barriers	I am worried about side effects of the influenza vaccine	/	Not applicable
								Perceived barriers	It is better to have natural	/	Not applicable

	immunity against influenza		
Attitudes towards influenza vaccine	Healthy young children should not get an influenza vaccine	/	Not applicable
Awareness	Children who have a chronic disease should get an influenza vaccine	/	Not applicable
Awareness	My child has had all their routine vaccines	/	Not applicable
Attitudes towards influenza vaccine	I don't believe that children should have any vaccinations	/	Not applicable
Self-efficacy	Getting two needles in the first year is difficult to organize	/	Not applicable

										Access	It is inconvenient to get an influenza vaccine	/	Not applicable
										Access	I am too busy to get my child vaccinated against influenza	/	Not applicable
Lei He	2015	Outpatient	Liwan District,Guangzhou, Guangdong province, China	Influenza vaccination within the preceding 12 months	Parents who took their children for regular body check (298)	Parents' children who received vaccination against seasonal influenza within the preceding 12 months (140)		47%	Caregivers' characteristics	Age of child (months)	>24	Reference
											6–24	2.59* (1.44, 4.68)
									Norms	If other parents I know have their children vaccinated against seasonal influenza, it will encourage me to do the same (social norms)	Strongly disagree/disagree/evens	
											Agree/strongly agree	2.08(1.06-4.06)
										If my families and	Strongly disagree/disag	

	friends though that i should take child to vaccinate, I though I should listen to their advice (social norms)	ree/evens	
		Agree/strongly agree	
	If most parents bring their child to take seasonal influenza vaccination, I feel that I should also do so (social norms)	Strongly disagree/disagree/evens	
		Agree/strongly agree	
Self-efficacy	If you do try, how difficult do you think it is for you to take your child for seasonal influenza vaccination in the coming 12 months?	Very difficult/difficult/evens	Reference
		Confident/very confident	2.96† (1.60, 5.50)
Anticipated regret for vaccinating children	If you vaccinate your child against	Definitely not regret	Reference
		Slightly regret	0.66 (0.35, 1.25)

										seasonal influenza, but your child subsequently still got influenza, will you feel that you would regret your decision?	Moderately regret/extremely		0.21 (0.08, 0.52)
Anise M.S. Wu	2015	Community	Hongkong, China	Influenza vaccination within the preceding 12 months	Parents of children (540)	Parents of children who had ever taken up influenza vaccination (318)	58.90%	Perceived susceptibility and severity	Scores of perceived susceptibility and severity	0–6		Reference
										6–10		2.06 (1.41, 3.01)
								Perceived benefits	Scores of perceived benefits		0	Reference
										1–3		1.86 (1.15, 3.02)
										≥4		3.33 (2.18, 5.09)
								Perceived barriers	Scores of perceived barriers		0	Reference
										1–3		0.62 (0.35, 1.08)
										≥4		0.48 (0.25, 0.95)*
								Cue to action	Scores of cue to action		0	Reference
										1–3		2.11 (1.39, 3.21)
										4–5		5.09 (3.02, 8.56)

									Norms	Scores of subjective norms	0	Reference
											≥1	4.81 (3.23, 7.16) **
									Vaccination history	Family members ever taken up IV in the past year	No/do not know	Reference
											Yes	5.81 (3.73, 9.08)
									Emotion	Fear during the H1N1 pandemic	No/do not know	Reference
											Little/moderate/much	2.15 (1.08, 4.26)
Louise E. Smith	2017	Community	England	Influenza vaccination during the 2015–16 flu season	Parents of children (1042)	Parents of children who had received the influenza vaccination this winter (529)		52.8%	Attitudes towards influenza vaccine	The vaccination campaign is just about making money for the manufacturers	Disagree	Reference
											Agree	0.23 (0.14–0.38)
									Attitudes towards influenza vaccine	I don’t like [child] having vaccinations in general	Disagree	Reference
											Agree	0.53 (0.34–0.82)
									Perceived susceptibility	If I don’t vaccinate child, then child will get flu	Disagree	Reference
											Agree	4.46 (2.66–7.48)

Perceived severity	Flu would be a serious illness for [child]	Disagree	Reference
		Agree	1.66 (1.03–2.66)
Perceived benefits	Having the child flu vaccine is an effective way of preventing from catching flu	Disagree	Reference
		Agree	4.56 (2.58–8.08)
Perceived barriers	The child flu vaccine has not been tested enough for me to feel it is safe	Disagree	Reference
		Agree	0.16 (0.10–0.26)
Perceived barriers	The child flu vaccine can cause unpleasant short-term side-effects	Disagree	Reference
		Agree	0.26 (0.16–0.43)
Perceived barriers	The child flu vaccine can cause long-term health problems	Disagree	Reference
		Agree	0.26 (0.15–0.42)
Perceived barriers	Vaccinating [child] against flu each year will overload his/her	Disagree	Reference
		Agree	0.27 (0.16–0.44)

									immune system		
								Perceived barriers	Vaccinating [child] against flu each year is too much of an ongoing time commitment	Disagree	Reference
										Agree	0.59 (0.35–1.00)
								Information sources	A health professional has recommended that [child] should be vaccinated	Disagree	Reference
										Agree	3.61 (2.36–5.50)
								Vaccination history	Child previous flu vaccine	No	Reference
										Yes	15.54 (11.00–21.96)
								Perceived barriers	I don’t know enough about the child flu vaccine	Disagree	Reference
										Agree	0.16 (0.10–0.25)
Qiuyan Liao	2016	Community	Hongkong	Children’s influenza vaccination uptake during the 2012/2013 CIVSS	Parents of children (1226)	Parents' children who received influenza vaccination uptake during the 2012/2013 childhood influenza vaccination	34.3%	Attitude	Vaccination intention	/	β = 0.57

				subsidy scheme (420)					
Ji Hyen Hwang	2017	Ansan & Jeonju, South Korea	Parents of children (638)	parents who had immunised their child against influenza in the previous year (615)	96.4%	Information sources	Early campaign of government or press	/	ORs not applicable
						Information sources	Recommendation from health care providers	/	ORs not applicable
						Information sources	Recommendation from the family members, acquaintances	/	ORs not applicable
						Information sources	Recommendation from the school or nursery	/	ORs not applicable
						Information sources	Parent’s decision	/	ORs not applicable
						Perceived barriers	Safety concern	/	ORs not applicable
						Perceived barriers	Mistrust in effectiveness	/	ORs not applicable
						Perceived barriers	Having no necessity	/	ORs not applicable

								Access	Cost	/	ORs not applicable
								Access	Lack of time	/	ORs not applicable
								Access	Missed vaccinating season	/	ORs not applicable
Kim Borg	2018	Community	Victoria, Australia	Childhood influenza immunisation between 2 May 2017 and 1 September 2017	Parents of children (5534; group of personalised letters:1845; group of pamphlet:1845; control group:1844)	Parents' children who received influenza vaccination uptake between 2 May 2017 and 1 September 2017 (273; group of personalised letters:109; group of pamphlet:83; control group:81)	Control group:4.4%; pamphlet group: 4.5%; the letter group:5.9%	Information sources	Intervention type	control	Reference
										pamphlet	1.03(0.75-1.40)
										letter	1.33(0.99–1.79)
Suchitra Rao	2019	Community	Colorado, USA	Children's receipt of at least one influenza vaccination within two years of age	Children in Colorado who are 6 months to 5 years of age (126,763)	Children who received at least one influenza vaccination within two years of age (63,572)	50.2%	Caregivers' characteristics	Number of Pre-natal visits	/	RR= 0.992 (0.986, 0.998) (Among hispanic mothers)
										/	RR = 0.984 (0.973,0.996) (Among white non-Hispanic, or black non-

												Hispanic)
									Caregivers' characteristics	Admission to the NICU and given supplemental oxygen were 20% less likely to be vaccinated	/	RR = 0.80(0.89, 0.96)
									Caregivers' characteristics	preterm birth	/	RR = 1.10(1.05, 1.15)
Anise M.S. Wu	2020	Community	Hongkong, China	Children's actual IV within the follow-up period	Parents with children (440)	Children who received influenza vaccination within the follow-up period (278)	63.2%				Very unlikely/Unlikely 1	Reference
									Attitude	Behavioural intention regarding the child's IV in the next 12 months	Likely	Never vaccinated at baseline: 6.06(1.59,23.04); Ever vaccinated at baseline:4.83(1.98, 11.80)
											Very likely	Ever vaccinated at baseline: 7.46 (2.70,20.65)
									Perceived benefit	Positive attitude score	0	Reference
											3~5	Ever vaccinated at baseline: 3.74 (1.78,7.85)

											0	Reference
									Norms	Perceived norm score	1~2	Ever vaccinated at baseline: 2.37 (1.26,4.45)
											3	Ever vaccinated at baseline: 3.55 (1.83,6.89)
Chareeya Thanee	2021	Outpatient	Thailand	Children's influenza vaccination status	Caregivers of children (700)	Children receiving influenza vaccination in the 2018 season (61)	9%	Caregivers' characteristics	Health insurance coverage during the enrolment visit	Private		Reference
										Out-of-pocket		
										Universal coverage		2.6 (1.1–6.6)
										Civil service		
								Information sources	Information source about influenza vaccine	Others		Reference
										Healthcare providers		2.8 (1.3–6.0)
								Attitudes towards influenza vaccine	Agreement with ministry of public health's recommendation for influenza vaccination in young children	Agreed		Reference
										Disagreed		
										Strongly disagreed		
										Not sure		
										Strongly		2.9 (1.5–5.9)

									agreed	
								Vaccination history	Received influenza vaccination in the 2017 influenza season or earlier	No	Reference
										1 dose	3.2 (1.4–7.8)
										> 1 dose	
Ye Lixia	2019	Community	Ningbo, Zhejiang, China	Coverage rates of 1 &2 doses of influenza vaccine 2017-18	Children aged from 6-35 months	Children who received only 1 and 2 doses of influenza vaccine during 2017-18 flu season	1 dose : 6.95%; 2 doses: 4.07%	Caregivers' characteristics	Months of age	6~12	Reference
										13~24	0.48(0.47-0.50)
										25-35	0.15(0.15-0.16)
								Caregivers' characteristics	Residence	Local	Reference
										Migrant	0.53(0.51-0.55)
								Caregivers' characteristics	Area	Rural	Reference
										Urban	4.89(4.69-5.09)
								Systematic factor	Frequency of vaccination service (days per week）	<5	Reference
										≥5	1.08(1.03-1.14)
								Systematic factor	Weekend service	No	Reference
										Yes	0.88(0.86-0.91)

									Systematic factor	No. of vaccination staff per 10 000 population	<1	Reference
											≥1	1.20(1.16-1.24)
Li Guangjin	2019	Outpatient	Binzhou, Shandong, China	Children's vaccination status	Caregivers of children (480)	Parents' children who received vaccination against seasonal influenza (134)	27.9%	Knowledge	Knowledge	No	Reference
											Yes	2.24(1.56-3.21)
								Caregivers characteristics	Parents education	Junior high and below	Reference
										Senior high school/technical secondary school/vocational school	1.49(1.08～ 2 .04)
										Undergraduate	2.45(1.61～3.73)
										Graduate school or above	3.9(1.70～8.87)
								Caregivers' characteristics	Monthly household income per capita	<3000	Reference
										3000～5999	1.35(1.07-1.71)
										≥6000	2.37 (1.25-4.51)
								Caregivers'	Occupation	Farmers	Reference

								characteristics		Employees of government enterprises and public institutions	3 .15(1.71-5.8)
Weiwei Yang	2018	Community	Nanjing city,Jiangsu, China	Children’s vaccination status	Parents of children (500)	Parents' children who received vaccination against seasonal influenza in 2017(115)	23%	Caregivers’ characteristics	Children's gender	Male	Reference
										Female	0.63(0.41～0.99）
								Knowledge	Knowledge status	Poor	Reference
										Good	1.14(1.03～1.27)
								Perceived barriers	Acceptance of vaccines price	Yes	Reference
										No	0.84(0.74～0.96）
								Attitudes towards influenza vaccine	Willingness to accept relevant knowledge training	Yes	Reference
										No	0.53(0.32～0.88)
MaoDong Mei	2017	kindergarten	Binhai,Jiangsu province, China	Children’s vaccination status	Parents of children (2596)	Parents' children who received vaccination against seasonal influenza in 2016(334)	12.87%	Caregivers’ characteristics	Gender(child)	Female	Reference
										Male	1.46(1.14-1.75)

									Caregivers' characteristics	Registered permanent residence	City	Reference
											Rural	1.82(1.47-2.38)
									Caregivers' characteristics	Census register	local	Reference
											immigration	1.63(1.42-1.85)
									Caregivers' characteristics	Monthly household income	≤2000	Reference
											5001～	0.83(0.68-0.95)
											＞10000	0.59(0.41-0.77)
									Knowledge	Score of influenza Knowledge	/	1.13(1.08-1.21)
Hongcai Gao	2014	NR	Chifeng, inner mongolia, China	Children's vaccination status	Parents of children (500)	Parents' children who received vaccination against seasonal influenza (98)	19.6%		Perceived barriers	Lack of confidence in the vaccine's effectiveness	/	ORs not applicable
									Awareness of vaccination	Parents' awareness of influenza	/	ORs not applicable
									Awareness of vaccination	Lack of parental awareness of influenza	/	ORs not applicable
									Perceived barriers	Vaccine safety concerns	/	ORs not applicable
									Attitude	Wait until there's a flu	/	ORs not applicable

									epidemic		
Xiangang Chen	2011	Kindergarten &Outpatient	Yuzhong District, Chongqing, China	Children's vaccination status	Parents of children (617)	Parents' children who received vaccination against seasonal influenza (98)	NR	Caregivers' characteristics	Father's Education	/	1.556
LI Weiwei	2021	Kindergarten & Outpatient	Nanshan, Shenzhen	Children's vaccination status	Parents of children (440)	Parents' children who received vaccination against seasonal influenza in 2018 or 2019(99)	48.31% (2018) &54.11% (2019)	Caregivers' characteristics	Hukou Status		ORs not applicable
								Caregivers' characteristics	Maternal education		ORs not applicable
								Caregivers' characteristics	Monthly household income		ORs not applicable

Supplement 4.2. Factors associated with caregivers' intention to vaccinate children against influenza.

First Author	Published Year	Setting	City& Country	Outcome Variable	Denominator	Numerator	Reported prevalence	Classification of non-biomedical factors	Factor	Category	ORs
Changhsun Chen	2015	Community	Taiwan, China	Intention of influenza vaccination this year	Parents or main caregivers of young children	Parents or main caregivers who intend to vaccinate their children against	73%	Caregivers' characteristics	Age (parent)	/	1.04(1.01-1.08)

(1300)	influenza (949)			
			<25,000	reference
			25,000 to <45,000 0.67 0.42 1.04 0.8374	0.62(0.33-1.18)
		Caregivers' characteristics	Average household income (TWD) for a month	45,000 to <65,000 0.67 0.43 1.06 0.8959	0.68(0.35-1.31)
				65,000 to <90,000	0.8(0.39-1.65)
				≥90,000	0.41(0.2-0.85)
		Symptoms	Children's average frequency of having colds for a year	/	1.05(1.01-1.09)
		Perceived benefits	Perceived benefits	/	1.22(1.13-1.33)
		Cue to action	cues to action (catching cold frequently, more people around catching cold, influenza vaccination of friends, advise from medical personnel,	/	1.3(1.23-1.37)

									advise from the government, celebrity speak for, media report)		
								Caregivers' characteristics: Vaccination history	Children ever vaccinated 2010-2011 influenza vaccine or not	No	Reference
										Yes	4.99(3.22-7.73)
								Self-efficacy	Self-efficacy (regardless of busy, other's opinion, without reminder, out of pocket payment still has confidence in doing so)	/	1.25(1.17-1.34)
Yaofeng Han	2019	School	Xiameng,Fujian province, China	Intention of parents to vaccinate their children against influenza under the free policy	Parents of kindergarten children (1211)	Parents intend to vaccinate their children against influenza under the free policy (1031)	1031 (85.1%)	Perceived susceptibility	Perceived susceptibility	/	1.77 (1.2-2.61)
								Perceived benefits	Perceived benefits	/	3.12(1.91-5.08)

								Perceived barriers	Perceived barriers	/	0.38 (0.28-0.51)
								Cue to action	Cues to action	/	3.54(2.5-5.01)
Yanbing Zeng	2019	School	Fujian (Non-free policy) & Taiwan (Free policy) province, China	Intention of parents to vaccinate their children against influenza	Parents with young children in kindergarten (Total:1506; Xiamen:1211 ;Taiwan:295)	Parents intend to vaccinate their children (Total:1256. Xiamen:1031; Hualian:225)	83.4%, Xiamen:85.1%, Hualian:76.3%	Knowledge	Knowledge scores	<5	Reference
										5~8	Total: 1.74 (1.18-2.56)
								Caregivers' characteristics	Monthly family income (RMB)	<4000	Reference
										＞16,000	Total: 0.46(0.23-0.93); Free policy:0.07(0.00-0.94)
								Perceived barriers	Safety worry	Less safety worry	Total: 1.35(1.1-1.66); non-free policy:1.45(1.13-1.86)
								Attitude	Perceived necessity-Influenza vaccination is necessary	/	Total:1.84(1.53-2.22); Non-free policy:1.74(1.39-2.16); Free policy:3.83(2.06-7.16)

Caregivers' characteristics	Parents age	<30	Reference
		30–39	Free policy:4.19(1-17.43)
Perceived susceptibility	Susceptibility	/	Total:1.44(1.09-1.91); Free policy:2.41(1.09-5.35)
Perceived benefits	Benefits	/	Total: 1.80(1.30-2.50); Non-free policy:1.96(1.31-2.92); Free policy:2.73(1.22-6.12)
Perceived barriers	Barriers	/	Total: 0.50(0.37-0.68); Non-free policy:0.51(0.35-0.73); Free policy:0.31(0.14-0.68)
Cues to action	Cues to action	/	Total: 3.32(2.47-4.46); Non-free policy: 3.14(2.16-4.57); Free policy:4.52(2.17-9.43)

										Senior high school or below	Reference
								Caregivers' characteristics	Parents education	University/college or above	Total:1.54(1.03–2.28)
								Caregivers' characteristics	Relationship with kids	Father	
										Mother	Free policy:4.37(1.37–13.96)
								Caregivers' characteristics: Vaccination history	Vaccinated during last year	No	
										Yes	Free policy:4.52(1.07–19.02)
Aery Choi	2017	Outpatient	Seoul, South Korea	Likelihood of vaccinating their child	Parents who visited the Paediatric Departments of the Korea Cancer Centre Hospital and Seoul Eulji Hospital, the Jungnang Borough Office Healthcare Centre, and 3 day-care centres in Seoul	Parents who would like to vaccinate their child (534)	83.57%	Caregivers' characteristics	Sex	Female	Not applicable

(639)

										Male	Not applicable
								Caregivers' characteristics	Highest level of education completed	Less than high school	Not applicable
										More than college degree	Not applicable
								Caregivers' characteristics	Current employment status	Employed	Not applicable
										Unemployed	Not applicable
								Caregivers' characteristics	Household income (USD)	≤2,500	Not applicable
										>2,500, ≤4,500	Not applicable
										>4,500	Not applicable
Lei He	2015	Outpatient	Liwan District,Guangzhou, Guangdong province, China	Parental intention to vaccinate their children	Parents who took their children for regular body check (298)	Parents who intend to vaccinate their children against seasonal influenza over the next 12 months (179)	60.1%	Cues to action	Perceived healthy status of child	Excellent good/very good	Reference
										Good	3.36 (1.68, 6.74)
										Fair/poor	2.12 (0.75, 6.00)
								Caregivers' characteristics: Vaccination history	Did your child ever receive seasonal influenza	No	Reference
										Yes	2.50(1.31,

									vaccine in the past		4.76)
								Perceived control	If you do try, how difficult do you think it is for you to take your child for seasonal influenza vaccination in the coming 12 months? (Perceived control)	Very difficult/difficult/evens	Reference
										Confident/very confident	3.21(1.65, 6.22)
								Emotion	In the past 1-week, have you worried that your child would catch seasonal influenza? (Worry)	Not worry/anxious	Reference
										Worry/anxious	2.31 (1.19, 4.48)
Louise E. Smith	2017	Community	England	Intention to vaccinate child in the 2016-17 season	Parents of children (1042)	Parents who intend to vaccinate child in the 2016-17 season (668)	70.3%	Attitude	The vaccination campaign is just about making money for the manufacturers	Disagree	Reference
										Agree	-2.14 (-2.53 to -1.75)
								Perceived benefits	Having the child flu vaccine is an effective way	Disagree	Reference
										Agree	3.43 (3.03–

	of preventing from catching flu		3.82)
Perceived barriers	The child flu vaccine has not been tested enough for me to feel it is safe	Disagree	Reference
		Agree	-1.78 (-2.12 to -1.44)
Perceived susceptibility	If I don't vaccinate child, then child will get flu	Disagree	Reference
		Agree	2.90 (2.48–3.31)
Perceived severity	Flu would be a serious illness for [child]	Disagree	Reference
		Agree	1.40 (0.99–1.81)
Perceived barriers	The child flu vaccine can cause unpleasant short-term side-effects	Disagree	Reference
		Agree	-1.37 (-1.77 to -0.96)
Perceived barriers	The child flu vaccine can cause long-term health problems	Disagree	Reference
		Agree	-1.83 (-2.22 to -1.45)
Perceived barriers	Vaccinating [child] against flu each year will overload	Disagree	Reference
		Agree	-1.43 (-1.80

	his/her immune system		to -1.05)
Perceived barriers	Vaccinating [child] against flu each year is too much of an ongoing time commitment	Disagree	Reference
		Agree	-0.48 (-0.94 to -0.03)
Information sources	A health professional has recommended that [child] should be vaccinated	Disagree	Reference
		Agree	1.11 (0.72–1.49)
Caregivers' characteristics: Vaccination history	Child previous flu vaccine	No	Reference
		Yes	2.25 (1.94–2.57)
Attitude	I don't like [child] having vaccinations in general	Disagree	Reference
		Agree	-1.34 (-1.73 to -0.95)
Self-efficacy	I don't know enough about the child flu vaccine	Disagree	Reference
		Agree	-1.08 (-1.45 to -0.70)
Perceived barriers	The child flu vaccine does not suit my religious or	Disagree	Reference
		Agree	-0.55 (-1.02

	cultural beliefs/values		to -0.09)
Perceived severity	Flu would be a serious illness for me	Disagree	Reference
		Agree	0.97 (0.60–1.35)
Perceived severity	Flu would be a serious illness for someone living in [child]'s household	Disagree	Reference
		Agree	1.27 (0.88–1.66)
Information sources	Another child I know had side-effects from the vaccine	Disagree	Reference
		Agree	-0.83 (-1.21 to -0.44)
Perceived barriers	Perception of side-effects	No	Reference
		Yes	-0.53 (-0.79 to -0.26)
Perceived barriers	Severity of side-effects	Very mild	Reference
		Mild	-0.63 (-1.18 to -0.08)
		Moderate	-1.59 (-2.27 to -0.91)
		Severe	—2.02 (-3.46 to -0.58)

Qiuyan Liao	2016	Community	Hongkong	Intention to vaccinate child	Parents of children (1226)	Parents' intention to vaccinate children during the 2012/2013 childhood influenza vaccination subsidy scheme (794)	57.6%	Caregivers' characteristics: Vaccination history	Parents who had previously vaccinated their child	/	β = 0.42
								Caregivers' characteristics: Vaccination history	Parental past flu vaccination history	/	β = 0.22
								Emotion	Perceived regret from vaccinating	/	β = −0.14
								Perceiver barrier	Perceived higher belief in vaccination safety	/	β = 0.35
								Norms	Perceived greater social norms influence	/	β = 0.25
								Emotion	Anticipated more regret from not vaccinating	/	β = 0.17
								Perceived susceptibility	Perceived higher risk to child from influenza	/	β = 0.15
Annika M. Hofstetter	2017	Outpatient	Seattle, USA	Parental verbal acceptance	Parents of young	Parents who accepted influenza vaccine for their	48%		Clinicians' communicatio	participatory format	Reference

				of influenza vaccine for their child	children (50)	child by the visit's end (24)				n format	
										presumptive format	48.2(3.5 to 670.5)
Anise M.S. Wu	2020	Community	Hongkong, China	Parental intention regarding the child's IV in follow-up period	Parents with children (440)	Parents who intended to vaccinate children against influenza in follow-up period	48.8% (Likely + Very likely)				0	Reference
								Perceived benefits	Positive attitude score		Never vaccinated at baseline:7.11 (2.25,22.47); Ever vaccinated at baseline: 5.28 (2.57,10.85)
										3~5	
											0	Reference
								Norms	Perceived norm score	1~2	Never vaccinated at baseline: 3.94(1.47,10.56); Ever vaccinated at baseline: 2.90(1.51,5.59)
										3	Never vaccinated at baseline:27.40(

											6.29,119.40); Ever vaccinated at baseline: 21.76 (7.63,62.04)
Joseph T. F. Lau	2020	Community	Hongkong, China	Parental behavioural intention regarding the child's influenza vaccination in the next year	Parents with children (540)	Parents who intend to vaccinate children against influenza in the next year (263)	48.7%	Caregivers' characteristics: Vaccination history	Family members have taken up IV in the past year	No/do not know	Reference
										Yes	Ever-vaccinated group: 1.79 (1.09-2.96)
								Perceived susceptibility	Perceived susceptibility score of H1N1 flu	0-5	Reference
										6~10	Ever-vaccinated group: 3.20 (1.07-9.54)
								Perceived benefits	No. of responses reflecting perceived benefit	0	Reference
										≥4	Ever-vaccinated group:4.77 (2.52-9.05); Never-vaccinated group: 8.85

			(3.36-23.34)
Perceived barriers	No. of responses reflecting perceived barrier	0	Reference
		≥3	Ever-vaccinated group:0.38 (0.17-0.84)
Cue to action	No. of responses reflecting cues to action	0	Reference
		3~4	Ever-vaccinated group: 3.57 (1.88-6.78)
Norms	No. of responses reflecting subjective norms	0	
		1~2	Ever-vaccinated group: 11.23 (6.17-20.46); Never-vaccinated group: 21.66 (9.25-50.71)

CHAPTER THREE

Childhood Influenza Vaccination and Its Determinants during 2020–2021 Flu Seasons in China: A Cross-Sectional Survey

In this chapter, I report on quantitative data analysis of a large-scale survey on caregivers' decisions of childhood influenza vaccination in three provinces of different geographic regions and economic development in China. Data were collected from September to November 2021 by the Fudan University. I assisted the research team of Fudan University in developing study design and instruments. I conducted data analysis and interpretation, and drafted and revised the manuscript independently. I employed two behavioural models - Health Belief Model and the Vaccine Hesitancy Determinants Matrix - for childhood influenza vaccination in the analysis and interpretation of the results. The findings have been prepared as a draft of the manuscript, with comments on drafts from Professors Heidi Larson, Tracey Chantler, Zhiyuan Hou. This manuscript has been accepted by Vaccines.

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SECTION A – Student Details

Student ID Number	LSH1805371	**Title**	MR.
First Name(s)	Kaiyi		
Surname/Family Name	Han		
Thesis Title	Caregivers' decision-making about childhood seasonal influenza vaccination in three provinces in China: A mixed-methods study		
Primary Supervisor	Professor Heidi Larson		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Vaccines		
When was the work published?	November 23, 2022		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	This study assessed influenza vaccination coverage and the factors associated with vaccination uptake among children in three Chinese provinces.		
Have you retained the copyright for the work?*	Yes	Was the work subject to academic peer review?	Yes

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SECTION E

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Childhood Influenza Vaccination and Its Determinants during 2020–2021 Flu Seasons in China: A Cross-Sectional Survey

Abstract: Young children aged 6–59 months are recommended as one of the priority groups for seasonal influenza vaccination in China. This study assessed influenza vaccination coverage and the factors associated with vaccination uptake among children in three Chinese provinces. In September 2021, 2,081 caregivers with children <5 years completed self-administered questionnaires as part of a cross-sectional survey. Logistic regression was used to assess determinants of childhood influenza vaccination. A total of 43.63% of respondents reported vaccinating their children against influenza during the 2020-21 flu season. Caregivers who lived in Anhui province, had a bachelor degree or above, and an annual household income <20,000 RMB were more likely to vaccinate their children against influenza. Confidence in the importance (OR: 2.50; 95%CI: 1.77–3.54), safety (OR: 1.60; 95%CI: 1.29–1.99), and effectiveness (OR: 1.54; 95%CI: 1.23–1.93) of influenza vaccine was significantly associated with childhood vaccine acceptance. Respondents who saw that other caregivers were vaccinating their children had significantly higher odds of vaccinating their own children. Caregivers' receiving positive influence from healthcare workers (OR: 1.33; 95%CI: 1.00–1.77), family members, or friends (OR: 1.30; 95%CI: 1.14–1.49) were also significantly associated with childhood influenza vaccination. Poor access, including conflicts between caregivers' availability and vaccination service schedules and inconvenient transportation to the vaccination site were negatively associated with childhood flu vaccination. To promote childhood influenza vaccination, public health information campaigns need to target wealthier and less educated caregivers to enhance caregivers' confidence in influenza vaccination. Targeted interventions are also needed to optimize access to vaccination services, including extending vaccination service hours and increasing the number of vaccination sites close to residential areas. Interventions are also needed to encourage primary care providers to play a greater role in promoting vaccination. Finally, the dissemination of related information and the public response need to be monitored for the timely understanding of public perceptions.

Keywords: influenza; vaccine; child; confidence; China

1. Introduction

Seasonal influenza is an infection of the airways caused by influenza viral strains that undergo annual antigenic variation. Annually, influenza can affect 5% to 15% of the world's population, with an estimated global burden of 3 to 5 million cases of severe disease and a death toll ranging from 290,000 and 650,000 [2]. Influenza viruses can cause disease in all age groups, but children have the highest rates of infection [181]. Limited studies suggest that the incidence of seasonal influenza in children is around 30% in China [182, 183], causing a large economic burden [184].

The World Health Organization (WHO) recommends that children be a priority group for vaccination [5]. Over 40% of countries offer free seasonal influenza vaccination in their National Immunisation Schedules, including most countries in North and South America, Europe, and some countries in Africa, South-East Asia, and the West Pacific Region [31, 33, 185-187]. In China, the national influenza vaccination coverage for all ages is only 2.2%, recorded in 2014 [35], and data collected between 2009 and 2012 indicate that influenza vaccination uptake among children <5 years living in five provinces in mainland China was about 26.4% [7]. Several factors contribute to this low coverage. Firstly, the seasonal influenza vaccine is not included in the national expanded program on immunisation (EPI) and needs to be paid for out of pocket, and secondly, previous studies have focused on the influence of individual-level knowledge, attitudes, and beliefs on vaccination behaviour. Results showed that caregivers' (i.e., parents and guardians) have a poor awareness of risk, fear of adverse reactions after vaccination, and poor knowledge of influenza, which are major obstacles to increase the childhood influenza vaccination coverage [36-38].

However, there are limitations to existing studies. Firstly, existing studies that adapted the health belief model (HBM) largely focused on individual perceptions and did not investigate external factors. Access to vaccination services and broader areas of fit between the patient and the healthcare system, which includes availability, accessibility, accommodation, affordability, and acceptability, were not considered [137]. Secondly, the HBM was developed based on the assumption that humans are rational decision- makers [13]. However, even when individuals have comprehensive information and make choices with the intention of maximizing utility, they do not exclusively act rationally [188]. Emotions aroused by getting or not getting vaccinated can influence vaccination decision-making; however, most existing HBM studies do not account for these factors. Hence, we argue that these factors need to be included to improve the predictive power of the model. Thirdly, multiple information sources play an increasingly important role in decision-making, and access to appropriate information is essential to guide vaccination decisions [189]. Different information sources vary in their reliability and impact on the individual. For example, health

professionals are regarded as the most reliable information sources [190], while information from media and interpersonal sources may be ambiguous [191, 192].

More importantly, the COVID-19 pandemic, which had an unrivalled impact on global healthcare and social systems, may also affect public perception and attitudes toward influenza vaccines. Though the COVID-19 virus and influenza are vastly different pathogens, there are important areas of overlap [93]. For example, the majority of COVID-19 patients present with influenza-like illness [193]. Meanwhile, the adoption of nonpharmacologic interventions (NPIs), such as mandated face coverings in public, have influenced the incidence of influenza. Study showed decreased influenza incidence in 2020 (January through May) after adoption of NPIs as compared with prior seasons [95]. Thus, it is necessary to understand how public perceptions of influenza changed during COVID-19.

Our study aimed to provide updated estimates of the uptake level of influenza vaccination among children during COVID-19, and to assess the association not only between individual perceptions but also access to influenza vaccination, emotion of caregivers (i.e., parents, and guardians), and various information sources and childhood influenza vaccination.

2. Materials and Methods

2.1. Study Design

This study used a cross-sectional survey, recruiting participants self-identified as parents or guardians of children < 6 years old across three purposefully selected Chinese provinces, between September to November 2021. China has 34 provinces, cities, autonomous regions, and special administrative regions with wide regional inequality. We purposefully selected Guangdong (South, ranked 6th in the 2020 provincial GDP ranking of economic development), Anhui (Central-East, ranked 15th) provinces, and Shaanxi (Northwest, ranked 19th) [194].

Multistage stratified random cluster sampling was conducted in three stages to enrol eligible participants, prefecture-level cities, urban and rural areas, and local sampling sites (Table 1): vaccination clinics (age 0.5-3 years old), and kindergartens (age 3-5 years old). (1) We select one urban district from Shenzhen megacity, Guangdong province, and one urban district and one rural county from Anhui and Shanxi provinces; (2) three or four communities were selected according to their socioeconomic status in each district/county. Taking Nanshan district of Shenzhen megacity as an example, we sampled Xili and Zhaoshang sub-districts with good economic development as well as Shahe sub-district with poorer economic development; (3) In each sampled community, one vaccination clinic and/or one kindergarten were selected to recruit caregivers. Every vaccination clinic and kindergarten in the selected communities had an equal chance of selection.

The Evidence to Policy pathway to Immunisation in China (EPIC) is a Global Health Research Group, which aims to help decision-makers in China build a vaccination program that ensures reliable, affordable, equitable and uninterrupted supply of vaccines to the Chinese population. The work of EPIC focuses on four key themes, including health and economic consequences of vaccine-preventable diseases, vaccine supply, demand and decision making among the public, manufacturers and other key stakeholders, health and economic impact that vaccine introductions could have, and evaluation of the non-pharmaceutical interventions for containing COVID-19 and the potential impact and cost-effectiveness of COVID-19 vaccination. Among them, EPIC Theme 2.1 is a mixed-methods study design, which includes primary data collection in the form of two rounds of questionnaire surveys interspersed with the collection of qualitative data. This survey is part of the second round of data collection.

The Fudan University School of Public Health and the London School of Hygiene and Tropical Medicine Ethics committees approved the study protocol (FDU IRB#2018-10-0703, LSHTM Ethics Ref 160160).

2.2. Data Collection

A web-based questionnaire was developed using Questionnaire Star (Chinese equivalent of Survey Monkey) [195], a website that helps generate, distribute, and retrieve electronic questionnaires on a mobile platform. Respondents could access the questionnaire through WeChat, a Chinese social media platform with 1.1 billion active users [196]. Each WeChat account was allowed to fill in the questionnaire once to avoid data duplication. The questionnaire was pilot tested in June 2021 among 10 caregivers in a non-study community in Shanghai to validate the questionnaire and to evaluate potential sources of response error and improve the instrument. None of them were included in the data analysis. The reliability and validity fit the requirements.

With assistance from administrators at the vaccination clinic and kindergarten, caregivers visiting the vaccination clinics or picking up their children from the sampled kindergartens on a given day during the survey period were invited to participate in the survey. Participants could complete the questionnaire by scanning a QR code via a mobile device. Vaccination clinics generally establish WeChat online groups for child health management which enrols caregivers of children registered in the community, mainly aged ≤ 3 years old. We sent a link with the questionnaire to the WeChat group and participants could access it directly online. For all children from the WeChat group in sampled vaccination clinics, one of their caregivers was also invited to join in the survey. A consent form was presented in the first section of the questionnaire that was signed by all participants. Participants were

informed that participation was confidential, voluntary, and could be terminated at any time. It took approximately 3 minutes to complete the self-administered questionnaire; therefore, we used 3 minutes as a cutoff point for valid questionnaires. Respondents received electronic currency worth CNY 5 (US 0.7) as a gift after they completed the questionnaire. In total, 2,877 caregivers accepted our invitation to participate in the survey. After excluding those completed in less than three minutes (256) and with children older than five years old (540). A total of 2,081 respondents with valid data were included for analysis (participation rate: 72.33%).

2.3. Instruments

This study used a systematically developed structured questionnaire. The questionnaire was comprised of seven sections: 1) caregivers' demographic and socio-economic characteristics, 2) perception of influenza, including perceived susceptibility and severity, 3) perception of influenza vaccine, including perceived benefit and barriers (confidence in the importance and safety of vaccine, and access to vaccination service), 4) cues to action, 5) emotions, 6) influence of various information sources, 7) acceptance of childhood influenza vaccination. Questions related perceived susceptibility and severity of influenza, perceived benefit and barriers (confidence in the importance and safety of vaccine) of influenza vaccination, cues to action, and emotions, were informed by review of existing literature [36, 38, 108, 109, 117, 138], while those related to perceived barriers to access to vaccination service and influence of various information sources informed by formative, qualitative interviews with members of research group and experts.

Childhood influenza vaccination behaviour was measured with the question, “Did your child receive influenza vaccine during the last flu season (October 2020 March 2021)?” The questions used to measure the perception of influenza vaccine and disease and cue to action of caregivers and the corresponding scale are presented in Table A1 in Appendix A.

For perceived barriers, we investigated not only caregivers’ confidence in the importance and safety of influenza vaccines, but also the reasons for the lack of confidence. Regarding lack of confidence in vaccine importance, specific reasons include “It’s better to have natural immunity against influenza”, “Vaccines do not work (children still catch a cold after being vaccinated)”, “Flu is self-limiting for most people”, and “There is another useful treatment if my child gets flu”. Specific reasons for lack of confidence in vaccine safety include “The vaccine may give them flu”, “There will be side effects of the influenza vaccine”, “Child has allergy to chicken products” and “This flu vaccine would have a negative effect in interaction with other vaccines to be taken up by the child”. We also investigated caregivers’ vaccine confidence in general (effectiveness, safety and importance).

In addition, the emotions of caregivers were investigated by asking respondents if they ever felt worried, anxiety, or fear because they think that (1) not vaccinating with influenza vaccine will mean they get infected and (2) influenza vaccination will cause adverse reactions. Caregivers were also asked to comment on the role of social connections and institutions in their decision-making process: (1) healthcare workers (HCWs); (2) friends or family members; (3) Centre for Disease Control and Prevention (CDC) or government department; and (4) internet or social media. Impacts of these different influencers include "recommended influenza vaccine" and "not recommended influenza vaccine".

2.4. Statistical Analysis

Data from the online questionnaires were automatically uploaded to the Wenjuanxing online platform in real time. Descriptive analysis was used to describe the demographic and socio-economic characteristics, and caregivers' perceptions on influenza and vaccines. The chi-square test was performed to compare the levels of influenza vaccine uptake with caregivers' demographic and socio-economic characteristics and perception on influenza and vaccine and childhood influenza vaccination behaviour. We used logistic regression analysis to identify the factors significantly associated with childhood influenza vaccine uptake. The associations are reported as odds ratios (ORs) with 95% confidence intervals (CIs). All tests were two-tailed, and *p*-values less than 0.05 were considered statistically significant. All statistical analyses were performed using Stata, version 14.0 (StataCorp LP, College Station, TX, USA).

3. Results

3.1. Sample Characteristics

Caregivers' demographic and socio-economic characteristics are presented in Table A2 in Appendix B. A total of 2,877 questionnaires were collected from caregivers. After excluding those completed in less than three minutes and completed by caregivers with children >6 years old, questionnaires from 2,081 caregivers (72.33%) were included in the analyses. Of the 2,081 respondents with valid data, 81.45% of caregivers' residence is registered locally, and 62.37% lived in urban areas. Around 70% of caregivers were less than 35 years old, and 77.9% were mothers. Over half (54.45%) of caregivers had obtained junior college or bachelor level education or above, and 39.64% had an annual household income of less than CNY 50,000. Around 52% of caregivers' children were male, and the majority (79.53%) were ≥24 months old.

3.2. Childhood Influenza Vaccination Behaviour in 2020–2021 Influenza Season

Nearly half (43.63%) of the respondents reported that they vaccinated their children against influenza in the 2020–2021 flu season. Among children of different age groups,

children aged 1–2 years had the highest uptake rate of 53.99%, while children aged 4–5 years had the lowest uptake rate of 37.02% (Figure 1).

3.3. Caregivers' Perception on Influenza and Vaccine in 2020–2021 Influenza Season

The majority (79.19%) of caregivers agreed that their children are highly susceptible to influenza and 63.96% believed that the susceptibility increased during the COVID-19 pandemic (Figure 2). In addition, 65.93% agreed that the likelihood of serious health consequences after getting infected with influenza is high. Three-quarters (75.01%) of caregivers agreed that flu vaccines are effective with 84.77% and 84.72% agreeing that flu vaccines are important for children and safe, respectively, while 88.8%, 92.36%, and 88.37% agreed that vaccines are safe, important, and effective, respectively. The main reason for lack of confidence in the importance of influenza vaccine reported by 10.0% caregivers (n = 208) was believing that it is better to treat diseases through the child's own immunity (Figure 3). Meanwhile, the top reasons cited by the respondents who were unsure about influenza vaccine safety were concerns about potential side effects in 6.78% (*n* = 141).

In terms of access to vaccination services, 10.91% agreed that the there was a conflict between their work and vaccination service schedules, with 20.57% and 18.6% agreeing that there were flu vaccine shortages and flu vaccines were expensive, respectively. Only 9.18% caregivers stated that they were unsatisfied with past vaccination service and 9.37% stated that transport to points of vaccination (POVs) was inconvenient (Figure 4).

The proportion of caregivers who reported that those who had a positive influence on their vaccine decisions included HCWs, family members or friends, government departments and the internet was 36.04%, 31.14%, 34.5%, and 15.71%, respectively. A total of 46.18% of caregivers stated that most of the parents they knew had their children vaccinated against the flu, and 21.24% think their children are in poor health. Moreover, 79% of caregivers had experienced anxiety about the safety of influenza vaccines, while 79.48% had anxiety because their children had not been vaccinated (Figure 4).

3.4. The Determinants of Childhood Influenza Vaccination

Table 1 show the univariate associations between childhood influenza vaccination and caregivers' demographic and socio-economic characteristics and their perception on influenza and vaccines. The prevalence of childhood influenza vaccination varied significantly by demographic characteristics such as province, rural or urban area, children's age, and socio-economic characteristics, such as caregiver education.

Childhood influenza vaccination was positively associated with a high level of caregivers' perceived susceptibility and severity of flu. It was also significantly higher among those who have confidence in the importance, safety, and effectiveness of the flu vaccine; saw

other caregivers vaccinating their children; received a positive influence from HCWs, family members or friends, government departments, and internet; and less anxiety associated with flu vaccination. Childhood influenza vaccination was negatively associated with caregivers' poor access to the vaccination services including conflicts between work schedules and time of the vaccination service and inconvenient transport to the POV.

After adjustment for covariates by multivariate logistic regression (Table 2). This analysis showed no relationship between childhood flu vaccination and other caregivers' socio-economic characteristics, except for province (Shaanxi province: OR: 0.66; 95%CI: 0.48–0.92), education level (Bachelor degree or above: OR: 1.41; 95%CI: 1.13–1.76), and annual household income (100,000 to 200,000 RMB: OR: 0.81; 95%CI: 0.68–0.95; >200,000 RMB: OR: 0.73; 95%CI: 0.65–0.82). Confidence in the effectiveness (OR:1.54; 95%CI: 1.23–1.93), importance (OR: 2.50; 95%CI: 1.77–3.54), and safety (OR: 1.60; 95%CI: 1.29–1.99) of vaccines was positively associated with childhood flu vaccination. Poor access, including conflicts between caregivers' schedules (OR: 0.61; 95%CI: 0.40–0.92) and vaccination service and inconvenient transportation to POV (OR: 0.66; 95%CI: 0.51–0.85) was negatively associated with childhood flu vaccination. In addition, caregivers who saw that other caregivers were vaccinating their children (OR: 2.16; 95%CI: 1.94–2.40) and were positively influenced by HCWs (OR: 1.33; 95%CI: 1.00–1.77), family members, or friends (OR: 1.30; 95%CI: 1.14–1.49) were more likely to vaccinate their children.

4. Discussion

Our study examined the factors associated with the childhood influenza vaccination uptake rate during the 2020–2021 flu season by drawing on cross-sectional survey data collected in three Chinese provinces. Our analyses found that the influenza vaccination uptake rate was 43.63% across all three provinces. Caregivers who lived in Anhui province, had a bachelor degree or above, and an annual household income <20,000 RMB were more likely to vaccinate their children against influenza compared to their counterparts. Having confidence in the importance of influenza vaccination and confidence in the vaccine effectiveness and safety were positively associated with childhood influenza vaccination. Convenient time of vaccination services, convenient transport to POVs, seeing that most parents around have had their children vaccinated against the flu, and getting a positive recommendation from HCWs and family members or friends were the key factors associated with caregivers being more likely to vaccinate their children in the 2020–2021 flu season.

Our analyses were similar to estimated childhood influenza vaccination uptake collected in Guangzhou in 2013 (47%) [38] but higher than the data collected in Qinghai Province (the 2014–15 flu season: 11.4%; the 2015–16 flu season: 11.9%) [37]. These findings show higher

rates than the childhood influenza vaccination rate in Singapore (the 2015–16 flu season: 32%) [108] and Thailand (the 2018–19 flu season: 9%) [104]. It is also lower than that in other countries or regions, such as Hong Kong (the 2011–12 flu season: 63.2%) [112, 118], England (the 2015–16 flu season: 52.8%) [113], and South Korea (the 2013–14 flu season: 96.4%) [114]. Notably, our study showed a high vaccination uptake rate, even though influenza vaccines were not included in the national immunisation program (NIP) in China, possibly due to the COVID-19 pandemic. The majority of COVID-19 patients in China presented with influenza-like illness (ILI), which increased the public awareness of respiratory pathogens [197]. Searches for the influenza vaccine during the 2020–2021 flu season were more frequent than previous ones [198], indicating increased public awareness about influenza vaccination.

Respondents' confidence in the importance, effectiveness, and safety of influenza vaccines were independent predictors of childhood influenza vaccination in our analyses. The association between caregivers having a high level of vaccine confidence and their decision on vaccination is consistent with previous research, highlighting the importance of maintaining vaccine confidence [37, 38]. As for caregivers' confidence in all dimensions of the influenza vaccine, compared with the global average for vaccines confidence in general, our study showed a positive view on influenza vaccines' safety (84.72% vs. 79% global), but more negative views on influenza vaccine effectiveness (75.01% vs. 84% global) [199]. Compared with vaccine confidence in general among caregivers, the proportions of respondents who had confidence in the safety of influenza vaccines and caregivers who agreed that vaccines in general were safe were similar, with them less likely to consider influenza vaccines as being effective and important. The gap in caregivers' confidence in the importance and effectiveness of influenza vaccines versus vaccines in general is consistent with previous studies [200]. Our study also showed that the main reasons for lack of confidence in the importance and safety of vaccines reported by caregivers was believing that it is better to treat diseases through the child's own immunity and having concerns about side effects, respectively. Therefore, targeted efforts should be made to address caregivers' lack of confidence on vaccine importance and safety.

Delivering accurate and timely information about vaccines is a good way to increase caregivers' confidence and promote vaccine acceptance [189]. The influence of different information sources, including HCWs, media, and interpersonal sources on the public's attitude and decision on vaccines was inconsistent across countries [129]. To investigate the impact of various information sources on caregivers' decisions about vaccines, we asked caregivers about the positive or negative impact of those sources on their decisions regarding childhood influenza vaccination. The percentage of caregivers who reported being positively influenced by HCWs was the highest because health professionals are regarded as the most

reliable information sources [201]. We also found that caregivers who reported being positively influenced by HCWs were more likely to vaccinate their children, which is consistent with previous studies.

Evidence-based information from healthcare professionals could improve caregivers' vaccination knowledge and positively influence awareness of the need for vaccination [202]. However, only 36.04% of caregivers reported positive influence from HCWs. The reason may lie in the low percentage (69%) of the public who refer to doctors as their primary source of information [129], which was 15–20% lower than estimates from developed countries [203, 204]. In addition, caregivers commonly use the internet to search for information and guide their health-related decisions [205]. Although the internet makes it possible to overcome the spatial and temporal barriers to obtaining information 24/7, the quality of the information available online is questionable, with misinformation sometimes spreading more widely than positive and accurate information [129]. This could explain why only 15.71% of caregivers were positively affected by the internet. Barriers exist to increase Chinese caregivers' access to vaccine information from professional information sources. Firstly, there is a segmentation between clinical and preventive care in China. Vaccination services and related health education or consultations are provided by few dedicated vaccinators at POVs, while other primary care providers do not play an active role in it [206]. Hence, further research is needed to investigate the communication mode between HCWs and caregivers. Tailored interventions are needed to support and encourage primary care providers to play a greater role in promoting vaccination. Secondly, as exposure to misinformation may influence public perceptions of risk, and these risk perceptions are likely to be amplified through viral dissemination on the internet, the dissemination of related accurate information and the public response need to be monitored for timely understanding of public attitudes and perceptions [207].

When humans face risks, emotional responses, including feeling worry/anxiety might influence individuals' decision-making process [208, 209]. However, we didn't find any significant associations between emotional responses to seasonal influenza and behavioural responses, which is not consistent with previous studies [38, 210, 211]. Further qualitative research is needed to explore the emotional responses experienced by caregivers during flu season and its impact on vaccination decision making. Previous studies in China have not focused on the access of vaccination services. Our study reported positive views on it. Only 10% of the respondents felt that they had a time conflict with the hours of vaccination service, were not satisfied with the vaccination service in the past, and felt the transportation to the POVs was inconvenient, respectively. We also reported that time conflict with vaccination service and inconvenient transport to POVs were associated with a significantly reduced odds of vaccinating children against influenza. Targeted interventions are necessary, including

extending vaccination service hours and an increase in the number of POVs close to residential areas.

Caregivers educated to bachelor's degree level or above were more likely to vaccinate their children against influenza than people with lower educational attainment. Previous studies have shown that higher education may be associated with both lower and higher levels of vaccine acceptance [140]. Meanwhile, studies conducted in China showed that caregivers with higher education had a significantly higher odds of being reluctant acceptors [212]. We also found that people with the highest household income levels were less likely to vaccinate their children against influenza. Public health information campaigns need to be appropriately targeted and tailored to wealthier and less educated caregivers with the aim to provide them with professional and accurate vaccination information.

This study has several limitations. First, since we only included caregivers in three provinces, findings cannot be generalized to all provinces or districts in China. Second, the questionnaires were self-administered, which may have led to a degree of recall bias. Third, because around half the participants were recruited via POVs, there may be some selection bias resulting from our sampling methodology. Caregivers who take children to POVs may have higher vaccine confidence than those who do not present at POVs. Finally, the cross-sectional study design limits causal inference on the various factors observed.

5. Conclusions

Our study presents a higher childhood influenza vaccination uptake rate than previous Chinese studies. Caregivers who had a high confidence in influenza vaccines saw other caregivers vaccinating their children and positively supported vaccination from HCWs, family members, or friends, and had an increased odds of vaccinating their own children. Poor access, including conflicts between caregivers' schedules and vaccination service and inconvenient transportation to POV, hinders the vaccination uptake. In addition to public health information campaigns to promote childhood influenza vaccination and enhance caregivers' confidence, interventions to optimize access to vaccination services are needed. Interventions are needed to support encourage primary care providers to play a greater role in promoting vaccination. The dissemination of related information and the public response online need to be monitored for the timely understanding of public perceptions.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by Ethics Committee at the Fudan University School of Public Health, and the London School of Hygiene & Tropical Medicine Ethics committees approved the study protocol [FDU IRB#2018-10-0703, LSHTM Ethics Ref 16016].

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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Figure 1. The Influenza vaccination uptake rates among children of each age group in three provinces

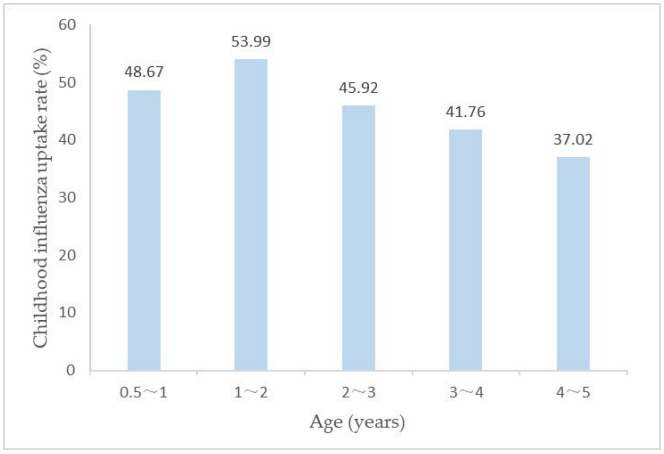

Figure 2. Caregivers' perception on influenza and influenza vaccine: (**A**) Caregivers' perceived susceptibility and severity of influenza; (**B**) Caregivers' vaccine confidence in general and towards influenza vaccine specifically.

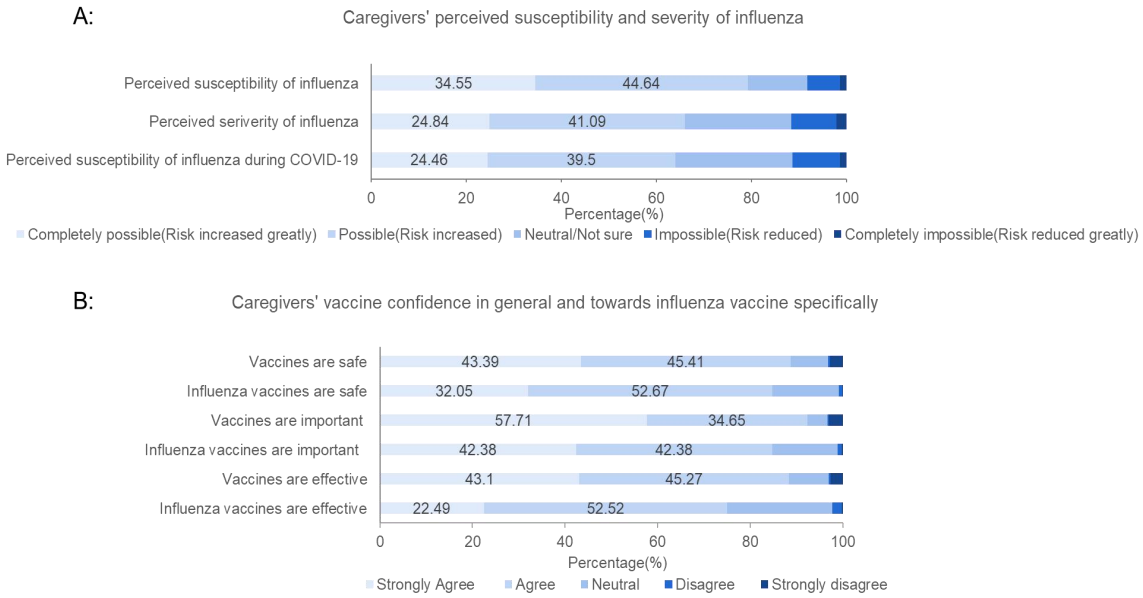

Figure 3. Caregivers' reasons for lacking vaccine confidence: (**A**) Reasons for lack of confidence in influenza vaccine importance; (**B**) Reasons for lack of confidence in influenza vaccine safety.

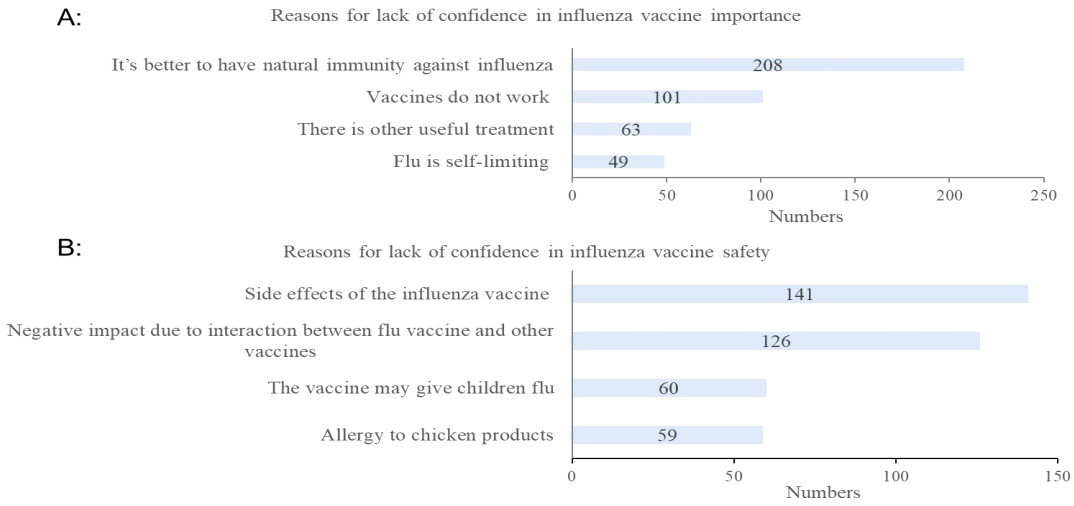

Figure 4. Access to vaccination service, influence of information sources, and caregivers' emotion associated with influenza vaccination: (**A**) Access to vaccination service and cue to action; (**B**) The influence of different information sources on caregivers; (**C**) Caregivers' emotion associated with influenza vaccination.

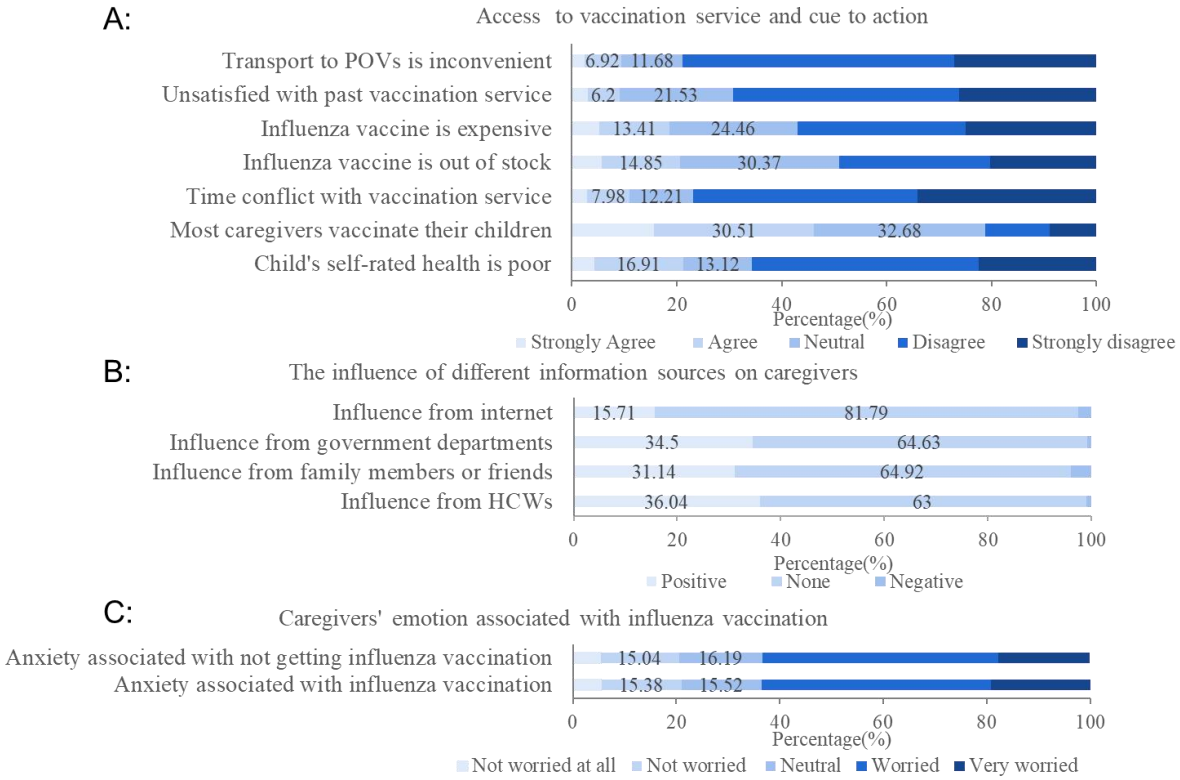

Table 1. Number of respondents at each sampling site

Province	Prefecture	District/ Coutnty	Townships	Vaccination clinics, N	Kindergarten, N
Guangdong	Shenzhen	Nanshan	Zhaoshang	/	58
			Shahe	47	96
			Xili	/	81
			Xinwei	39	/
			Shenzhenwan	39	/
Anhui	Chizhou	Dongzhi	Zhangxi	54	72
			Shengli	39	73
			Xiangyu	42	80
	Hefei	Shushan	Wulidun	19	114
			Nanqi	60	/
			Nangang	34	93
			Xiyuan	36	109
			Renban	56	51
Shaanxi	Xianyang	Qindu	Gudu	24	92
			Weixi	31	92
			Gaoxin	14	113
		Jingyang	Sanqu	73	63
			Yunyang	53	93
			Qiaodi	52	89

Table 2. Determinants of childhood influenza vaccination.

Variables	Influenza Vaccination in 2020–2021 Flu Season		Univariate Analyses	Multivariate Analyses
	Vaccinated (%)	Unvaccinated (%)	*p*	OR
Total	908 (43.63)	1,173 (56.37)	—	—
Region			0.001	
Anhui province	398 (48.24)	427 (51.76)		Ref
Shenzhen city	134 (37.22)	226 (62.78)		0.8 (0.51–1.26)
Shaanxi province	376 (41.96)	520 (58.04)		0.66 (0.48–0.92) *
Living area			0.019	
Urban	592 (45.61)	706 (54.39)		Ref
Rural	316 (40.36)	467 (59.64)		0.75 (0.47–1.20)
Registered residence			0.236	
Local residents	750 (44.25)	945 (55.75)		Ref
Internal migrants	158 (40.93)	228 (59.07)		0.87 (0.69–1.10)
Caregiver's age group (years)			0.731	
<=30	247 (44.83)	304 (55.17)		Ref
~35	388 (44.09)	492 (55.91)		0.95 (0.68–1.33)
~40	164 (42.71)	220 (57.29)		0.94 (0.74–1.18)
>40	109 (40.98)	157 (59.02)		0.71 (0.36–1.39)
Gender (Caregiver)			0.106	
Female	715 (42.76)	957 (57.24)		Ref
Male	193 (47.19)	216 (52.81)		1.22 (0.90–1.65)
Caregiver relationship with children			0.19	
Mother	691 (42.63)	930 (57.37)		Ref
Father	153 (46.36)	177 (53.64)		0.89 (0.72–1.09)
Grandparents and others	64 (49.23)	66 (50.77)		1.79 (0.70–4.59)
Education			0.003	
Middle school or below	189 (37.72)	312 (62.28)		Ref
High school	185 (41.39)	262 (58.61)		1.09 (0.89–1.33)
Junior college	250 (46.55)	287 (53.45)		1.32 (0.95–1.84)
Bachelor degree or above	284 (47.65)	312 (52.35)		1.41 (1.13–1.76) **
Annual household income (1000 Renminbi)			0.304	
<20	172 (40.38)	254 (59.62)		Ref
20–50	172 (43.11)	227 (56.89)		0.99 (0.74–1.34)
50–100	253 (46.85)	287 (53.15)		0.97 (0.86–1.08)

100–200	196 (44.65)	243 (55.35)		0.81 (0.68–0.95) *
>200	115 (41.52)	162 (58.48)		0.73 (0.65–0.82) **
Gender (Child)			0.202	
Female	449 (45.08)	547 (54.92)		Ref
Male	459 (42.3)	626 (57.7)		0.91 (0.79–1.04)
Child's age group (months)			<0.001	
<24	222 (52.11)	204 (47.89)		Ref
>=24	686 (41.45)	969 (58.55)		0.78 (0.54–1.11)
Susceptibility of flu			<0.001	
Low	146 (33.72)	287 (66.28)		Ref
High	762 (46.24)	886 (53.76)		1.1 (0.70–1.73)
Susceptibility of flu during COVID-19			0.004	
Decreased	296 (39.47)	454 (60.53)		Ref
Increased	612 (45.98)	719 (54.02)		0.87 (0.75–1.02)
Severity of flu			<0.001	
Low	261 (36.81)	448 (63.19)		Ref
High	647 (47.16)	725 (52.84)		1.16 (0.92–1.47)
Confidence in flu vaccine effectiveness			<0.001	
Disagree	133 (25.58)	387 (74.42)		Ref
Agree	775 (49.65)	786 (50.35)		1.54 (1.23–1.93) **
Confidence in flu vaccine importance			<0.001	
Disagree	48 (15.14)	269 (84.86)		Ref
Agree	860 (48.75)	904 (51.25)		2.50 (1.77–3.54) **
Confidence in flu vaccine safety			<0.001	
Disagree	64 (20.13)	254 (79.87)		Ref
Agree	844 (47.87)	919 (52.13)		1.60 (1.29–1.99) **
Time conflict with vaccination service			0.007	
Disagree	828 (44.66)	1,026 (55.34)		Ref
Agree	80 (35.24)	147 (64.76)		0.61 (0.40–0.92) *
Influenza vaccine is out of stock			0.428	
Disagree	714 (43.19)	939 (56.81)		Ref
Agree	194 (45.33)	234 (54.67)		0.92 (0.73–1.17)
Influenza vaccine is expensive			0.091	
Disagree	754 (44.51)	940 (55.49)		Ref

Agree	154 (39.79)	233 (60.21)		1.02 (0.66–1.56)
Unsatisfied with past vaccination service			0.475	
Disagree	820 (43.39)	1,070 (56.61)		Ref
Agree	88 (46.07)	103 (53.93)		1.4 (0.82–2.39)
Transport to POVs is inconvenient			0.047	
Disagree	836 (44.33)	1,050 (55.67)		Ref
Agree	72 (36.92)	123 (63.08)		0.66 (0.51–0.85) **
Most caregivers vaccinate their children			<0.001	
Disagree	371 (33.13)	749 (66.88)		Ref
Agree	537 (55.88)	424 (44.12)		2.16 (1.94–2.40) **
Child's self-rated health is poor			0.757	
Disagree	718 (43.81)	921 (56.19)		Ref
Agree	190 (42.99)	252 (57.01)		0.79 (0.55–1.12)
Influence from HCWs			<0.001	
Negative	512 (38.47)	819 (61.53)		Ref
Positive	396 (52.8)	354 (47.2)		1.33 (1.00–1.77) *
Influence from family members or friends			<0.001	
Negative	556 (38.8)	877 (61.2)		Ref
Positive	352 (54.32)	296 (45.68)		1.30 (1.14–1.49) **
Influence from government departments			0.002	
Negative	562 (41.23)	801 (58.77)		Ref
Positive	346 (48.19)	372 (51.81)		0.9 (0.58–1.38)
Influence from internet			<0.001	
Negative	732 (41.73)	1,022 (58.27)		Ref
Positive	176 (53.82)	151 (46.18)		1.04 (0.64–1.67)
Anxiety associated with flu vaccination			<0.001	
Yes	680 (41.36)	964 (58.64)		Ref
No	228 (52.17)	209 (47.83)		1.74 (0.95–3.20)
Anxiety associated with not getting flu vaccination			0.145	
Yes	735 (44.44)	919 (55.56)		Ref
No	173 (40.52)	254 (59.48)		0.64 (0.40–1.04)

Appendix A. Table A1. Construction and corresponding questions used to measure the perception of influenza vaccine and disease and cue to action of caregivers.

Constructs	Question	Scale
Perceived susceptibility	How likely is your child to get the flu this fall or winter?	Completely possible, possible, neutral/not sure, impossible, completely impossible.
Perceived severity	If your child has the flu, what do you think the chances are of serious consequences (severe complications such as pneumonia)?	
Impact of COVID-19 on perceived susceptibility	Is there any change in children's risk of influenza during COVID-19 compared to previous autumn and winter?	The risk becomes very high, risk increased, neutral/Not sure, risk reduced, the risk becomes very low.
Perceived benefit	Do you think vaccinating children against influenza is effective in preventing infection?	Definitely yes, possibly yes, not sure, possibly no, definitely no.
Perceived barrier (influenza vaccine importance)	Influenza vaccines are important for children to have.	Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree.
Perceived barrier (influenza vaccine safety)	Overall, I think influenza vaccines are safe.	
Perceived barrier (accessibility)	Time for vaccination service conflicts with working time.	
Perceived barrier (availability)	There is a lack of availability of the influenza vaccine in my local hospital.	
Perceived barrier (acceptability)	Not satisfied with past vaccination service/healthcare service.	
Perceived barrier (affordability)	Influenza vaccine costs too much.	
Perceived barrier (accommodation)	Transportation to the POV is not very convenient.	
Cue to action	Most of the parents you know take their children for flu shots.	
	My child catching colds frequently.	

Appendix B. Table A2. Respondent Characteristics, N (%).

Characteristics	Total Sample, N (%)
Region	
Anhui province	825 (39.64%)
Shenzhen city	360 (17.29%)
Shaanxi province	896 (43.06%)
Living area	
Urban	1,298 (62.37%)
Rural	783 (37.63%)
Registered residence	
Local residents	1,695 (81.45%)
Internal migrants	386 (18.55%)
Caregiver's age group (years)	
<=30	551 (26.48%)
~35	880 (42.29%)
~40	384 (18.45%)
>40	266 (12.78%)
Gender (Caregiver)	
Female	1,672 (80.35%)
Male	409 (19.65%)
Caregiver relationship with children	
Mother	1,621 (77.9%)
Father	330 (15.86%)
Grandparents and others	130 (6.25%)
Education	
Middle school or below	501 (24.07%)
High school	447 (21.48%)
Junior college	537 (25.8%)
Bachelor degree or above	596 (28.64%)
Annual household income (1000 Renminbi)	
<20	426 (20.47%)
20–50	399 (19.17%)
50–100	540 (25.95%)
100–200	439 (21.1%)
>200	277 (13.31%)
Gender (Child)	

Female	996 (47.86%)
Male	1,085 (52.14%)
Child’s age group (months)	
<24	426 (20.47%)
>=24	1,655 (79.53%)
Susceptibility of flu	
Low	433 (20.81%)
High	1,648 (79.19%)
Susceptibility of flu during COVID-19	
Decreased	750 (36.04%)
Increased	1,331 (63.96%)
Severity of flu	
Low	709 (34.07%)
High	1,372 (65.93%)
Confidence in flu vaccine effectiveness	
Disagree	520 (24.99%)
Agree	1,561 (75.01%)
Confidence in flu vaccine importance	
Disagree	317 (15.23%)
Agree	1,764 (84.77%)
Confidence in flu vaccine safety	
Disagree	318 (15.28%)
Agree	1,763 (84.72%)
Time conflict with vaccination service	
Disagree	1,854 (89.09%)
Agree	227 (10.91%)
Influenza vaccine is out of stock	
Disagree	1,653 (79.43%)
Agree	428 (20.57%)
Influenza vaccine is expensive	
Disagree	1,694 (81.4%)
Agree	387 (18.6%)
Unsatisfied with past vaccination service	
Disagree	1,890 (90.82%)
Agree	191 (9.18%)
Transport to POVs is inconvenient	

Disagree	1,886 (90.63%)
Agree	195 (9.37%)
Most caregivers vaccinate their children	
Disagree	1,120 (53.82%)
Agree	961 (46.18%)
Child's self-rated health is poor	
Disagree	1,639 (78.76%)
Agree	442 (21.24%)
Influence from HCWs	
Negative	1,331 (63.96%)
Positive	750 (36.04%)
Influence from family members or friends	
Negative	1,433 (68.86%)
Positive	648 (31.14%)
Influence from government departments	
Negative	1,363 (65.5%)
Positive	718 (34.5%)
Influence from internet	
Negative	1,754 (84.29%)
Positive	327 (15.71%)
Anxiety associated with flu vaccination	
Yes	1,644 (79%)
No	437 (21%)
Anxiety associated with not getting flu vaccination	
Yes	1,654 (79.48%)
No	427 (20.52%)

CHAPTER FOUR

Caregivers' understanding of childhood influenza vaccination during the epidemic in China. A mixed-methods study

In this chapter, I report on a mixed-methods study combining a questionnaire survey and semi-structured interviews conducted in Anhui, Shaanxi, and Guangdong provinces in China, with the aim of estimating childhood influenza vaccination during the COVID-19 pandemic and investigating the decision-making process of caregivers regarding childhood influenza vaccination during the COVID-19 pandemic. I investigated and identified the reasons for caregivers' perception about influenza and vaccines, how caregivers perceive and understand the communication on influenza vaccines. Data were collected from September to November 2021 by the Fudan University. I assisted the research team of Fudan University in developing study design and instruments. I conducted data analysis and interpretation, and drafted and revised the manuscript independently. The findings have been prepared as a draft of the manuscript, with comments on drafts from Professors Heidi Larson, Tracey Chantler, Zhiyuan Hou. This manuscript has been accepted by Frontiers in Public Health.

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SECTION A – Student Details

Student ID Number	LSH1805371	**Title**	MR.
First Name(s)	Kaiyi		
Surname/Family Name	Han		
Thesis Title	Caregivers' decision-making about childhood seasonal influenza vaccination in three provinces in China: A mixed-methods study		
Primary Supervisor	Professor Heidi Larson		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Frontiers in Public Health		
When was the work published?	Augest 10, 2023		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	This study helps understand not only the reasons for caregivers' perception about influenza and vaccines, but also how caregivers perceive and understand the communication on influenza vaccines, and whether and how this influences their decision to vaccinate, to furtherly contribute to structure and implement communication interventions appropriately.		
Have you retained the copyright for the work?*	Yes	Was the work subject to academic peer review?	Yes

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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	ZH, HJL, TC and ST contributed to conception and design of the study. KH and QW, SH, YX, JD and SZ contributed to data collection. KH organized the database. KH performed the statistical analysis. KH wrote the first draft of the manuscript. ZH, TC and HJL wrote sections of the manuscript.

SECTION E

Student Signature	
Date	1/9/2023

Supervisor Signature	
Date	1/9/2023

Caregivers' understanding of childhood influenza vaccination during the epidemic in China. A mixed-methods study

Background Influenza vaccination uptake among young children has been very poor in China, but it is unclear how it changed during the COVID-19 pandemic. This study aimed to investigate the uptake status and reasons of childhood influenza vaccination during the pandemic in China.

Methods A mixed-methods study combining a questionnaire survey and semi-structured interviews was conducted in Anhui, Shaanxi, and Guangdong provinces between September and November 2021. 2,081 caregivers completed the valid questionnaire, and 38 caregivers participated in interviews.

Findings A total of 2,081 caregivers completed the valid questionnaire, and 38 caregivers participated in interviews. Among the surveyed caregivers, 46.10% and 43.63% of the respondents reported that they vaccinated their children against influenza in the 2019-2020 and 2020-2021 flu season, respectively. Many caregivers indicated that the adoption of nonpharmacologic interventions (NPIs) during COVID-19 reduced the risk of influenza infection for children. Most caregivers consider the severity of influenza to be low, and some confused the common cold with influenza. Meanwhile, some caregivers lack confidence in the vaccine's effectiveness and importance. They thought that vaccines are not effective in preventing the constantly mutating virus. Despite clear perceptions about the severity of influenza and the effectiveness of the vaccine, we found that most caregivers didn't receive any relevant medical information, and the communication about vaccines between caregivers and professional information sources, such as healthcare workers, is inadequate. Hence, caregivers have no scientific evidence to back up their perceptions. In terms of access to vaccination service, caregivers reported conflicts between time of vaccination service and their schedule, and the need for vaccine prices to be reduced.

Interpretation Targeted interventions are needed to address caregivers' lack of risk perception on influenza during COVID-19 and promote communication between caregivers and professional information sources. Extending vaccination service hours and increasing the number of vaccine clinics close to residential areas and expansion of financing sources for self-paid vaccination have the potential to facilitate the access to influenza vaccination service.

Funding The NIHR (16/137/109) using UK aid from the UK Government to support global health research.

Keywords: influenza, vaccine, mixed-methods, China, child.

1. Introduction

The COVID-19 pandemic continues to have a major impact worldwide [39]. Co-circulation of COVID-19 and influenza may lead to great burden on hospitalization and intensive care unit (ICU) resources [213]. To avoid potential surge resource needs, it's essential to focus on maximizing the impact of the available control measures for both COVID-19 and influenza. Influenza vaccination of risk groups should be the cornerstone of seasonal influenza management [214]. Recommended by the World Health Organization (WHO), vaccination uptake among high-risk groups, is an effective strategy for decreasing influenza burden and therefore allowing for better preparedness for anticipated COVID-19 waves. In China, however, influenza vaccine remains excluded from national Expanded Program of Immunisation (EPI) and needs to be paid out of pocket [6], although many countries have included it in their National Immunisation Program [31, 33, 185-187]. Influenza vaccination uptake has been keeping at low level for decades in China and difference exists between regions, even for children aged 6–59 months - one of the high-risk groups recommended by the WHO [5]. Uptake rate of influenza vaccination among the young children ranged from 3.1% in a city in Fujian Province in 2015 to 47.7% in Guangzhou city in 2013 [36-38]. The low influenza vaccination coverage cannot protect children during the pandemic. Studies have shown that caregivers' knowledge, perceived risk of getting influenza, beliefs regarding the vaccine's efficacy and safety, perceived barriers of vaccination and recommendation from healthcare workers (HCWs) were associated with their decision on childhood influenza vaccination [36-38]. An important barrier, leading to doubts about the trade-offs between the benefits and risks of vaccination, is a lack of appropriate information [8]. Sufficient communication from professional information sources could enhance their capacity to counter negative information about vaccines and achieve community support for vaccination programs. The Strategic Advisory Group on Experts (SAGE) Working Group on Vaccine Hesitancy established in 2012, concluded that communication can play an important role in the public's decision to vaccinate [140]. In most settings, communication about childhood vaccination is common, but to date, there have been few attempts to explore how caregivers perceive and experience communication about vaccination and if the information or mode of communication influences their intention to vaccinate [215]. In addition, the COVID-19 pandemic may affect the public's perception on influenza in different ways. Due to increased diversion of resources to COVID-19, there is a heightened importance for seasonal influenza vaccination to minimize the viral reservoir in the population [213]. On the other hand, continued use of face coverings and reinstating local lockdowns during periods of increased transmission could substantially reduce the rates of infection for both COVID-19 and influenza diseases [193]. A study has shown decreased influenza incidence in 2020 after adoption of nonpharmacologic interventions (NPIs) as compared with prior seasons [95].

Thus, it's necessary to understand how public perceptions of influenza vaccination changed during the COVID-19 pandemic. This study aims to estimate childhood influenza vaccination during the COVID-19 pandemic using a national survey. We further conducted semi-structured interviews to investigate the decision-making process of caregivers regarding childhood influenza vaccination during the COVID-19 pandemic. This will help understand not only the reasons for caregivers' perception about influenza and vaccines, but also how caregivers perceive and understand the communication on influenza vaccines, and whether and how this influences their decision to vaccinate, to furtherly contribute to structure and implement communication interventions appropriately.

2. Methods

2.1. Study design and sites

We conducted a mixed-methods study combined with questionnaire survey and semi-structured interview between September and November 2021 in Shenzhen megacity, Anhui province, and Shaanxi province, covering the East, Middle and West of China, respectively. One urban district and one rural county were selected separately in the Anhui and Shaanxi provinces, and one urban district was selected in Shenzhen megacity. Three or four communities were selected according to their socioeconomic status in each district/county.

The Fudan University School of Public Health, and the London School of Hygiene and Tropical Medicine (LSHTM) Ethics committees approved the study protocol [FDU IRB#2018-10-0703, LSHTM Ethics Ref 16016].

2.2. Survey data collection and analysis

2.2.1 Recruitment of survey participant

The survey participants were defined as caregivers (parents and guardians) of children aged six and under. In each sampled community, eligible participants were recruited from one vaccination clinic and one kindergarten respectively. Caregivers of all children visiting the vaccination clinics on a given day during the survey period and from a class in the sampled kindergartens were invited to participate in the survey. Caregivers were invited to complete an online questionnaire after signing informed consent. Data from the self-completed online questionnaires were automatically uploaded to the Wenjuanxing online platform in real time.

In total 2,081 caregivers were surveyed, 360 from Nanshan district in Guangdong Province, 360 and 465 were from Dongzhi County and Shushan district in Anhui Province, 423 and 473 were from Jingyang county and Qindu district in Shaanxi Province, respectively.

2.2.2. Survey questionnaire

The questionnaire included questions about demographic and socio-economic characteristics, and childhood influenza vaccination. Childhood influenza vaccination behaviour was measured with two questions, “Did your child receive influenza vaccine during the last flu season (October 2020 March 2021)?” and “Did your child receive influenza vaccine during the 2019-2020 flu season?”

2.2.3. Statistical analysis for survey data

Descriptive analyses were performed to compare the levels of childhood influenza vaccine uptake by living area and child’s age during the two flu seasons. All statistical analyses were performed using Stata, version 14.0 (StataCorp LP, College Station, TX, USA).

2.3. Interview data collection and analysis

2.3.1 Recruitment of Interview Participant

We recruited caregivers for interview from the vaccination clinic in each sampled community. We applied purposive sampling to obtain a range of perspectives and achieve variation in terms of childhood influenza vaccination status. Caregivers were sampled according to their children’s influenza vaccination status in the 2020-2021 flu season, i.e. whether they (i) vaccinated their children against influenza in the 2020-2021 flu season, or (ii) didn’t vaccinate their children. For each influenza vaccination status, one or two caregivers were recruited from one vaccination clinic in each sampled community. All participants signed a consent form before the interview commenced and were given a token. (e.g., cup) for their time and effort.

In total 38 caregivers were interviewed: 8 from Nanshan district in Guangdong province, 8 and 10 from Dongzhi county and Shushan district in Anhui province, and 5 and 7 from Jingyang county and Qingdu district in Shaanxi province.

2.3.2 Interview guides

We interviewed a total of 38 caregivers at vaccination clinics from September to November 2021. Each interview lasted approximately 20 minutes. The sample of interviewees was determined by the principal of data saturation (no new information emerges from the interviews). We developed interview guides according to the Hesitancy Determinants Matrix [140]. The Matrix highlights not only individual perceptions and attitudes towards diseases and vaccines, but also the influence of various information sources and the access of vaccination services on individual decisions on vaccination. Topic guides

were developed based on the research objectives to structure caregivers decision-making processes and cover the following key areas:

• Access to influenza vaccination service, including the transportation to the vaccine clinics, the time of the vaccination service, satisfaction with HCWs, and affordability of influenza vaccines

• Perception of the disease and the vaccine, including perceived causes, symptoms, and complications of influenza, their perceived susceptibility and severity of influenza of children before and during COVID-19, confidence in influenza vaccines' importance, effectiveness, and safety.

• Sources of information and influencers in relation to influenza vaccination

• Caregivers' communication with professional information sources, including HCWs and staffs from Centre for Disease Control and Prevention (CDCs) or Community Healthcare Centres (CHCs).

Topic guides were piloted with three caregivers (not included in the analysis) to further refine the questions and topics. The interviews were audio-recorded (with participant consent) and transcribed verbatim by a professional software service (iflynote) [216]. We also took notes during the sessions. All participants were informed that participation was voluntary and that they could withdraw at any time. All interviewees were assured of the confidentiality of the interviews. None of the participants left the study before the interviews were concluded.

2.3.3. Data analysis for interviews

All interviews were audio-recorded and transcribed verbatim by the research team. A thematic analysis was conducted [217]. The two researchers (HKY and WQ) conducted all the fieldwork and analysis to ensure the consistency and opportunities for cross-validation in relation to the collection and interpretation of data. Through reading the transcripts, researchers produced a summary of initial ideas, and discussed with each other to develop initial coding framework. Quotations, with minor changes to improve readability, have been extracted from the data where they gave a good example of a finding or captured what several participants said.

The qualitative software management system NVivo, version 11 (QSR International Inc., Burlington, MA, USA), was used to systematically organize the transcripts and to support coding and data analysis.

3. Results

3.1. Characteristics of participants

Characteristics of survey participants are presented in table 1. Of the 2,081 respondents with valid data, 62.37% lived in urban areas, and 81.45% of caregivers' residence is registered locally. Over half (54.45%) caregivers had obtained junior college or bachelor level education or above, and 39.64% had an annual household income of less than CNY 50,000. Around 52% of caregivers' children were male, and a majority (79.53%) were ≥24 months old.

Among 38 caregivers who received interview: Most were women (32), aged 25–35 (23), educated to High school and below (15) (Table 2).

3.2. Quantitative results on vaccination uptake

Of the 2,081 respondents, a total of 1,796 were in the age group for high-risk groups in the 2019-2020 flu season, and 46.10 % reported that they vaccinated their children against influenza in the 2019-2020 flu season; meanwhile, 43.63% said that they vaccinated their children against influenza in the 2020-2021 flu season. In rural area, 43.82% and 40.36% of caregivers said that they vaccinated their children against influenza in the 2019-2020 and 2020-2021 flu season, while 47.49% and 45.61% indicated that they did in the 2019-2020 and 2020-2021 flu season in urban area. For caregivers with children younger than 24 months, 49.69 % and 52.11% said that they vaccinated their children against influenza in the 2019-2020 and 2020-2021 flu season, while 44.10% and 41.45% of caregivers with children older than 24 months indicated that they did in the 2019-2020 and 2020-2021 flu season (Table 1).

3.3. Qualitative results on vaccination decision process and reasons

Of all caregivers interviewed, 17 vaccinated their children against influenza in the 2020-2021 flu season, 18 didn't vaccinate their children and 3 were willing to vaccinate children but ultimately did not. Their vaccination decision process and reasons are as follows.

3.2.1. Availability of influenza vaccination services

Most caregivers expressed satisfaction with the transportation to and from the vaccine clinics (36/38) and the vaccination service provided by HCWs (36/38). Just over half of respondents (23/38) reported no conflicts between their schedules and the time of vaccination services, a small number (9/38) said they experienced time conflicts.

"Today is fine, (but) usually there will be many people waiting here, I might have to wait in line all morning, (and) because I own my own store, so I can't open my store all morning.'' (Caregiver 28, female, childhood influenza vaccination in the 2020-2021 flu season:

No,Qindu District, Xianyang city). Regarding the price of influenza vaccine ranging from 31 to 298 Chinese Yuan, some respondents (15/38) indicated that there is a need to lower the price of influenza vaccine.

“I'm fine with charging for vaccines, but I think it's better to provide free vaccines to children. [...].” (Caregiver 4, male, childhood influenza vaccination in the 2020-2021 flu season: Yes, Nanshan District, Shenzhen city).

3.2.2 Reduction in caregivers' risk perception of influenza during COVID-19

Half of the caregivers (19/38) indicated that the risk of influenza remained the same or decreased during the pandemic. Nearly half (17/38) said that the adoption of nonpharmacologic interventions (NPIs), such as mandated face coverings in public, reduced the risk of getting the flu.

“It is certainly an effective protection. Double protection. In the past, people did not pay much attention to wearing masks and keeping distance with each other, but due to the COVID-19 pandemic, we pay more attention to these things, and the awareness of personal protection has been strengthened. We know it also has a positive effect in blocking this spread of influenza.” (Caregiver 22, male, childhood influenza vaccination in the 2020-2021 flu season: Yes, Shushan District, Hefei city).

3.2.3 Low risk perceptions of influenza and high confidence in influenza vaccines

More than half of the caregivers (21/38) indicated that their children were highly susceptible to influenza. However, only a few (7/38) reported that getting the flu would lead to serious health consequences. Caregivers low level of perceived severity of influenza was associated with their understanding of the health consequences of influenza infection. Among all caregivers, half of them (19/38) thought that influenza is an illness similar to a cold.

“The symptoms of the flu? Like catching are a cold, fever, a runny nose. That's all I know. I really don't pay attention to the rest.” (Caregiver 4, male, childhood influenza vaccination in the 2020-2021 flu season: Yes, Nanshan District, Shenzhen city).

Most caregivers (32/38) had a high level of confidence in the safety of influenza vaccines because they believe that government and the healthcare system were trustworthy, and they have strict oversight and testing of vaccine development and production. Some caregivers however remained uncertain about influenza vaccines’ effectiveness and importance. The main reason is that they believe the virus is constantly mutating, and the vaccine will not work against the mutated virus.

“Because flu virus mutates very fast, all of the vaccines are against influenza virus which have been discovered, if we haven't found it yet, there is no effective vaccine, Now the speed of vaccine development can’t keep up with the speed of virus mutation. [...]” (Caregiver 5, female, childhood influenza vaccination in the 2020-2021 flu season: No, Nanshan District, Shenzhen city).

We found that the caregivers’ perceived severity of influenza in children and confidence in influenza vaccines’ effectiveness and importance differed between participants who made different decisions about childhood influenza vaccination. Caregivers who vaccinated their children against influenza reported greater likelihood of perceiving high severity of influenza in children and more confidence influenza vaccines’ effectiveness and importance.

3.2.4 Limited knowledge of influenza among caregivers and a lack of health information

The majority of caregivers in the three provinces (28/38) indicated that they did not have a good knowledge of influenza. Their general perspectives are that influenza is an infectious disease, but the causes, symptoms and possible complications of influenza are not well understood.

“I do not know the cause of the flu, but I always feel that it is due to the weather or the infection? If you ask me which virus caused it? I do not know. It may be a cold.” (Caregiver 17, male, childhood influenza vaccination in the 2020-2021 flu season: Yes, Shushan District, Hefei city).

The reason why caregivers don not have a good knowledge of influenza may be that caregivers receive limited health information. Over half of participants (22/38) said they did not have any access to health information. Less than half of caregivers said they had not been exposed to any flu-related information.

“The health information I'm concerned about is mainly more in terms of parenting, sent by the official account in WeChat, or TikTok. Mainly about children’s education, and less information about vaccines. Because I've vaccinated my child (with) all the required vaccines, so there's nothing else to think about.” (Caregiver 30, female, childhood influenza vaccination in the 2020-2021 flu season: No, Qindu District, Xianyang city).

3.2.5 Insufficient communication with professional information sources

Many caregivers (20/38) reported lack of communication with HCWs about vaccination. Because professional information sources cannot meet the information needs of caregivers,

some caregivers said that they will look for relevant health information through the Internet. At the same time, caregivers (22/38) also said that HCWs will only briefly introduce the age-appropriate non-EPI vaccines to them when they take children to vaccination clinics. Caregivers understood the enormous daily workloads that the HCWs faced.

"Not a lot of communication. After all, there are a lot of people in the hospital. When you have questions for these healthcare workers, their answer is the same, just a few words, there is no in-depth talk. We don't have much access to doctors. I don't have much contact with them. [...]" (Caregiver 1, male, childhood influenza vaccination in the 2020-2021 flu season: Yes, Nanshan District, Shenzhen city).

Over half of the caregivers said they had not received any flu vaccine-related health education from staffs in other medical institutions, including CHCs, and CDCs. The brochures and videos provided at vaccination clinics didn't interest them and influence their decision on vaccination. Caregivers who indicated that they had received health education at vaccination sites said that the content of health education is mainly about vaccination procedures, vaccine types and how to deal with contraindications and emergency responses.

Another reason for insufficient communication between caregivers and HCWs is the vaccination schedules of EPI vaccines and non-EPI vaccines. When children are one year old, the number of EPI vaccines required on the vaccination schedule and the non-EPI vaccine greatly reduce, resulting in HCWs being unable to remind parents of the need for influenza vaccination face-to-face.

"I didn't know there was such a thing as a flu shot. Every shot is indicated in the vaccine record book. My child needs to be vaccinated at the age of 6, but between the ages of 3 and 6, the record book is empty and says nothing about any vaccination. This is for you to choose. And then when the doctor tells you about it, they only tell you about EPI vaccine, so I didn't pay attention to vaccinations for years. The flu vaccine is still a bit under-advertised." (Caregiver 24, female, childhood influenza vaccination in the 2020-2021 flu season: No, Shushan District, Hefei city).

4. Discussion

Our study explored caregivers' understanding of childhood influenza vaccination and their communication with various information sources during the COVID-19 pandemic. We found a similar coverage (around 45%) of influenza vaccination in the 2019-2020 and 2020-2021 flu seasons. Many caregivers indicated that the adoption of NPIs during COVID-19 reduced the risk of influenza infection for children. Our study showed that there is limited knowledge about influenza and its potential severity among caregivers. Meanwhile, some

caregivers lacked confidence in the vaccine's effectiveness and importance. Communication about vaccines between caregivers and professional information sources including HCWs and staffs from other medical institutions is inadequate. We also found that some caregivers indicated conflicts between the time of vaccination service and their schedule, and the need for vaccine prices to be reduced.

In our study, influenza vaccination rates among children were higher than the results of previous studies [37, 107]. Influenza vaccination uptake was similar during the 2019-2020 and 2020-2021 flu seasons. Qualitative results show that many caregivers believed that the adoption of NPIs, such as use of face coverings and reinstating local lockdowns during COVID-19, reduced the incidence of influenza, and ultimately chose not to vaccinate their children against the flu. However, as restrictions on individual movement are loosened, the transmission on influenza is expected to increase [193]. Hence, education campaign will be critical to address caregivers' lack of risk perception on influenza during COVID-19.

Our study highlighted that caregivers think that children are highly susceptible to influenza, but that the consequences of infection are not serious, and this was also observed in other studies [38]. Perceived low severity of influenza may be linked to caregivers confusing the common cold with influenza and/or influenza-like illness [179]. It resonates with previous study in Xining City, Qinghai province, which showed that 40% of parents of local kindergarten children perceived Influenza as a common cold [37]. Meanwhile, caregivers surveyed in this study conveyed high level of confidence in the safety of influenza vaccine. Confidence in vaccine safety stems primarily from the public's trust in government departments and HCWs. This trust is also the main reason that vaccine confidence among the public was restored relatively quickly after vaccine quality incidents in China [200, 218-220]. Despite evident confidence in the safety of influenza vaccine, we observed clear uncertainty about the effectiveness and importance of influenza vaccines in some caregivers. The reason for the lack of confidence in the effectiveness of caregivers is the belief that the virus is constantly mutating so that the vaccine is not effective in preventing infection and not necessary. Despite strong clinical evidence demonstrating the efficacy of the influenza vaccine [221-224], it can be speculated that the public is not clear about these data, which could in turn translates into a reluctance to vaccinate.

Although respondents had a clear perception about the severity of influenza and attitude toward influenza vaccine, as well as a fair bit understanding of the mutation of influenza viruses, we found that caregivers lack sufficient knowledge about influenza, including the causes, symptoms, and complications of the flu. Previous studies in China also showed a lack of knowledge about influenza among caregivers, with only 21·6% of parents saying they

knew how influenza is transmitted [37]. Our results suggested that their perceptions and attitude toward influenza and vaccine were not supported by scientific evidence. The study also showed that caregivers receive little influenza-related health information. Regarded as the most reliable information sources [190, 225], HCWs didn't provide adequate information for caregivers' influenza vaccination decisions. Many caregivers were only informed about the availability of influenza vaccines and did not have in-depth communication with HCWs, which resonates with previous qualitative research that found health professionals only provided information about non-scheduled vaccines to caregivers and emphasized parental autonomy in decision-making at the same time [170]. Further research is needed to quantitatively describe how HCWs recommend non-EPI vaccines and figure out its influencing factors. Caregivers in our study also indicated that they had not received health education about vaccines from staffs in other medical institutions, including CHCs, and CDCs, or paid little attention to existing health education methods, such as brochures and videos. The results suggest that current methods for providing health information need to be reviewed and optimized. Over the last several decades, the practice of health communication has undergone significant changes, with increasing recognition that health decisions are shaped not only by knowledge or awareness but also by risk perception and self-efficacy [226]. Therefore, in addition to simply describing knowledge, health communication programs need to make health information interpretable, persuasive, and actionable. To better motivate and change the public's choices on vaccination, it is necessary to summarize the existing ways of health education and extract the effective parts to be implemented. In addition, to improve the accessibility of information for caregivers who cannot receive vaccination notifications without going to the vaccine clinics, medical institutions should make use of the Internet, including social media, to actively share vaccination-related information to caregivers in a timely manner and address caregivers' misconceptions regarding immunisation and influenza.

Our research shows that most caregivers were satisfied with the access of influenza vaccination services, while some caregivers were dissatisfied with the time of vaccination services and the price of influenza vaccines. Targeted interventions are necessary, including extending vaccination service hours and establishing more vaccine clinics close to residential areas. Furthermore, previous research showed that a subsidy that would reduce the price for caregivers could contribute to increasing the demand for non-EPI vaccination [227]. Our results suggest that an expansion of financing sources is needed to alleviate economic barriers to the cost of influenza vaccines, and specific strategies should also be tailored to each region according to their disease burden and fiscal capacity.

5. Strengths and limitations

The main strength of our study was the nature of the semi-structured interviews, which allowed the conversation to be framed by the research questions but steered by the caregivers themselves. In addition, the cooperation of local CHCs helped the researchers gain trust and acceptance among participants. There were several limitations to our study. Firstly, given the qualitative nature of the research, the participant sample size for our study limits its generalizability. A quantitative research design approach is needed to extrapolate the findings to the wider community. Secondly, sample bias is applicable to this study as participants showed a genuine interest in the management and prevention of respiratory tract infections in young children, which may not apply across all parental cohorts. Thirdly, our findings concerning other parties involved in health communication including the HCWs, staffs from CHCs and CDCs were based on indirect answers from caregivers. Further studies need to focus on HCWs responsible for providing or managing immunisation services, who would likely have provided different and additional perspectives.

6. Conclusions

Our study reveals higher influenza vaccination uptake rates among children than previous studies. However, the adoption of NPIs during COVID-19 reduced the risk perception of influenza among caregivers. A number of caregivers had a poor knowledge of the influenza, and there were misconceptions that the influenza is not serious and that the flu vaccine is not effective. Many caregivers received little health information and had inadequate communication with professional information sources, including HCWs and staffs from other medical institutions. We also found that caregivers were generally satisfied with access to vaccine services, except for the price and where there were conflicts between their schedule and the time of vaccine services. More evidence-based interventions are needed to encourage communication between HCWs and caregivers, raise caregivers' risk perception of influenza and eliminate misconceptions. In addition, extending vaccination service hours and increasing the number of vaccination clinics close to residential areas and expansion of financing sources for self-paid vaccination, could help improve access to vaccination services.

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Data sharing statements The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Table 1 Characteristics of Respondent in survey, N (%)

	Total (2020), N	**Uptake rates for 2020-21 flu season**	**Total (2019), N**	**Uptake rates for 2019-20 flu season**
Total	2,081	43.63%	1,796	46.10%
Region				
Anhui province	825(39.64%)	398(48.24%)	682(37.97%)	369(54.11%)
Shenzhen city	360(17.29%)	134(37.22%)	320(17.82%)	133(41.56%)
Shaanxi province	896(43.06%)	376(41.96%)	794(44.21%)	326(41.06%)
Living area				
Urban	1,298(62.37%)	592(45.61%)	1,116(62.14%)	530(47.49%)
Rural	783(37.63%)	316(40.36%)	680(37.86%)	298(43.82%)
Registered residence				
Local residents	1,695(81.45%)	750(44.25%)	1,488(82.85%)	683(45.90%)
Internal migrants	386(18.55%)	158(40.93%)	308(17.15%)	145(47.08%)
Caregiver's age group (years)				
<=30	551(26.48%)	247(44.83%)	440(24.50%)	208(47.27%)
~35	880(42.29%)	388(44.09%)	757(42.15%)	343(45.31 %)
~40	384(18.45%)	164(42.71%)	357(19.88%)	173(48.46%)
>40	266(12.78%)	109(40.98%)	242(13.47%)	104(42.98%)
Gender (Caregiver)				
Female	1,672(80.35%)	715(42.76%)	1,449(80.68%)	651(44.93 %)
Male	409(19.65%)	193(47.19%)	347(19.32%)	177(51.01%)
Caregiver relationship with children				
Mother	1,621(77.9%)	691(42.63%)	1,410(78.51%)	630(44.68%)
Father	330(15.86%)	153(46.36%)	278(15.48%)	141(50.72%)
Grandparents and others	130(6.25%)	64(49.23%)	108(6.01%)	57(52.78%)
Education				
Middle school or below	501(24.07%)	189(37.72%)	444(24.72%)	193(43.47%)
High school	447(21.48%)	185(41.39%)	391(21.77%)	178(45.52%)
Junior college	537(25.8%)	250(46.55%)	455(25.33%)	220(48.35%)

Bachelor degree or above	596(28.64%)	284(47.65%)	506(28.17%)	237(46.84%)
Annual household income (1000 Renminbi)				
<20	426(20.47%)	172(40.38%)	376(20.94%)	149(39.63%)
20–50	399(19.17%)	172(43.11%)	337(18.76%)	153(45.40%)
50–100	540(25.95%)	253(46.85%)	460(25.61%)	235(51.09%)
100–200	439(21.1%)	196(44.65%)	386(21.49%)	189(48.96 %)
>200	277(13.31%)	115 (41.52%)	237(13.20%)	102(43.04 %)
Gender (Child)				
Female	996(47.86%)	449(45.08%)	871(48.50%)	410(47.07%)
Male	1,085(52.14%)	459(42.30%)	925(51.50%)	418(45.19%)
Child's age group (months)				
<24	426(20.47%)	222(52.11%)	644(35.86%)	320(49.69%)
>=24	1,655(79.53%)	686(41.45%)	1,152(64.14%)	508(44.10%)

Table 2 Characteristics of caregivers participating in interviews

	Total, N
Total	38
Children's influenza vaccination status in the 2020-2021 flu season	
Vaccination	17
Non vaccination	18
Non vaccination while with the willingness to receive vaccination	3
County/city	
Rural county, Anhui province	8
Urban city, Anhui province	10
Rural county, Shaanxi province	6
Urban city, Shaanxi province	6
Shenzhen city	8
Relationship with children	
Mother	32
Father	6
Age (years)	
25-30	5
30-35	19
35-40	9
>40	3
Education	
High school and below	15
Junior college	9
Undergraduate and above	13

CHAPTER FIVE

Investigate Non–EPI Vaccination Recommendation Practice from a Socio-Ecological Perspective: A Mixed-Methods Study in China

In this chapter, I report on secondary data analysis of a mixed-methods study on vaccination service provides' recommendation practices for non-EPI vaccines from a socio-ecological perspective. Data were collected by the Fudan University in January 2019 in Shenzhen megacity, Anhui province, and Shaanxi province, covering the East, Middle and West of China, respectively. I assisted the research team of Fudan University in developing study design, and instruments. I conducted data analysis and interpretation, and drafted and revised the manuscript independently. I employed Social Ecological Model for VSPs' recommendation practices for non-EPI vaccines in the analysis and interpretation of the results. The findings and results have been prepared as a draft of the manuscript, with comments on drafts from Professors Heidi Larson, Tracey Chantler, Zhiyuan Hou and Shiyi Tu. This manuscript has been accepted by Vaccines.

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SECTION A – Student Details

Student ID Number	LSH1805371	**Title**	MR.
First Name(s)	Kaiyi		
Surname/Family Name	Han		
Thesis Title	Caregivers' decision-making about childhood seasonal influenza vaccination in three provinces in China: A mixed-methods study		
Primary Supervisor	Professor Heidi Larson		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Vaccines		
When was the work published?	December 8, 2022		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	This study frames the determinants of HCWs' recommendation for non-EPI vaccines in China, which was identified as an important factors to promote vaccination uptake among the public, from a socio-ecological perspective.		
Have you retained the copyright for the work?*	Yes	Was the work subject to academic peer review?	Yes

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Stage of publication	Choose an item.

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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Conceptualization, ZH, HJL, TC and ST; data curation, KH and QW; formal analysis, KH and QW; funding acquisition, HJL, TC, ZH and ST; investigation, ZH, TC and ST; methodology, ZH, HJL, TC and ST; project administration, ZH and ST; resources, BW, XL and SJ; software, KH; supervision, ZH, TC and HJL; validation, KH; visualization, KH; writing—original draft, KH; writing—review & editing, ZH, TC and HJL

SECTION E

Student Signature	
Date	1/9/2023

Supervisor Signature	
Date	1/9/2023

Investigate Non–EPI Vaccination Recommendation Practice from a Socio-Ecological Perspective: A Mixed-Methods Study in China

Abstract: The uptake of non-EPI vaccines, such as influenza and pneumonia vaccines, are very low in China compared to other countries. In China, immunisation services are provided by dedicated vaccination service providers (VSPs), and their recommendation is the key to improve vaccine uptake. This study explores VSP recommendation practices for non-EPI vaccines from a socio-ecological perspective. A mixed-methods study, combining a questionnaire survey and key informant interviews, was conducted in Anhui, Shaanxi, and Guangdong provinces. 555 VSPs completed the valid questionnaire, and 49 VSPs participated in in-depth interviews. Among the surveyed VSPs, 51.54% stated that they always or often recommended non-EPI vaccines in work, and the remaining half reported that they sometimes or never recommended non-EPI vaccines. Most VSPs interviewed communicated about non-EPI vaccines with the public in an informed style, not a presumptive one, and provided the public with all the decision-making latitude. The infrequent recommendation of non-EPI vaccines was widely prevalent among Chinese VSPs regardless of their individual characteristics, and was mainly driven by the interpersonal relationship, institutional arrangement, and public policy. Firstly, the VSPs were concerned about conflicts arising from the recommendation of self-paid vaccines and the risk of adverse reactions following vaccination. Secondly, high workloads left them insufficient time to communicate about non-EPI vaccines. Thirdly, there was no performance assessment or financial incentive for VSPs to recommend non-EPI vaccination, and their main responsibility was around EPI vaccination. Therefore, multi-level socio-ecological systems around non-EPI vaccination should be improved to optimize the communication between VSPs and the public, which include a better system of legal redress to resolve potential misunderstandings between the VSPs and the public, more effective workload management through whole-process health information system and strengthening public health workforce, and the introduction of performance assessment and appropriate incentives on non-EPI vaccination.

Keywords: vaccination; non-EPI vaccine; recommendation; communication; health care worker; China

1. Introduction

Immunisation has proven to be one of the most cost-effective health interventions [228, 229]. China initiated its national expanded program on immunisation (EPI) in 1978. Currently, the EPI program includes 14 vaccines against 15 vaccine-preventable diseases, which are provided to children free of charge and are required for school enrolment [24]. Vaccines not covered by the EPI program can be accessed voluntarily but must be paid for (Appendix A. Table A1). Compared to almost universal coverage of EPI vaccines, the uptake rates for non-EPI vaccines remain low in China [230-232]. For example, according to a survey, influenza vaccine (a non-EPI vaccine) uptake for young children was only 3.1% during the 2014–2015 influenza season in Xiamen city [107]. Research conducted in three provinces, with different socio-economic characteristics in China in 2013 suggests that vaccine affordability could explain this low uptake; Hou et al. found that the majority of caregivers of children zero–three years old were not willing to pay the market price for non-EPI vaccines [233].

While the reasons for the low uptake of non-EPI vaccines are complex, healthcare workers (HCWs) can play a core role in supporting public confidence in vaccination and making vaccination more accessible. There is a significant body of evidence that suggests that HCWs are the most trustworthy sources of health information for the public [128, 129] and communication between HCWs and the public is considered to be the cornerstone of maintaining the public's confidence in vaccinations [130]. In many countries, such as United States and United Kingdom, vaccination services are provided by HCWs, such as general practitioners and nurses, who also provide other medical services to the public [234]. In China, however, immunisation services are provided by dedicated vaccination service providers (VSPs) at vaccination clinics held in community healthcare centres [129]. Vaccinators are fully trained to deliver immunisation programs and schedule appointments with the public directly. A community healthcare centre in China typically employs 40–100 HCWs, of which only three–five serve as vaccinators, and generally HCWs do not have any vaccination responsibilities.

Two systematic reviews have summarized the determinants of HCWs' recommending the HPV vaccine worldwide, and found that recommendation behaviours varied by HCWs' knowledge, perceptions, and professional characteristics [235, 236]. Very few studies have investigated Chinese HCWs' vaccine recommendation behaviours. Previous studies reported that a low proportion (56.26%) of HCWs recommended the influenza vaccination for children in China, and that public health workers were more likely to recommend flu vaccine in contrast to general practitioners, as were those who had received a flu vaccination and those with more knowledge about national influenza vaccination guidelines [164, 237].

There are limitations with the existing studies that investigate HCW-patient communication and recommendation for vaccines. Firstly, HCW-patient communication can be rendered in three styles: Informed, shared, or presumptive [238]. These three different styles vary in the flow of information exchange, the leading role in expressing treatment preferences, and choosing a treatment to implement, and therefore have different levels of strength of recommendation for vaccines. In the informed and presumptive styles, the information exchange is largely one way and the HCW is assumed to be the primary source of information to the patient on medical issues about the patient's disease and treatment options, however, in the former, the HCW has no further role in the decision-making process, in the latter, the treating HCW may communicate to the patient only the ultimate treatment decision, failing to reveal knowledge and values considered in the selection process and how these were weighted. In the shared style, the information exchange is two-way, and both sides work towards reaching an agreement and have an investment in the ultimate decision made. Presumptive style communication from HCWs, a more HCW-driven communication style, has been associated with decreased hesitancy and increased receipt of vaccination [239]. Most existing studies do not take these communication styles into account. Secondly, individual behaviour is viewed as being affected by multiple levels of familial, social and cultural influences. The WHO Strategic Advisory Group of Experts on Immunisation developed a determinants matrix for vaccine hesitancy, which covers contextual influences, individual and group influences, and vaccine/vaccination-specific influences [140]. Previous studies on vaccination recommendation mainly focus on the intrapersonal layer such as HCWs' knowledge and perception but lack an overarching framework that incorporates the influences from other layers, such as institution regulation and policy.

The social-ecological model provides a conceptual framework to direct attention to both behaviour and its individual and environmental determinants [141, 240]. This model presents behaviour as a product of the interdependence between the individual and subsystems of the ecosystem (e.g., family, community, culture, physical and social environment) [240]. In this model, patterned behaviour is the outcome of interest and is viewed as being determined by five sub-ecosystems, which are intrapersonal, interpersonal, institutional, community, and policy. It has been used as a framework for studying medical services, such as non-prescription antibiotic dispensing [241]. It can also help to investigate HCWs' recommendation behaviours for vaccines in a comprehensive manner. This study aims to frame the potential determinants of HCWs' recommendation for non-EPI vaccines in China from a socio-ecological perspective. A mixed-methods study combining a cross-sectional survey and key informant interviews was adopted for this purpose. Our target population was VSPs since they are dedicated to deliver vaccination services in China, instead of general HCWs.

2. Materials and Methods

2.1. Study Design

We conducted a mixed-methods cross-sectional study in January 2019 in Shenzhen megacity, Anhui province, and Shaanxi province, covering the East, Middle and West of China, respectively. One urban district and one rural county were selected separately in the Anhui and Shaanxi provinces, and one urban district was selected in Shenzhen megacity. In total, this study was conducted in five districts/counties in China.

The Fudan University School of Public Health, and the London School of Hygiene and Tropical Medicine Ethics committees approved the study protocol [FDU IRB#2018-10-0703, LSHTM Ethics Ref 16016].

2.2. Data Collection

2.2.1. Survey of Vaccination Service Providers

To estimate the recommendation practice of non-EPI vaccines, a cross-sectional survey was conducted for all VSPs in the sampled districts and counties. A multi-stage sampling process was used to ensure the representativeness of the sample. Guangdong Province, Anhui Province and Shaanxi Province were selected to represent higher, median and lower social-economic tiers, respectively. At the provincial level, one urban district and one rural county were included in Shaanxi and Anhui provinces, and one urban district was included in Shenzhen megacity, Guangdong province. All VSPs (600) working in the sampled areas were invited to participate in a mobile-phone-based questionnaire survey by scanning a QR code. The self-administered questionnaire was distributed and managed using the online platform Wenjuanxing (https://www.wjx.cn/ (accessed on 9 June 2021)).

2.2.2. Interview

To understand the determinants of recommendation practice of non-EPI vaccines in depth, semi-structured interview was conducted following the questionnaire survey. In each sampled district/county, we interviewed one immunisation program manager from CDC, and VSPs from vaccination clinics in three selected community healthcare centres. These three community healthcare centres were selected to represent low, medium, and high socio-economic tiers within each district/county. Generally, there are 3–5 VSPs at a vaccination clinic, who are the director in charge of the clinic, vaccinators for vaccination service delivery and consultation, and a pediatrician for medical pre-screening and adverse reaction response. In each vaccination clinic, we invited one VSP from each job responsibility to participate in an interview.

2.3. Instruments

2.3.1. Questionnaire

The questionnaire was piloted for 10 VSPs in two non-study communities in Shanghai. The content of the questionnaire included the (a) study site, rural or urban residence, gender, age, education level, and profession (doctors, nurses or public health workers); (b) recommendation frequency of non-EPI vaccines, measured using the following question—How often do you recommend non-EPI vaccines to the public? There were four response options— "always", "often", "sometimes" and "never". Response options were further grouped into two categories for the analysis: often (including "always" and "often"), and not often (including "sometimes" and "never"). The question were linked to previous studies in the fields of HCWs' recommendation practice of vaccines [164].

2.3.2. Interview Guides

We developed interview guides according to five sub-ecosystems of the social-ecological model (Appendix B. Table A2) [240]. First, we asked interviewees about their communication and recommendation of vaccines to the public in their daily work. In terms of intrapersonal sub-ecosystem, we focused on VSPs' knowledge, perception, and confidence in vaccines and vaccination services. For interpersonal sub-ecosystem, we asked about the quality of doctor-patient relationships and relationships with other colleagues. For the institutional sub-ecosystem, we asked the VSPs about their routine work, self-evaluation of workload, and the potential impact of both on the recommendation practice of non-EPI vaccines. For community sub-ecosystem, we enquired about the supply of non-EPI vaccines and whether any shortage of non-EPI vaccines had ever occurred. For public policy sub-ecosystem, we investigated the influence of financial incentive policy on the recommendation practice of non-EPI vaccines and assessment from superiors (CDC).

The Interview guides was developed based on the research questions and objectives to explore influence of stakeholders, including the public, colleagues, vaccine manufacturers and superior department (CDC), on VSP recommendation practice for non-EPI vaccines. The guide covers predetermined questions around VSPs' knowledge, perception, and confidence in vaccines and vaccination services, self-rated quality of doctor-patient relationships and relationships with other colleagues, self-evaluation of workload, supply of non-EPI vaccines from vaccine manufacturers as well as the financial incentive policy on the recommendation practice and assessment from superiors (CDC).

All participants were informed of the purpose of the study. They were also informed that participation was voluntary and that they could withdraw at any time. All participants were assured of the confidentiality of the interviews. Each interview lasted between 30 and 60 min and were audio-recorded after obtaining written informed consent.

2.4. Statistical Analysis

2.4.1. Statistical Analysis for Survey Data

The recommendation practice of non-EPI vaccines was measured by the proportion of VSPs, who often recommend non-EPI vaccines among the total sample. Univariate analyses were performed to compare the VSPs' recommendation practice of non-EPI vaccines by their socio-demographic characteristics using Chi-square tests. A multivariable logistic regression analysis was further conducted to examine the factors associated with the VSPs' recommendation practice of non-EPI vaccines. Odds ratios with 95% confidence intervals were presented. All survey data were analyzed using STATA, version 14.0 (Stata Corp, College Station, TX, USA).

2.4.2. Data Analysis for Interviews

All interviews were transcribed verbatim and checked by another investigator. We conducted a thematic analysis using a combination of deductive and inductive coding to analyze the transcripts of the interviews [217]. We first identified detailed sub-themes via deductive, iterative coding of the data. Subsequently, exemplary data extracts were selected from the key sub-themes for inclusion as quotations. The interview transcripts were independently coded by two investigators, and any discrepancies were then discussed until a consensus was reached. All qualitative analysis were conducted using NVivo, version 11 (QSR International Inc., Burlington, MA, USA).

3. Results

3.1. Quantitative Results

Surveyed VSPs' characteristics and recommendation practices for non-EPI vaccines are summarized in Table 1. Respondents who completed the questionnaire in less than 2 min or left more than 50% of the questionnaire incomplete, 45 in all, were excluded. In total, 555 of 600 VSPs completed the valid questionnaire. Of the 555 respondents, 15.32% and 36.22% stated that they always or often recommended non-EPI vaccines to patients in work, whereas 36.4% and 12.07% of respondents reported that they sometimes or never recommended these vaccines, respectively.

Results from multivariate logistic regression (Table 1) suggested that respondents living in Anhui province were significantly more likely to recommend non-EPI vaccines than those in Shenzhen city (OR = 1.52, 95%CI: 1.04–2.20). VSPs older than 45 years old were significantly more likely to recommend non-EPI vaccines than those younger than 25 years old (OR = 2.50, 95%CI: 1.42–4.39). However, rural or urban residence, gender, education level, and professions had no significant association with recommendation practices for non-EPI vaccines.

3.2. Quantitative Results on Health Education and Recommendation Practices for Non-EPI Vaccines

In total, we conducted 43 interviews with VSPs and six interviews with immunization program managers (Table 2).

3.2.1. Health Education on Immunisation

Most participants said that health education on immunisation (including education to parents of newborn babies) was provided routinely in their workplace. The content mainly covered the importance of vaccination and the introduction of the EPI in China. As one VSP noted:

"First, we will give a general explanation of the components of the vaccine. Then, patients could wonder, some vaccines are free, and the other are not, why? Any difference between those two types of vaccines? We will tell, every vaccine is of the same importance. We also want parents to make sufficient preparation before vaccination. We will tell them to focus on five things: wearing the right clothes to keep warm; [...]. We need to popularize these for parents. The main thing is to get them to understand the importance of vaccination, the safety, right? And vaccines are very cost-effective." (VSP 4, male, Dongzhi county, Anhui province).

3.2.2. Recommendation Practices for Non-EPI Vaccines

Most VSPs said that they informed parents about age-appropriate vaccines for their children and asked about their intention to be vaccinated (mainly non-EPI vaccines) after the completion of EPI vaccinations. However, they did not actively recommend non-EPI vaccines. Almost all VSPs said that the purpose of this notification was to remind parents of the availability of non-EPI vaccines, and at the same time, honor parents' decision-making autonomy on non-EPI vaccinations for their children. As one VSP noted:

"Definitely no recommendation, but every time after finishing one free (EPI) vaccination, I would talk to them. It's like, before the next free (EPI) vaccine, there are other vaccines available, they are voluntary and not free. Then I would tell them, if you want to get it, I can make another appointment for you. If you don't, we won't force you to get vaccinated. It's voluntary, basically. They would ask, didn't you say vaccination was free? Then I say this is non-EPI vaccine, you can choose to get it or not [...]." (VSP 3, female, Dongzhi county, Anhui province).

3.3. Qualitative Results on the Ecosystems Influencing Recommendation Practices for Non-EPI Vaccines

3.3.1. Intrapersonal Sub-Ecosystem

Participants expressed the high confidence in vaccines and vaccination services no matter which are covered by the EPI or not. They believed that the benefits of vaccination outweigh the risks in general. As one participant said:

"I think I agree with the statement (the benefits of vaccination outweigh the risks), it's not because I work on this [...]. Vaccines like influenza, my colleague's child got influenza vaccination, and then went to kindergarten. There are more than 40 children in the class, and only a dozen of them can come to school this time (Others stayed away from school because they had the flu). But his child has been fine and have not caught the flu." (VSP 27, female, Shushan District, Anhui province).

Meanwhile, participants indicated a lack of knowledge about vaccines. They knew the vaccination schedule and service procedure but did not know about data on the effectiveness or safety of specific vaccines. As one participant said:

"I think it's... Just my knowledge about these vaccines... is too little, I know too little about it [...]. Most parents don't ask too much, but we really know little... my knowledge isn't very comprehensive." (VSP 41, female, Jingyang County, Shaanxi province).

3.3.2. Interpersonal Sub-Ecosystem

Many VSPs indicated that they were concerned about adverse reactions following vaccination, which could cause conflicts between parents and themselves if they recommended non-EPI vaccines to parents. As one participant said:

"One problem is. In one hospital, there was a case of adverse reaction related to non-EPI vaccination, and the dispute is very tricky. I remember that they compensated for it. They (the hospital) make so little money on vaccination, but finally have to pay so much compensation. They can't even carry out routine work at that time. Later, because of this, they almost gave up the inoculation of non-EPI vaccine. We just don't want to do it. The dean thought this was so tricky and he did not want to get involved in non-EPI vaccine. This case really hit him hard." (VSP 39, female, Jingyang County, Shaanxi province).

Some VSPs also stated that parents resent being recommended paid medical services (including vaccines). Therefore, recommending non-EPI vaccines may lead parents to perceive that the healthcare providers are profit-seeking and may further reduce parents' trust in them. As one participant said:

"We don't recommend it, only inform them (with the age-appropriate vaccines). Why? They will be unsatisfied. For example, we will tell him that there are two kinds of

Hepatitis A vaccines, one is imported, the other is domestic, and we let parents choose on their own. They would ask which one is better? Go online for information, we just tell you we have the vaccine." (VSP 15, female, Nanshan District, Shenzhen city).

3.3.3. Institutional Sub-Ecosystem

Many VSPs said that heavy workloads leave them insufficient time to communicate to parents about vaccines. As one VSP said:

"[...]., I need to vaccinate more than 100 people a day. I remember a training I received before, it goes like, vaccination service provider should not vaccinate more than 50 people per day, otherwise, his/her working status will be negatively affected, and he/she may make mistakes, or not be able to communication well with parents, so the satisfaction of parents will decrease [...]." (VSP 26, female, Shushan District, Anhui province).

In addition to the heavy workload of vaccinating itself, vaccinators often mentioned two other reasons contributing to their increased workload. Firstly, since many vaccination clinics are not equipped with electronic information system, all the work, including the reminders for children's vaccination appointments and entry of vaccination information, needs to be done manually. Secondly, some vaccinators said that, in addition to their vaccination work, they are also given other public health responsibilities within their respective jurisdictions, such as a health check-up. As two participants said:

"There is too much work to serve so many people. Now the requirements are so strict, and more and more detailed, right? Registration work, for example, can take you a whole morning if you write it by hand. If there is a set of electronic information system, first, it could alleviate the shortage of workforce, then avoid some mistakes [...]." (VSP 4, female, Dongzhi County, Anhui province).

"What I've been thinking is how to fulfill the annual work plan, I think a lot, but the plan just couldn't catch up with change. Our VSPs don't work only on vaccination, but also other types of work, such as poverty alleviation in rural area. Then scheduled work, such as professional improvement, will be disrupted. We also have to carry out physical examination for the elderly every year. It basically takes two months to complete the physical examination for the elderly in the whole town, and we work every day in two months." (VSP 10, female, Jingyang County, Shaanxi province).

3.3.4. Community Sub-Ecosystem

Many VSPs said that the cost of non-EPI vaccines is too expensive for local residents. High costs make them feel hesitant to recommend it to parents. As a director of a vaccination clinic described:

"Especially Pentaxim, its price is very high, 500 or 600 Chinese yuan. I do not advocate this vaccine, because we are in rural areas, here residents' affordability is limited, right? Its demand is not large." (VSP 1, male, Dongzhi County, Anhui province).

Many VSPs also indicated that there was a shortage of non-EPI vaccines, such as flu vaccine. They said that they could not recommend it to parents if they did not have it in stock. One VSP commented:

"For EPI vaccines, it's the leprosy vaccine, for non-EPI vaccines, it's Pentaxim, both vaccines are often out of stock. It was really difficult to conduct vaccination work at that time." (VSP 17, female, Nanshan District, Shenzhen city).

3.3.5. Public Policy Sub-Ecosystem

All VSPs indicated that the superior unit (District/County CDC) has clear assessment criteria for EPI vaccination rates but not for non-EPI vaccines. A director of a vaccination clinic described it as follows:

"We will count how many children need to be vaccinated, how many children have been vaccinated. County CDC's assessment criteria is that the vaccination rate of EPI vaccines should be at least 95%. Depending on the percentage you reach, you reach 80% and you get 80% merit pay, if 90% and then 90% merit pay. There is no assessment for non-EPI vaccines." (VSP 42, male, Jingyang County, Shaanxi province).

All VSPs said that a small service fee can be charged for non-EPI vaccinations. However, their income was fixed and not related to the number of non-EPI vaccines they administer. Two vaccinators described:

"We are paid a fixed salary. It has nothing to do with the number of non-EPI vaccine used." (VSP 24, female, Qingdu District, Shaanxi province).

"Non-EPI vaccines have no impact on our performance salary. Our work performance is generally assessed by the dean. It just depends on the working hours... Our performance income has nothing to do with the amount of EPI and non-EPI vaccination services. It's all arranged by the hospital [...]." (VSP 43, female, Jingyang County, Shaanxi province).

4. Discussion

This study used a mixed-method design to investigate the patterns and determinants of VSPs' communication and recommendation for non-EPI vaccines in the Chinese context. Only half (51.54%) of the VSPs often recommended non-EPI vaccines, and the low frequency

of recommendation was independent of their individual characteristics. The VSPs routinely conducted health education about vaccination for the public. Most VSPs recommended non-EPI vaccines in an informed style, not a presumptive one, and provided the public with all decision-making latitude.

Recommendation from HCWs is regarded as one of the most consistent correlates of vaccination [242]. In our study, nearly half of the VSPs never or only sometimes recommended non-EPI vaccines, although they are full-time designated staffs in charge of vaccination services in China. The low level of recommendation practice is consistent with the previous surveys in China [164, 165], but much lower than that in US and European countries [166-169]. Meanwhile, as for the style of VSPs' communication practice, the qualitative analysis showed that most VSPs did not recommend but instead informed parents about non-EPI childhood vaccines to honor the parents' decision-making autonomy. That is only information flows from VSPs to parents, but deliberation and decision on a vaccination option are delegated to parents, according to the framework of patient-provider interactions proposed by Charles et al. [238]. It has been shown that provider-driven communication through the shared and presumptive styles was highly effective for encouraging vaccination than the informed style [239]. Therefore, it is necessary to identify the factors associated with VSPs' communication practice.

The infrequent recommendation of non-EPI vaccines was widely prevalent among Chinese VSPs in this study sample, no matter their individual characteristics. This indicated that recommendation practices were possibly not influenced by individual characteristics. Among the five sub-ecosystems in the social-ecological model, interpersonal relationship, institutional arrangement, and public policy mainly contribute to the widely infrequent recommendation of non-EPI vaccines in an informed style instead of a presumptive one in China.

Firstly, at the interpersonal sub-ecosystem, some VSPs were concerned about potential conflicts arising from recommending the self-paid non-EPI vaccines and adverse reactions after administering these vaccines. The recommendation of paid medical services may lead to patients considering doctors as retailers pursuing profits and reducing their adherence to the doctors' recommendation [243]. Discontentment from patients and doctors can even lead to the occurrence of adverse events [244]. In China, doctor-patient relationships has deteriorated during the past decade [245]. The tense doctor-patient relationship may be rooted in the Chinese health system with the long history of profit-pursuing medical behaviours and unaffordable medical services before the 2009 healthcare reform [246]. In addition, most parents have the low awareness on vaccine-preventable diseases due to the preventative nature of vaccines, which may make the public more adverse to being recommended vaccines than clinical services. To reduce the concerns of VSPs, it is necessary to address the tense

doctor–patient relationship and improve the compensation mechanism for adverse reactions following vaccination.

Secondly, at the institutional sub-ecosystem, heavy workloads leave VSPs little time to communicate with the public about vaccines. With more vaccines introduced, public demand for vaccination has surged, leading to an inadequate number of VSPs available to meet the demand [247]. Our findings among VSPs who participated in the study in Shenzhen city, for example, were less likely to recommend non-EPI vaccines due to the pressure on their time than those in Shaanxi and Anhui provinces. There is a much higher proportion of young migrant workers and a more developed economy in Shenzhen than the other two provinces [248], which translated to a greater demand for local vaccination services. Moreover, a lack of electronic information systems also contributed to the overload of the VSPs. Dan Gong et al. found that insufficient infrastructure was one of the main barriers of delivering additional vaccines through the national EPI schedule [249]. While most provinces have an immunisation information system capable of managing vaccine stocks and keeping official vaccination records, it cannot support vaccination services [250]. For example, vaccination appointment procedures were primarily traditional, using reservation books and oral notification. In addition, VSPs have to take on additional responsibilities, such as chronic disease management [251, 252], and this extended work scope has exacerbated the shortage of the VSPs. Therefore, to ensure the reasonable workload of VSPs and leave time for health communications, the government should promote the construction of the whole-process health information system and strengthen the public health workforce through both retaining and recruiting staff, using financial and nonfinancial incentives [249].

Thirdly, at the public policy sub-ecosystem, there were no performance assessments or financial incentives for VSPs to recommend non-EPI vaccination. In China, there is strict performance assessment for EPI vaccination coverage for each vaccination clinic and CDC, and their performance is related to the staff merit pay, meanwhile there is no performance assessment for VSPs regarding non-EPI vaccination as their main responsibility is around EPI vaccination. Therefore, the non-EPI vaccination should also be covered as a part of performance assessment [249]. Moreover, to address the phenomenon of over-prescriptions, China issued the zero mark-up drug policy (including non-EPI vaccines) by disengaging prescribing from profits in 2009 [253]. It was reported that the policy promoted rational use of medicines [254, 255]. Unlike drugs such as antibiotics, which are overprescribed and could lead to adverse health consequences, vaccines are preventative and need to be promoted by VSPs through incentives. Previous studies highlighted that HCWs' recommendation behaviours were notably influenced by financial incentives [170], and the financial incentives were effective in improving the uptake and delivery of health services [256-258]. However, implementing financial incentives could bring additional concerns, including neglect of non-

incentivized tasks and distorted motivation among HCWs [259]. Thus, to avoid excessive and unnecessary non-EPI provision for economic benefit, it is important to establish an appropriate income distribution system [170], which could balance basic salary and performance-based incentives (e.g., avoiding overly high incentives and overly low basic salary) [260]. In addition to the above measures, governmental engagement can also contribute to the promotion of non-EPI vaccines. Taking rabies vaccine as an example, in order to meet the goal of eliminating dog-mediated rabies by 2030 [261], the Chinese government promoted rabies prevention education programs, particularly in high-risk provinces; meanwhile, the Chinese national reference laboratory for animal rabies provided training to more than 500 laboratory staff from provincial and municipal animal disease control centres [262]. These measures greatly improve the awareness of HCWs and the access to post-exposure prophylaxis, including the rabies vaccine. Since peaking in 2007 with more than 3,000 reported human rabies deaths, substantial progress has been made in reducing these deaths [263].

Our study provides important insights into recommendation practices and the different communication styles among VSPs for non-EPI vaccines in China from a socio-ecological perspective. While previous studies have investigated HCWs' recommendation of influenza vaccines and their intrapersonal determinants (including knowledge and attitudes towards influenza and influenza vaccines) in China [164, 237], there has been less attention paid to the influence of macro-level factors, such as demand, system capacity and public policy on VSPs' recommendation practice. Given that many childhood vaccines are optional and paid out of pocket in low- and middle-income countries [264], the implications of our study could be valuable for China and other countries with similar contexts.

Our study has several limitations. First, the recommendation behaviour of VSPs was self-reported and potentially influenced by recall bias. Second, our study only covered three provinces, and our findings may not be generalized to all parts of China. Third, we only interviewed the VSPs who deliver vaccination services, and did not interview general HCWs who are not responsible for vaccination services but may give health education on vaccination during clinical services. Finally, the study focused on recommendation for non-EPI vaccines in general. Recommendation behaviours may vary across different non-EPI vaccines, and further studies need to consider recommendation for specific non-EPI vaccines.

5. Conclusions

Our study reveals a low frequency of VSPs recommending non-EPI vaccines. Fears of potential conflicts with patients over recommending paid medical services, heavy workload, and the lack of performance assessment and financial incentive are the major barriers to VSPs' recommending practice. The multi-level ecosystem around non-EPI vaccination should

be improved to incentivize and support VSPs and the public, which include a better system of legal redress to resolve potential disputes between the VSPs and the public, more effective workload management through the whole-process health information system and strengthening the public health workforce, the introduction of performance assessment and appropriate income distribution system for non-EPI vaccination, and more governmental engagement in infectious disease prevention programs.

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Table 1. Recommendation for non-EPI vaccines and its associated factors among vaccination service providers participating in the survey.

		Recommendation Practices for Non-EPI Vaccines		Univariate Analyses	Multivariate Logistic Regression
	Total, N (%)	Always or often, n (%)	Sometimes or never, n (%)	χ2	OR (95% CI)
Location				1.31	
Shenzhen city	132(23.78)	63(47.73)	69(52.27)		ref.
Shaanxi province	250(45.05)	129(51.6)	121(48.4)		1.25(0.98–1.60)
Anhui province	173(31.17)	94(54.34)	79(45.66)		1.52(1.04–2.20) *
Residence				0.05	
Rural	126(22.7)	66(52.38)	60(47.62)		ref.
Urban	429(77.3)	220(51.28)	209(48.72)		1.15(0.76–1.74)
Gender				5.06 *	
Female	483(87.03)	240(49.69)	243(50.31)		ref.
Male	72(12.97)	46(63.89)	26(36.11)		1.12(0.47–2.69)
Age (years)				10.04 *	
≤25	63(11.35)	27(42.86)	36(57.14)		ref.
25–35	244(43.96)	117(47.95)	127(52.05)		1.14(0.82–1.58)
35–45	186(33.51)	100(53.76)	86(46.24)		1.40(0.91–2.15)
>45	62(11.17)	42(67.74)	20(32.26)		2.50(1.42–4.39) **
Education				0.04	
High school and below	46(8.29)	24(52.17)	22(47.83)		ref.
Junior college	237(42.7)	123(51.9)	114(48.1)		1.43(0.67–3.03)
Undergraduate and above	272(49.01)	139(51.1)	133(48.9)		1.41(0.68–2.94)
Profession				9.78 **	
Doctor	99(17.84)	60(60.61)	39(39.39)		ref.
Nurse	362(65.23)	169(46.69)	193(53.31)		0.65(0.33–1.27)
Public health worker	94(16.94)	57(60.64)	37(39.36)		1.12(0.52–2.43)

Notes: Significance level: ** $p < 0.01$, * $p < 0.05$.

Table 2. Characteristics of vaccination service providers participating in the interview.

	Total, N
Total	49
County/city	
Rural county, Anhui province	10
Urban city, Anhui province	11
Rural county, Shaanxi province	11
Urban city, Shaanxi province	6
Shenzhen city	11
Position	
Vaccinator	21
Paediatrician	11
Director of vaccination clinics	11
Immunisation program director of CDC	6
Gender	
Female	38
Male	11
Age (years)	
≤25	3
25–35	15
35–45	17
>45	14
Education	
High school and below	6
Junior college	19
Undergraduate and above	24

Note: Centre for Disease Control and Prevention (CDC).

Appendix A. Table A1. Lists of EPI and non-EPI vaccines in China.

Category	List of Vaccines	The Price of Vaccines * (Chinese Yuan)
EPI vaccines (14 vaccines against 15 diseases, paid by government)	Domestic Hepatitis B vaccine Bacille Calmette Guerin vaccine Polio vaccine Diphtheria, tetanus and pertussis vaccine Diphtheria-tetanus vaccine Measles and Rubella Combined vaccine Hepatitis A vaccine Group A Meningococcal vaccine Group A + C Meningococcal vaccine Encephalitis B vaccine Measles-mumps-rubella vaccine HFRS (Hantavirus) vaccine Anthrax vaccine Leptospirosis vaccine	/
Non-EPI vaccines (Some examples, paid out of pocket by recipients)	Hepatitis B Vaccine	118~320
	Seasonal influenza vaccine	31~298
	Human papilloma virus vaccine	329~1298
	Rabies vaccine	87~300
	Pneumonia vaccine	182~698
	Oral rotavirus vaccine	172~280
	Hepatitis A vaccine	158~199
	Varicella vaccine	136~155
	Hib vaccine	65~105
	Live attenuated Measles-Mumps-Rubella vaccine	76

Note: *the prices of non-EPI vaccine come from Shanghai public resources trading platform in 2022.

Appendix B. Table A2. Sub-ecosystems of social-ecological model.

Sub-Ecosystems	Definition	Examples of Question
Intrapersonal level	Individual characteristics, such as knowledge, attitudes, behaviour, self-concept, skills, etc.	How confident are you that the benefits of vaccination outweigh the risks?
Interpersonal level	Influence from social network, including family members, friends, neighbours, contacts at work, and acquaintances	Have you ever had a resident who was hesitant or opposed being vaccinated or having their child vaccinated? Could you describe what happened, why was the resident hesitant or opposed and how did you respond?
Institutional level	Influence from formal (and informal) rules and regulations for operation from social institutions	What is your role in providing immunisation services? Could you describe some details of your daily work? Such as timetable or regular meeting, etc. (Probes: current, past)
Community level	Relationships among organizations, institutions, and informal networks within defined boundaries	What works well in how immunisation programs are delivered in your workplace and what could be improved?
Public policy level	Local, state, and national laws and policies	Have you ever had any questions or concerns about any of the vaccination services that are offered at your workplace? If yes, what were your questions and concerns and what did you do about them? (Probes: seek advice/support from line managers or staff from CDC)

CHAPTER SIX: DISCUSSION

6.1 Introduction

The aim of this PhD study was to identify factors that influence caregivers' decision-making about childhood influenza vaccination uptake in China. Through a mixed-methods study, I investigated the factors influencing childhood influenza vaccination and further explored the communication between caregivers and health information sources from the perspective of both caregivers and healthcare workers (HCWs) to inform the design of future behavioural interventions and increase uptake of childhood influenza vaccination.

6.2 Summary of main findings

While many frameworks on individual decision making around vaccination have been developed, less evidence exists on the impact of health information and access to vaccination service, despite their important role in vaccination decision-making. In my thesis I developed a conceptual framework to guide the investigation of factors influencing caregivers' decisions on childhood influenza vaccination, by adapting the constructs of the Vaccine Hesitancy Determinants Matrix and incorporating constructs from Health Belief Model (HBM) [192]. In addition to individuals' perceptions of diseases and vaccines, the framework emphasizes the impact of communication with different information sources, non-rational risk assessment, and the access of vaccination services on individuals' vaccination decision-making. In Chapter 3, I conducted a quantitative analysis of the association between these above constructs and caregivers' decision-making about childhood influenza vaccination. I confirmed that vaccine confidence and positive influence from HCWs was significantly associated with childhood vaccine acceptance, while poor access, including conflicts between caregivers' availability and vaccination service schedules and inconvenient transportation to the vaccination site were negatively associated with childhood influenza vaccination. Results of Chapter 3 confirm the relevance of the framework, and no further changes were made to the framework after data collection. Then, the further in-depth interview helps me understand the role of non-rational risk assessment in caregivers' decision-making on childhood influenza vaccination and communication between caregivers and professional information sources (HCWs) (chapter 4). I found that despite clear perceptions about the severity of influenza and the effectiveness of the vaccine, caregivers lack sufficient knowledge about influenza, and didn't receive any relevant medical information from HCWs. In Chapter 5, I investigated the recommendation behaviours of vaccination service providers (VSPs) with reference to non-EPI vaccines in China by applying the social-ecological model to explore the

communication between the public and the professional information sources from HCWs' perspective [50].

6.2.1 Systematic review

The systematic review of research on influencing factors of childhood influenza vaccination (Chapter two, Aim one) showed a wide range of childhood influenza vaccination uptake rates across different countries. Compared with high-income countries and regions, childhood influenza vaccination uptake rates in mainland China are lower. The review indicated that individual level factors, including caregivers' knowledge of and attitudes about influenza vaccine, their perceived susceptibility and severity of influenza, and perceived benefit of influenza vaccine, were associated with their decision on vaccinating their children against influenza.

The review identified four knowledge gaps of previous studies and guided my data collection and analysis:

1) There is a lack of national-level studies on childhood influenza vaccination uptake in China, the findings of existing regional studies cannot be directly generalized to all provinces;

2) Most published literature has focused on caregivers' perceptions and attitudes about influenza and influenza vaccines, and less on how those perceptions were formed. Understanding the influencing factors in the process of concept formation, such as the interaction with different information sources, is important in guiding the development of targeted interventions;

3) HCWs' recommendations can increase the uptake of childhood influenza vaccination. Hence, interventions encouraging HCWs to communicate with the public about vaccines and recommend them are more likely to be successful. However, there is a lack of research on the communication between HCWs and caregivers about vaccines;

4) There is a lack of research on contextual factors influencing vaccine uptake, such as access to vaccination services.

6.2.2 Determinants of vaccine acceptance

Vaccine decision-making is strongly influenced by individual perceptions of disease and vaccine. In Chapter 3, my analysis found that the childhood influenza vaccination uptake rate was 43.63% across all three provinces (Guangdong province, Anhui province, and Shaanxi province) during the COVID-19 pandemic. Among surveyed caregivers, 79.19% perceived

that their children were highly susceptible to influenza and 65.93% perceived that influenza disease is severe. Meanwhile, 75.01% agreed that flu vaccines are effective with 84.77% and 84.72% agreeing that flu vaccines are important for children and safe, respectively. Caregivers' confidence in the importance, effectiveness, and safety of influenza vaccines were positively associated with childhood influenza vaccination. In terms of access to vaccination services, 20.57% and 18.6% agreed that there were flu vaccine shortages and flu vaccines were expensive, respectively. Only 10% felt that there was a conflict between their work and vaccination service schedules, were unsatisfied with past vaccination service, and stated that transport to point of vaccination (POVs) was inconvenient, respectively. Among them, conflicts between caregivers' schedules and vaccination service and inconvenient transportation to POV was negatively associated with childhood flu vaccination. Qualitative data in Chapter 4 also showed that caregivers were dissatisfied with the time of vaccination services and the price of influenza vaccines. Our study confirmed the association between being positively influenced by HCWs or family members and uptake of childhood influenza vaccination. Data also showed that only 36.04% of caregivers said they received positive influence from HCWs. Meanwhile, parts of the results are also worth to be explored in depth. First, although study showed a positive view on influenza vaccines' safety, many expressed negative views on influenza vaccine effectiveness, and further research is needed to explore caregivers' access to relevant health information and the reasons for the formation of perceptions of influenza vaccines; second, although HCWs have been identified as an important information sources, further research is needed to explore the details of the communication between these two sides.

6.2.3 Communication between caregivers and information sources

Information can influence vaccination decisions in many ways, from the quality, quantity and content of the information. However, a quantitative survey cannot explore the content of communication which caregivers receive, and the impact of different information sources on caregivers' perceptions of influenza and the flu vaccine. This research further explored the reasons behind caregivers' perceptions of influenza and influenza vaccine, and health information reception of them. Qualitative data in Chapter 4 showed that caregivers had misconceptions about influenza as being just a cold and perceptions that influenza virus mutations can make vaccines ineffective. This explains why the percentage of caregivers who think influenza infection is serious and that the flu vaccine is effective are low in Chapter 3. Meanwhile, caregivers' perceptions and attitudes toward influenza and influenza vaccination were not always supported by scientific evidence, and there was a lack of knowledge related to influenza among caregivers. The study showed that caregivers receive little influenza-

related health information from any information sources. While previous studies have shown that the majority of the public regard HCWs as their primary information source, HCWs didn't provide adequate information for caregivers' influenza vaccination decisions. Many caregivers were only informed about the availability of influenza vaccines and did not have in-depth communication with HCWs. Caregivers in our study also indicated that they had not received health education about vaccines from staff in other medical institutions, including Community Healthcare Centres (CHCs), and Centres for Disease Control and Prevention (CDCs), or paid little attention to existing health education methods, such as brochures and videos.

Getting a positive recommendation from HCWs was the key factors associated with caregivers being more likely to vaccinate their children. To improve caregivers' perception of influenza and vaccines, and correct misconceptions, further study is necessary to focus on the promotion of vaccines by HCWs and frame the potential determinants of HCWs' recommendation for non-EPI vaccines. This research (Chapter 5) explored HCW recommendation practices for non-EPI vaccines and confirmed that communication is inadequate between HCWs and the public from HCWs' perspective. The quantitative data presented in Chapter 5 showed that 51.54% of HCWs always or often recommended non-EPI vaccines, however, most of them did not give parents much information beyond just informing them about age-appropriate vaccines for their children, which is consistent with the results in Chapter 4 where the caregivers reported little communication with HCWs. This informed style of communication about non-EPI vaccines with the public was less effective for encouraging vaccination while providing the public with decision-making latitude. The tense doctor-patient relationship makes patients tend to consider the recommendation of paid medical services as profits-pursuing behaviour. In addition, heavy workloads leave VSPs little time to communicate with the public about vaccines. At the policy level, the lack of corresponding assessments for the uptake of non-EPI vaccines from superiors and financial incentive to recommend non-EPI vaccination were main barriers for HCWs' non-EPI vaccination recommendation.

Overall, Chapter 3, 4 and 5 are closely linked. In Chapter 3, I identified problems (caregivers' uncertainty about vaccine effectiveness) and trusted information sources (HCWs). Meanwhile, in Chapter 4, I explored specific reasons for caregivers' uncertainty and details of communication with HCWs. Finally, in Chapter 5, I further explored communication with the public about vaccines from HCWs' perspective and suggested interventions based on each influencing factor.

6.3 Strengths and limitations of the study

The strengths of this study include: 1) use of large-scale population survey data, with web-based questionnaire on influenza vaccination-related perceptions and practices among caregivers of young children[1]; 2) integration of quantitative survey data and the qualitative interview data, which enabled us to investigate the attitudes and perceptions of the participants, and understand caregivers' considerations in the decision-making process of receiving (or rejecting) vaccination in sufficient details; 3) the collaborative aspect of the PhD study is also important in the context of China. This study involved relationships with directors of the local CDCs and CHCs which are important for collaborative research activities. The cooperation with local CHCs also helped us gain trust and acceptance among local participants. The smooth implementation of data collection was also supported by the expertise of the local collaborators in Fudan University.

The systematic review in chapter two found that there have not been consistent methods for measuring knowledge, attitudes, and perceptions about influenza and influenza vaccines, making comparisons across studies and regions challenging. The limitations of this PhD study are as follows: 1) In terms of quantitative data analysis, because caregivers of children aged 6 months to 3 years were mainly recruited through convenience sampling at vaccine clinics, there may be some selection bias. We invited caregivers to fill out questionnaires or be interviewed after their children received vaccination services. The data was collected after September 2021, when the flu season already began, and flu vaccines were already available in those vaccine clinics. Caregivers are informed of the availability of flu vaccines at the same time their children received vaccination services. Participants whose HCWs had recommended influenza vaccination were more likely to have a positive attitude toward the flu vaccination, be more aware of influenza disease and think of influenza as serious. But, given the sampling for the study, the percentage among the Chinese caregivers who regard their children to be susceptible and at risk of serious complications to influenza could be lower than what has been presented here, while confidence in the safety, effectiveness and importance of influenza vaccines among them could also be lower. Second, we only included caregivers in three provinces, so findings cannot be generalized to all provinces or districts in China, a country with a large population which is diverse in culture and development stages. However, the three provinces are of different development levels – Guangdong province, Anhui province, and Shaanxi province, located in eastern, central, and western China, respectively. One urban district and one rural county were selected separately in the Anhui

[1] I did not identify any nationally representative studies on childhood influenza vaccination uptake, the numbers of participants included in the primary data analyses and the secondary data analyses of this study represented one of the largest studies ever conducted on this topic in mainland China

and Shaanxi provinces, and one urban district was selected in Shenzhen megacity, Guangdong province. Variations at the province and urbanicity levels were accounted for in the quantitative analyses. Third, questionnaire-gathered data of childhood influenza vaccination uptake (chapters three) and HCWs' non-EPI vaccination recommendation practice (chapters five) was self-reported by caregivers and HCWs who may have been subject to recall bias or may have been preferred to report practices that could be considered appropriate, which is an inherent limitation of self-reported questionnaire survey data. Hence, studies that include behavioural data, such as childhood vaccination records, are required to minimize recall bias. Fourth, the cross-sectional study design limits causal inference on the various factors observed. For example, results from this study found that receiving positive influence from HCWs were also significantly associated with uptake of childhood influenza vaccination. However, reverse causality is also likely, where caregivers deciding to vaccinate their children against influenza were more willing to consult HCWs and therefore more likely to receive positive influence from them.

In terms of qualitative data analysis, first, sample bias is applicable to caregivers' interview as participants showed a genuine interest in the management and prevention of respiratory tract infections in young children, which may not apply across all parental cohorts. Second, there exists the possibility of social desirability bias. Although we reassured all interviewees of their anonymity, interviews may not accurately reflect caregivers' actual perceptions on influenza and influenza vaccines. Third, as for non-EPI vaccination recommendation practice among HCWs, we only interviewed VSPs who specifically deliver vaccination services and did not interview general HCWs who are not responsible for vaccination services but may give health education on vaccination during clinical services. However, studies have shown that public health system and clinical departments in China are fragmented and lack communication and collaboration. Therefore, we could anticipate that HCWs from clinical departments seldom carry out the promotion of vaccines and other preventive measures to the public. Hence, the general pattern of findings observed in this study is sufficiently robust. Fourth, interviews with HCWs focused on recommendation for non-EPI vaccines in general, while recommendation behaviours may vary across different non-EPI vaccines. For example, there is a high awareness among caregivers that chicken pox is a common infectious disease in schools, so they have a high level of acceptance of varicella vaccine, and HCWs are more willing to recommend varicella vaccine to caregivers. Future research is needed to specifically investigate influenza vaccine.

6.4 Implications

The study found that 46.10 % of the respondents reported vaccinating their children against influenza in the 2019-2020 flu season, which was similar with the uptake rate during 2020-2021 flu seasons. The coronavirus disease 2019 (COVID-19) was first recognized in Wuhan, China, in December 2019 and rapidly spread across mainland China, posing a threat to global public health [70, 265]. Because most COVID-19 and influenza patients show relatively similar symptoms, including fever, cough, fatigue, and sore throat, it was anticipated that the COVID-19 pandemic will arouse public's risk perception of upper respiratory tract infection and thus increase the use of influenza vaccine [266]. However, we did not find a significant increase in childhood influenza vaccination in 2020-2021 flu season compared to 2019-2020. Qualitative interviews showed that many caregivers believed that the adoption of NPIs, such as use of face coverings, closure of school and online classes during COVID-19, decreased the risk of influenza for their children. As the governments gradually loosened those NPIs measures in early December, 2022, a looming threat of concurrent influenza and COVID-19 epidemics now is a major concern for healthcare and social systems in China [267]. Further research would be necessary to monitor the changes in caregivers' attitudes towards influenza. If the risk perception of influenza does not increase with the loosen of NPIs measures, corresponding measures will be critical to address this problem.

Individual health decisions are not only driven by cognitive and rational decision-making. Contextual factors – such as access to influenza vaccination services – are also critical to healthcare decision. Our research shows that most caregivers were satisfied with the access of influenza vaccination services. Only around 10% of the respondents felt that they had a time conflict with the hours of vaccination service, were not satisfied with the vaccination service in the past, and felt the transportation to the POVs was inconvenient, respectively. In 2009, Chinese central government launched the essential public health package to promote equalization of public services across the country [268]. The list covered a wide range of services to be delivered free of charge to users, albeit not including influenza vaccination, from services in chronic disease management to vaccinations [269]. Since then, the budget per capita for included healthcare services increased from 15 Renminbi (RMB) in 2009 to 79 Renminbi (RMB) in 2021 [270], it contributed to the increase of the number of primary health care facilities providing services under the essential public health package , and optimized the access of vaccination services to the public. However, in Chapter three, we found that time conflicts with vaccination services and inconvenient transport to POVs were associated with significantly reduced odds of vaccinating children against influenza. In addition, qualitative data in Chapter 4 showed that some caregivers were dissatisfied with the price of

influenza vaccines. Despite the quantitative data in Chapter 3 showing that only 18.6% of caregivers thought influenza vaccines were expensive, statistics show that national influenza vaccine uptake would be higher in countries where vaccination costs are subsidized by the governments [26]. To our knowledge, many cities in China currently provide reimbursement for influenza vaccination. However, current reimbursement policies were mainly implemented in developed regions such as Beijing and Dongli district, Tianjin in China and had limited impact on stimulating demand for childhood influenza vaccination, as the reimbursement framework covered only 9% of the national population. In addition, the eligibility criteria for reimbursed influenza vaccination mainly included the elderly, school children HCWs and beneficiaries of basic social medical insurances but did not include pre-school children. Promoting childhood influenza vaccine uptake requires reducing out-of-pocket expenses for influenza vaccination [26, 28-30, 271]. In China, pricing strategies for EPI vaccines and non-EPI vaccines in China are different. Prices of EPI vaccines are strictly regulated and kept at a very low level in China. The national unified bidding procurement for EPI vaccines currently covers the whole country [272]. In the volume-based procurement process, prices and doses are both set for selected manufacturers [273]. Meanwhile, the bidding and procurement of non-EPI vaccines is instead carried out by provinces. The provincial CDC requests bidding for procurement prices for non-EPI vaccines without specifying quantities of doses, then for each county CDC procures non-EPI vaccines with a relatively small number of doses from any manufacturer on the procurement list [273]. Because the sales of doses are not guaranteed, manufacturers generally have no desire to reduce prices. As a result, the prices of non-EPI vaccines in China are much higher than those set by the United Nations Children's Emergency Fund (UNICEF) [274]. To meet the health needs in the Chinese market and to improve the equity of vaccines, the bidding and procurement of non-EPI vaccines could also be conducted at the national level, with prices and doses procured being simultaneously set [273]. High economics of scale resulting from a large number of doses procured could prompt manufacturers to lower their prices. Furthermore, the introduction of the influenza vaccine into the current list of EPI vaccines can also effectively reduce health expenditure. Currently, the National Health Commission (NHC) has a duty to make evidence-based decisions regarding further expansion of the EPI and the replacement of current EPI vaccines with new ones [275]. Decisions for vaccine introduction must be based on scientific evidence. The National Immunization Advisory Committee (NIAC) in China, was established in 2017 to advise national authorities with evidence-based recommendations on immunization policy and program [276, 277]. According to experts' opinions, inclusion of vaccines in the EPI system requires sufficient evidence in five areas, including: features of the disease (epidemiological characteristics and disease burden); features of the vaccine (vaccine characteristics performance, and cost-effectiveness); ability

of the vaccination to be implemented in the EPI system (Availability of vaccine supply, financial issues, and human resource and infrastructure); international experience with the vaccine (WHO recommends, Experience of other countries); and potential societal impact of the vaccine(acceptability, and ethical consideration) [278]. Preliminary evaluation showed that experts in NIAC consider influenza vaccine to be beneficial to children. The final decision on whether to include influenza vaccine in the EPI system depends on the further evaluation of the vaccine using robust frameworks, which requires a substantial amount of resource-intensive scientific work [279].

There exists a high level of confidence in the safety of influenza vaccines. Reported levels of confidence in influenza vaccine safety were close to the Chinese average for confidence in vaccine safety in general, and higher than the global average[200, 280]. A previous study showed that 82.7% of Chinese members of the public agreed that vaccines were safe [200]. In addition, our survey also reported more positive views on influenza vaccines than the 2018 Global Monitor survey, which found that the proportion of people agreeing that vaccines were safe was 79.0% in global average[199]. This high level of confidence in the safety of influenza vaccines could be attributed to caregivers' trust in the government and healthcare system. However, such a high level of vaccine confidence did not translate into childhood influenza vaccination uptake. Such a phenomenon might be explained by caregivers perceived low severity of the influenza and lower confidence in influenza vaccines' effectiveness. First, quantitative data showed that only 65.93% of respondents perceived the health consequence of getting the influenza as serious. The risks influenza imposes on children are unlikely to be felt directly or immediately by caregivers, who may confuse the common cold with influenza and/or influenza-like illness [281]. Second, reported confidence in the effectiveness of influenza vaccines was lower than the Chinese, as well as global, average for confidence in vaccine effectiveness in general. Similar proportions of survey respondents in China and around the world agreed that vaccines were effective (88.2% vs 84.0%) with Chinese caregivers in our study less likely to consider influenza vaccines as effective (75.01%)[200] . Qualitative data in Chapter 4 suggested that the reason for caregivers' lower confidence in the effectiveness of vaccines is the belief that the virus is constantly mutating so that the vaccine is not effective in preventing infection and not necessary. However, we found that caregivers did not have adequate knowledge or receive enough health information to support their vaccine decisions. When information is limited and the complexity of the situation is overwhelming, individuals could use non-rational strategies, such as experiential knowledge and intuition, to deal with risk and uncertainty, and assist decision-making [282]. This phenomenon has also been observed in other types of health behaviours, such as the overuse of antibiotics [283, 284]. The results highlight that an

education campaign on childhood influenza vaccination is insufficient to enable the desired behavioural change. Heterogeneity exists in various aspects of knowledge about influenza and influenza vaccine and its association with childhood influenza vaccination. Being aware of the severity of influenza and the effectiveness of influenza vaccine helps to increase caregivers' level of confidence in the effectiveness and importance of influenza vaccine and contribute to caregivers' decision vaccinate their children against influenza. Therefore, the content of health education measures needs to be targeted and these two points must be included.

The Strategic Advisory Group on Experts (SAGE) Working Group on Vaccine Hesitancy concluded that confidence, complacency and convenience, are key determinants of vaccine hesitancy [140]. In addition, poor or inadequate information can negatively influence vaccination uptake [285]. Qualitative results in Chapter 4 indicated that caregivers paid little attention to existing health education, such as brochures and videos. The results suggest that current methods for providing health information need to be reviewed and optimized. In Chapter 3, we also investigated the impact of different information sources on caregivers' vaccine decisions. The rapid proliferation of health information on the Internet has resulted in individuals' health information seeking on the Internet has become more pervasive [286, 287]. However, the quality of online health information content can vary in quality, and the public may not possess the necessary skills to evaluate the accuracy of the information [124]. In our study, only 15.71% of respondents reported that the internet had a positive influence on their vaccine decisions, meanwhile, around 40% of respondents said they had been positively influenced by HCWs. Such a phenomenon is likely due to that HCWS are the most trusted information source for the public [203]. HCWs play an essential role in vaccine recommendations and uptake. In Chapter 5, we found that 15.32% and 36.22% of the HCWs always or often recommended non-EPI vaccines, respectively. Previous studies that have focused on HCWs' recommendations for the influenza vaccine, showed that nearly 40-60% of HCWs in China were not willing to recommend influenza vaccine to their patients [164, 237, 288], results which are similar to the findings in of our study. Previous studies also highlight that HCWs' knowledge and perception of influenza vaccine were the positive predictors of recommendation behaviours of them [164, 165, 237]. Qualitative data in Chapter 5 indicated that HCWs generally have a high level of vaccine confidence. Our study shows that HCWs' willingness to recommend vaccination in China may be influenced by reports of patient mistrust, which could lead to conflicts due to being recommended the self-paid non-EPI vaccines or that they may risk potential adverse reactions. Doctor–patient trust is a fundamental building block of medical service. The development of patient mistrust in China mainly stems from perceptions of societal injustice and the commercialisation of medicine

[289]. In China, since 1980, public hospitals were allowed to make a 15% mark-up on drug purchase price, including non-EPI vaccines, to remedy the loss of funds due to a tight government budget [290]. With major revenue for hospitals and physicians coming from drug sales, the phenomenon of over-prescriptions aggravates the economic burden of patients and has become a serious social problem in China [291]. Hence, the recommendation of paid medical services may lead to patients considering doctors as retailers pursuing profits and reducing their adherence to the doctors' recommendation [243]. Although China issued a zero-mark-up drug policy (ZMDP) in 2009 to improve rational use of medicines by disengaging prescribing from profits in public hospitals [210], focusing on financial rather than humanistic aspects of medicine has eroded doctor–patient trust. To reduce the concerns of VSPs, it is necessary to address the tense doctor–patient relationship and improve the compensation mechanism for adverse reactions following vaccination.

Results shows that heavy workloads leave VSPs little time to communicate with the public about vaccines. A previous study showed that not just VSPs, but other primary healthcare providers, including doctors, nurses, and other public health workers all reported heavy workloads and pressures at work [292]. The primary healthcare system in China, which provides basic clinical care and public health services to a fifth of the world's population, has contributed substantially to reductions in the burden of diseases [206, 293]. But a shortage of primary healthcare providers has persisted. Although the number of primary healthcare providers is increasing, the growth is slow, and the regional distribution of primary healthcare doctors is uneven [294]. Most medical school students in China prefer to join high-level hospitals, where there are considerable salaries and nice working conditions [295]. This poses great difficulties for CHCs and township healthcare centres to recruit enough qualified health workers [296], let alone retain experienced and qualified health workers already working there [297]. Unsurprisingly, the underlying reasons included not only monetary factors such as insufficient income, welfare benefits and opportunities for career development, but also non-monetary factors such as working conditions and low job security [292, 298-300]. To ease the workload burden on the current workforce, increasing the size of the primary healthcare providers workforce could be an effective strategy as long as recruitment efforts are accompanied by financial and nonfinancial incentives, including better pay, welfare benefits, professional development and training opportunities and better working conditions.

Finally, the ZMDP reform decreased medical expenses [229, 301-304], and promoted the healthcare service utilization [305]. To date, all public hospitals across the country have eliminated non-EPI vaccine mark-ups [306]. It's also expected to have a significant impact on

the recommendation of non-EPI vaccines by HCWs, due to no economic incentive. However, unlike drugs such as antibiotics, which are overprescribed and could lead to adverse health consequences, vaccines are preventative, and vaccination of key populations is cost-effective.. Qualitative data shows that the current performance appraisal mechanisms for individual VSP and vaccination clinics have failed to encourage VSPs to recommend non-EPI vaccines, and the payments for VSPs do not reward recommendation for non-EPI vaccines. Hence, there is a need for performance assessment system that are linked with incentives to ensure that the public is informed and recommended to receive non-EPI vaccines, and providers are held accountable.

CONCLUSIONS

I integrated four studies into a synthesis of evidence to present influencing factors of caregivers' decision on childhood influenza vaccination and inform the development of interventions to increase caregivers' awareness of the necessary of influenza vaccine for their children and promote the communication between HCWs and the public. The research consists of four interlinked aims using a combination of qualitative and quantitative data collection and analysis methods. The systematic review under Aim 1 allowed me to identify the focus and limitations of previous studies on the topic of childhood influenza vaccination. SEU-type health behaviour models including the Health Belief Model and Vaccine Hesitancy Determinants Matrix were used to inform the conceptual framework to guide this study under Aims 2 and 3. The quantitative data analyses identified influencing factors for childhood influenza vaccination, whereas the qualitative data analyses of caregivers interviews under Aim 3 helped pinpoint and prioritise key features relating to caregivers perceptions about influenza and influenza vaccine, and aided in the exploration of communication between caregivers and different health information sources. The Social Ecological Model were used to guide the secondary data analyses of healthcare workers surveys under Aim 4, which contributed to informing the elements of multifaceted interventions, and better adapting the interventions to local conditions. Findings from this study would help inform the design and development of a proposal for a multi-level intervention to promote childhood influenza vaccination uptake in China. First, access to vaccination services needs to be further optimized through extending vaccination service hours, and establishing more vaccine clinics close to residential areas. Interventions are needed to reduce out-of-pocket expenses for influenza vaccination, including optimizing the process for the bidding and procurement of non-EPI vaccines, and accelerating the evaluation of influenza vaccines for inclusion in the EPI system. As for health education for caregivers, caregivers need to be informed about the severity of influenza and the efficacy of the influenza vaccine to enhance their confidence in influenza vaccination. Multifaceted interventions are vital to encourage HCWs, a trusted information source, to communicate the above information to the public and recommend non-EPI vaccines, including improving the compensation mechanism for adverse reactions, using financial and nonfinancial incentives to retain and recruit staff and strengthen the primary healthcare workforce, and establishing a performance assessment system that are linked with incentives to ensure that the public is informed and recommended to receive non-EPI vaccines.

APPENDIX I. ETHICS APPROVAL

The primary objective of this PhD study was to figure out the influencing factors of caregivers' decision on childhood influenza vaccination and inform the development of a intervention to promote childhood influenza vaccination. No sensitive and private data were collected. The PhD study was nested in the theme 2.1of The Evidence to Policy pathway to Immunisation in China (EPIC). The data used in Chapters three and four were collected as part of 2nd round of data collection of theme 2.1 from September to December 2021. The data used in Chapter five were collected as part of 1st round of data collection of theme 2.1 in January 2019. Ethical approval for two round of data collection was granted by Fudan University and the London School of Hygiene and Tropical Medicine:

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

Dr Tracey Chantler

LSHTM29 October 2018 Dear Tracey,

Study Title: EPIC 2.1: Investigating vaccine confidence in China

LSHTM Ethics Ref: 16016

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Investigator CV	Larson.CV.short.July.2017	01/07/2017	1
Investigator CV	CV_Shiyi Tu_Aug_2017_English	01/08/2017	1
Investigator CV	SCHOOL CV TEMPLATE_June 2018_Tracey Chantler_Final	01/06/2018	1
Investigator CV	CV of zhiyuan hou	30/07/2018	1
Protocol / Proposal	EPIC 2.1. Health professionals topic guide_Aug 17th 2018	17/08/2018	1
Protocol / Proposal	EPIC 2.1 Parent-caregivers topic guide_Aug 17 2018	17/08/2018	1
Protocol / Proposal	EPIC 2.1 Questionnaire_health professionals_Aug_17th 2018	17/08/2018	1
Protocol / Proposal	EPIC 2.1 Questionnaire_ caregivers_Aug_17th 2018	17/08/2018	1
Information Sheet	EPIC 2.1. Investigating vaccine confidence_study information letter_v1_17th August 2018	17/08/2018	1
Information Sheet	EPIC 2.1 Investigating vaccine confidence_consentform_v1_17th August 2018	17/08/2018	1
Protocol / Proposal	EPIC 2.1. Investigating vaccine confidence_Study protocol_v1_Aug 29th 2018	29/08/2018	1
Covering Letter	Clarification Response Letter Ref 16016-11th Oct 2018	11/10/2018	1
Protocol / Proposal	EPIC 2.1. Investigating vaccine confidence_Study protocol_v2_Oct 11th 2018_TC	11/10/2018	2
Protocol / Proposal	1010 EPIC 2.1 Questionnaire_ caregivers version 2., 11th Oct 2018	11/10/2018	2
Protocol / Proposal	1010 EPIC 2.1 Questionnaire version 2_health professionals_11th Oct 2018	11/10/2018	2
Protocol / Proposal	EPIC 2.1 Topic guide- Health professionals version 2, 11th Oct 2018	11/10/2018	2

Protocol Proposal	/ EPIC 2.1 Topic guide- Parent-caregivers version 2, 11th Oct 2018	11/10/2018	2
Information Sheet	EPIC 2.1. Investigating vaccine confidence_study information letter_v2_11th Oct 2018	11/10/2018	2

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study. At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Yours sincerely,

Professor John DH Porter

Chair

ethics@lshtm.ac.uk

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Observational / Interventions Research Ethics Committee

Dr Tracey Chantler

LSHTM

7 June 2021

Dear Dr Chantler ,

Study Title: EPIC 2.1: Investigating vaccine confidence in China

LSHTM Ethics Ref: 16016 - 2

Thank you for your letter responding to the Observational Committee's request for further information on the above amendment to research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above amendment to research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval for the amendment having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Local Approval	LSHTM 16016 Application - Approval Notification		
Local Approval	Fudan Application - Approval Notification		
Other	EPIC 2.1 Questionnaire_health professionals-amendment- v3 1st June 2021		
Other	Project ID 16016 - Questionnaire- caregivers -amendment - v3 1st June 2021		
Other	Project ID 16016 - Questionnaire- caregivers -amendment	30/04/2021	
Other	Project ID 16016 - Questionnaire_health professionals-amendment	30/04/2021	
Covering Letter	Cover Letter-amendment	02/06/2021	V3

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study. At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

Professor Jimmy Whitworth

Chair

ethics@lshtm.ac.uk

Fudan University School of Public Health – Medical Ethics Committee Scientific Research Project Ethics Review Application Form (1st round of data collection)

复旦大学 公共卫生学院
School of Public Health Fudan University
上海市东安路130号 邮编 200032 130 Dong An Road, Shanghai 200032, P.R.China http://sph.fudan.edu.cn Email: fdsph@fudan.edu.cn

研究课题： **中国疫苗信心调查**

课题负责人： **涂诗意 博士、侯志远 博士** **复旦大学公共卫生学院**

复旦大学公共卫生学院医学研究伦理委员会于 2018 年 10 月 10 日批准了涂诗意博士、侯志远博士有关《中国疫苗信心调查》的伦理学申请。批准号为 IRB#2018-10-0703，有效期为即日起至 2020 年 6 月 30 日。

在项目开展期间，研究方案及具体工作计划、调查表、知情同意书等如有任何修改和变动，必须在向本委员会报告并获得批准后方可付诸实施；由于研究项目的执行对研究对象造成的不良影响或后果必须向本委员会报告并征求调查指导。研究项目在有效期后还将继续进行的，必须向本委员会申请批准延期。

复旦大学公共卫生学院医学研究伦理委员会

国际注册号：IRB00002408 & FWA00002399

2018 年 10 月 10 日

Fudan University School of Public Health – Medical Ethics Committee Scientific Research Project Ethics Review Application Form (2nd round of data collection)

复旦大学 公共卫生学院
School of Public Health Fudan University
上海市东安路130号 邮编 200032 130 Dong An Road, Shanghai 200032, P.R.China http//sph.fudan.edu.cn Email: fdsph@fudan.edu.cn

研究课题：中国疫苗信心调查

课题负责人： 涂诗意、侯志远 博士 复旦大学公共卫生学院

复旦大学公共卫生学院医学研究伦理委员会于 2020 年 12 月 10 日批准了涂诗意博士和侯志远博士有关《中国疫苗信心调查》的伦理学申请。批准号为 IRB# 2020-12-0861，有效期为即日起至 2022 年 6 月 30 日。

在项目开展期间，研究方案及具体工作计划、调查表、知情同意书等如有任何修改和变动，必须在向本委员会报告并获得批准后方可付诸实施；由于研究项目的执行对研究对象造成的不良影响或后果必须向本委员会报告并征求调查指导。研究项目在有效期后还将继续进行的，必须向本委员会申请批准延期。

复旦大学公共卫生学院医学研究伦理委员会

国际注册号：IRB00002408 & FWA00002399

2020 年 12 月 10 日

APPENDIX II. STUDY TOOLS INTERVIEW GUIDES

中国疫苗信心调查-儿童家长

参与者知情同意书

2020 年 11 月

调查背景 (For interviews with caregivers in Chapter 4)

非常感谢您能够参与关于疫苗信心的访谈。我们是来自复旦大学、伦敦卫生与热带医学院以及中国疾病预防与控制中心的研究团队。本研究的目的旨在了解公众对疫苗的信心水平，探索影响免疫接种相关决策的因素，以帮助卫生人员对疫苗问题迅速作出反应，并制定适合中国社会文化特点的应对策略。我们希望和多种人群进行交流，包括免疫规划项目管理者、免疫接种服务提供者，以及 6 岁及以下儿童的家长。如果您愿意参与这项研究，研究人员将对您进行访谈。您在访谈中提供的信息将有助于改善卫生机构和家长之间关于疫苗的交流和免疫规划项目的实施。

知情同意

如果您愿意参加这项研究，请在方框内打勾：

1. 我确认已经阅读并理解了调查背景信息。我有机会思考所提供的信息，询问有关研究的问题，并且已经获得了这些问题的满意回答； ☐
2. 我明白我的参与是自愿的，并且我可以在任何时候无条件退出访谈； ☐
3. 我同意参与这项研究； ☐
4. 我同意对访谈进行录音； ☐
5. 我同意在研究报告中匿名引用我所提供的信息； ☐
6. 我同意将我的访谈中的匿名数据存储于复旦大学科研管理数据库中。 ☐

参与者姓名_____ **日期**_____ **签名**_____

调查者姓名_____ **日期**_____ **签名**_____

如果您有任何关于本研究的问题，您可以与本项目负责人涂诗意博士联系或侯志远博士联系，电话是 021-33565182、33563935。您也可以与复旦大学公共卫生学院伦理委员会联系，电话是 021-54237262，这个机构代表您的利益。

中国疫苗信心研究-儿童家长

儿童家长 访谈提纲

2020 年 9 月 28 日

基本信息

访谈日期: _____年_____月_____日
访谈地点: _____
访 谈 员: _____

受访者社会人口特征

姓名: _____ 年龄: _____
性别: (1)男 (2)女；
您有 6 岁以下的孩子吗？ (1)有 (2)无
教育水平: (1)无教育经历 (2)小学 (3)初中 (4)高中或中专 (5)大专 (6)本科(7)研究生及以上
宗教: (1)无 (2)佛教 (3)伊斯兰教 (4)基督教 (5)道教 (6)天主教 (7)其他，请注明_____。
职业: (1)国家公务员 (2)专业技术人员 (3)企业职员 (4)企业管理人员 (5)工人 (6)农民 (7)现役军人 (8)自由职业者 (9)个体经营者 (10)其他
您是否是 6 岁及以下的孩子的监护人？ (1)是 (2)否 您有___个孩子？他们分别几岁
您与孩子的关系: (1)父亲 (2)母亲 (3)爷爷 (4)奶奶 (5)其他，请注明_____ **孩子的免疫接种状况：**根据年龄完全按计划接种/根据年龄部分按计划接种/从未接种（比计划接种时间晚一个月以内不算此类）

如果访谈对象不止一个人，请将第二个人的信息在此添加:

姓名: _____ **年龄:** _____
性别: (1)男 (2)女；
宗教: _____
职业: _____ **教育水平:** _____
与孩子的关系: _____

访谈提纲--儿童家长

新冠疫情对于疫苗接种服务接受的影响

让我们先谈一谈疫情期间您带孩子接种疫苗的经历

新冠疫情以来，您带孩子接种疫苗的体验方面有什么变化吗？(提示—比如预约程序、接种流程、留观，和疫情之前相比有什么变化？您怎么看待这种变化？

对于新冠疫情以及疫苗的看法

对疫情的风险感知

您平时接触的疫情相关的信息来自哪里？（提示—网络和社交媒体（如微信、微博），传统媒体（电视、广播、报刊杂志)，朋友和同事，家人或其他亲戚，专业书籍等）

您对现在新冠疫情怎么看？（提示—您觉得自己感染新冠的风险大吗？感染对健康造成的影响严重吗）

对新冠状疫苗的看法与态度

您关注新冠疫苗的研发进展吗？（提示—您觉得疫苗的重要性、安全性、有效性、受益如何？是否打算接种？您希望对哪些方面有进一步了解，比如效果、安全、接种人群等）

接受过什么形式的动员与宣传

对于现有的动员形式，有什么看法，哪里要改进

疫情期间对于其他疫苗的接种需求

和疫情前相比，您对疫苗的接种意愿有何变化？为什么？（例子）

儿童流感疫苗接种行为及相关影响因素

秋冬季儿童流感疫苗接种行为

您能告诉我您的孩子去年流感季（2020.9 月-至今）是否接种了季节性流感疫苗?请描述接种时间、地点和疫苗接种服务的评价。描述接种疫苗后的经历，例如，副反应是否发生?

对于流感病毒及疾病的了解

您能告诉我您对流感了解多少?（提示—流感的原因是什么?流感的症状和并发症是什么?您觉得感染后会出现危险的情况吗?哪类人谁更容易感染流感?）

如何预防流感?您认为除了接种疫苗，还有其他预防流感的方法吗?

您孩子身体状况如何，是否常感冒或者患其它呼吸道疾病？您认为您的孩子有感染流感的风险吗？

您认为疫情的发生对于流感的流行有没有影响？（提示—对于儿童发病风险的影响，以及流感疫苗重要性的改变）

是否采取某些措施来预防儿童患病？具体采取哪些措施，预防哪些疾病？

对于流感疫苗的态度

能谈谈您对流感疫苗的看法吗?（提示—您觉得疫苗的重要性、安全性、有效性、受益如何以及价格高低）

COVID-19 是否改变了你对流感和流感疫苗的态度?(提示- COVID-19 对儿童流感风险的影响和流感疫苗重要性的变化)

流感及流感疫苗相关信息的获取

您平时获取医学、健康信息的主要渠道和来源有哪些?您能大致描述一下您从中得到的印象比较深的信息内容吗?（提示—是否有和二类疫苗或者流感疫苗相关的？疫情期间有没有接受到二类疫苗或者流感疫苗接种的信息？）您是否信任这些信息?

您是否主动查询过关于流感以及疫苗的信息？（提示—网络和社交媒体（如微信、微博），传统媒体（电视、广播、报刊杂志)，朋友和同事，家人或其他亲戚，专业书籍等，是否信任此来源？）是否存在某些信息改变或者巩固了您对于疫苗的看法？能描述一下内容吗？

您是否被动接受过关于流感疫苗的信息？（提示—医务人员提供的健康教育，微博会微信公众号推送的信息）信息来源是？是否存在某些信息改变或者巩固了您对于疫苗的看法？能描述一下内容吗？

您是否和卫生专业人员有过沟通?（提示—沟通以您主动咨询为主还是对方主动进行健康教育）是否就流感疫苗或者其它二类疫苗交流过？疫情期间有没有接受到二类疫苗或者流感疫苗接种的信息？主要会讨论哪些内容？

医生曾向您的孩子推荐过二类疫苗吗？（提示—推荐哪个疫苗？主动表示接种某疫苗对您的孩子有好处）您接受这个建议了吗? 您通过其它途径从医务人员

那里获得疫苗接种相关知识和信息？（提示—宣传册，在接种机构播放的视频，医务人员提供的课程，社区免疫宣传活动，电话或面对面咨询服务等）

社会准则与儿童流感疫苗接种

您是否与家人或者朋友讨论过关于您的孩子接种流感疫苗的事?（提示—他们对流感疫苗有什么看法?他们自己决定接种疫苗了吗?他们是否影响了您对疫苗的看法和最终决定?）

您身边的家长是否给孩子接种了流感疫苗？对您有影响吗？

过往相关经历

您给孩子接种过其它二类疫苗吗？决定为孩子接种该疫苗的主要考量有哪些?

总的来说，对于之前的接种疫苗以及就诊的经历的总体感受如何？（提示—从家到医疗结构的交通是否方便，医务人员的态度，接种的时间是否和自己的工作时间冲突？如果是，那么是如何克服的？）

是否有要求接种某种疫苗但被告知没有该疫苗提供的经历？如果有，是哪种疫苗？

疫苗接种决策

总体来说，您决定为孩子接种/不接种流感疫苗的主要考量有哪些?哪些方面对您的决定影响最大?（提示—孩子当时过敏或发烧生病，自己没时间，疫苗本身的安全性和有效性，疫苗价格，到接种点的距离，家人朋友等的影响，宗教信仰，社会文化等）

四．其他补充问题

关于我们今天讨论的话题，你还有什么要补充的吗？

你认为疫苗接种服务哪里需要改善？如何改善？有什么建议？

感谢您的参与！

医务人员访谈提纲

INTERVIEW TOPIC GUIDE FOR Healthcare Worker (For interviews with Healthcare Workers in Chapter 5)

2018 年 8 月 17 日

基本信息

访谈日期: _____ 地点: _____

访谈员:_____

受访者社会人口特征 Interviewee(s) Socio-demographic characteristics

姓名:

_____

性别: 男 女 出生日期:

_____

民族: _____ 宗教信仰:

_____

受教育程度:

_____

专业: _____

访谈提纲

提供免疫接种服务的经验

1）你从事免疫接种服务多久了？

2）你在提供免疫接种服务方面的具体职责是什么？（提示：现在，过去）

3）你接受过什么样的针对免疫接种服务的训练？（提示：什么时候，涵盖了什么内容，谁提供了培训）

4）你是否曾对你的工作场所提供的疫苗接种服务有任何疑问或担忧？如果是的话，你的问题和担忧是什么？你采取了哪些行动（提示：从 CDC 工作人员那里寻求建议/支持）

5）你的工作场所是否提供第二类疫苗？如果有的话，有哪些二类疫苗？你会推荐这些疫苗给谁？当你提出接种建议时，你会考虑哪些因素？（提示：不同疫苗的有效性，接受者的经济或健康状况）

6）您是否向居民推荐了您认为不符合居民最佳利益或不确定是否符合居民最佳利益的疫苗？

如果是，请说明哪些疫苗？为什么你不相信这（他们）符合居民的最佳利益？

7）你的工作场在免疫接种服务中哪些方面做得很好以及哪些地方可以改进？

免疫服务信息

8）你如何参与对家长/看护者进行疫苗接种方面的咨询？

9）你的信息来源是什么，哪些是你最信任的？（卫生专业人员、卫生部门、疾控中心工作人员、医学出版社、互联网、制药公司、朋友和家人，其他人，请详细说明）？

10）你的工作场所中有哪些对父母/看护者可及的信息？或指引父母或照顾者去哪些地方查询信息？

11）你对父母得到的建议和信息的质量和数量有什么看法？

12）您/您的同事与家长/看护者讨论免疫接种的时间有多长?

13)你是否曾经不同意你的同事给父母/看护者的免疫接种的建议?如果是，发生了什么，你是怎么处理的? 你的同事是否对疫苗接种持怀疑态度（不确定、怀疑/担心或反对的态度）？如果有，主要关于什么，你如何回应?

病人对于疫苗接种的意见

14)关于疫苗接种，父母最常问你的问题是什么?他们最常见的担忧是什么?

15)您是否曾遇到过患者对接种疫苗或在孩子接种疫苗时犹豫不决或干脆反对?你能描述一下发生了什么，为什么病人犹豫或反对，你是如何回应的?

a)你是如何回答他/她的担心的?

b)你是否有足够的信息/资源帮助你解决这些问题?你是如何获得这些信息的?

C)他们最终选择接种了吗？

d)这次事件对您对疫苗接种的看法有何影响?

个人对于于疫苗接种的观点

16)您对接种疫苗的好处大于风险这个陈述有多大信心?

17)您是否担心接种疫苗?如果是，你担心哪种疫苗，担心哪方面?(提示:安全性、有效性、接种后反应)

18)你有孩子吗?如果是，您的孩子/您的孩子是否按照推荐的免疫接种计划进行接种?如果没有，他们缺少接种什么疫苗，为什么?

a)作为父母，您在疫苗接种方面的决策过程是怎样的?

b)您对为您的孩子推荐的疫苗是否有任何疑问或担心?如果是，主要是哪方面，与哪些疫苗有关?

疫苗事件

19)您对过去几年发生的影响疫苗质量的事件了解多少?

20)你是如何知道这些事件的?你的想法/意见是什么?

21)这些事件在你的工作中是否产生影响?(提示:父母的问题/担忧，你是否需要检查批号，是否需要给病人再次补种疫苗)

22）政府、疾病预防控制中心、制造商、接种者的反应是什么？您如何看待他们的反应？

23)疫苗事件如何影响您对疫苗的信心或看法？（提示: 疫苗本身及其生产， 疫苗质量，采购，交付和服务，监管）

24)这些事件是否影响了您的免疫接种相关的行医行为?(提示:推荐疫苗的不确定性)

25)你认为需要采取什么措施来防止这类事故的发生?

此外

26)您认为是否有必要提高接种公众对疫苗的信心和居民疫苗的接受程度，如果有，您认为如何改进?(提示:改进的交流材料，政府对于检测制造质量方面的行动)

27)您认为是否有必要提高卫生保健人员对于疫苗接种的信心，如果有，您认为如何改进?(提示:工具，培训，信息，谁负责提供这些)。

28)您对地方或国家政府有什么建议吗？

INTERVIEW TOPIC GUIDE FOR PARENTS/CAREGIVERS (For interviews with caregivers in Chapter 4)

BASIC INFORMATION

Date of visit: _____ Place: _____ Interviewer: _____

Interviewee: Socio-demographic characteristics

Name: _____ Gender: (1) male (2) female Age: _____yeas old

Education level:

(1) No formal schooling; (2) Elementary school; (3) middle school; (4) high school or vocational school; (5) Three-Year College; (6) undergraduate degree; (7) postgraduate degree

Religion:

(1) None; (2) Buddhism; (3) Muslim; (4) Christian; (5) Taoism (6) Catholic; (7) others, please specify

Occupation:

(1) civil servant; (2) professional technicians; (3) company employees ; (4) company managers; (5) workers; (6) farmers; (7) soldiers; (8) freelancers; (9) self-employed; (10) others, please specify

Do you have responsibility for a child(ren) under the age of 6?

if yes, how many and how old are they? _____

Relationship to child(ren):

(1) father; (2) mother; (3) grandfather; (4) grandmother; (5) others (please state)

Immunisation status of the child (ren): *Fully vaccinated for age/Partially vaccinated for age/Unvaccinated (Vaccination delay within 1 month later than regular day is tolerable.)*

If the interview involves more than one person, add the details of the second person:

Name: _____ Gender: (1) male (2) female Age: _____yeas old

Education level: _____

Religion: _____ Occupation: _____

Relationship to child: _____

Topic Guide

The impact of COVID-19 on access to vaccination services

Let's start off by talking about your experience of taking your child to be vaccinated during the COVID-19 epidemic

Talk about your experience of vaccinating your child during COVID-19? (Hints - vaccination reservation procedure, vaccination, practice of observation) What do you think of this change?

Risk perception on COVID-19

Risk perception of the epidemic

Where do you get your information related to COVID-19 from? (Hints - Internet and social media (e.g., WeChat, Weibo), traditional media (TV, radio, newspapers and magazines), friends and colleagues, family or other relatives, professional books, etc.)

What do you think of the risk of COVID-19 now? (Hints - do you think you are at high risk of COVID-19 infection? Is the health impact of the infection serious?)

Knowledge and information needs for COVID-19 vaccines

Are you aware of the development progress of the potential COVID-19 vaccine? (Hints- What do you think of the importance, safety, effectiveness and benefits of the vaccines? What information would you like to know about the COVID-19 vaccine under development, including time to market, efficacy, safety, cost, vaccination population, etc.)

Demand for other vaccines during the COVID-19 epidemic

Has your child received or intends to be vaccinated with pneumococcal vaccine? Why?

How has your willingness to vaccinate changed after the outbreak? Why? (Hints- require healthcare providers to vaccinate children, or a significant change in the perception of vaccines)

Children's influenza vaccination behaviour and related influencing factors

Influenza vaccination behaviour of children in this autumn and winter

Can you tell me if your child has been vaccinated against seasonal influenza during this influenza season (September 2020 - present)? Please describe the time, place and general evaluation of vaccination service. Describe the experience after vaccination, e.g. did side effects occur?

Knowledge of flu and the vaccine

Could you tell me what you know about the flu? (Hints：What are the causes of flu? What are symptoms and complications of flu? Do you think it could be dangerous? who is more likely to catch flu?)

How can you prevent flu? Do you think there is other ways to prevent flu except vaccination?

How is your child's physical condition? Does he/she often suffer from cold or other respiratory diseases? Do you think your child is at risk of influenza?

Does the occurrence of the COVID-19 affect the risk of influenza? (Hints - the impact on the risk of childhood onset)

Did you ever take any measure to prevent children from getting sick? What specific measures?

Attitude towards influenza vaccine

Could you tell me what you think about flu vaccines? what is your opinion on the vaccine's safety, effectiveness and price?

Has the COVID-19 changed your attitude towards influenza and influenza vaccine? (Hints - the impact of COVID-19 on the risk of influenza in children and the change of the importance of influenza vaccine)

Information seeking for influenza vaccine

What are the main channels and sources of your usual access to medical and health information? Can you roughly describe the information you get from it which impressed you? (Hints - is there any information related to self-paid vaccine or influenza vaccine? Have you received any information about vaccination of self-paid vaccine or influenza vaccine during the epidemic period? Do you trust this information?)

Have you ever proactively sought for information about influenza and vaccines? What is the source of the information? Do you trust this source? Is there any information that changes or consolidates your view on vaccines? Can you describe the content? (Hints - network and social media, such as Wechat and microblog, traditional media (TV, radio, newspapers and magazines), friends and colleagues, family members or other relatives, professional books, etc.)

Have you received information about influenza vaccine? What is the source of information? Is there any information that changes or strengthens your view of the vaccine? Can you describe the content?

Have you ever communicated with health professionals? (Hints - communication is mainly based on your active consultation or health education given from health professionals?) Have you ever communicated with health professionals about influenza vaccine or other self-paid vaccines? Have you received any information about self-paid vaccine or influenza vaccine during the COVID-19?

Have doctors ever recommended self-paid vaccines to your child? (Hints - say that vaccination is good for your child) Did you accepted this recommendation? Did you get vaccination related information from medical staff through other channels? (Hints - brochures, videos played in vaccination institutions, courses provided by medical staff, community immunisation publicity activities, telephone or face-to-face consultation services, etc.)

Social norms

Have you discussed your child's flu vaccination with family or friends? (Hints— what do they think about flu vaccines? Have they decided to be vaccinated themselves? Did they influence your opinion and final decision on the vaccine?)

Have you discussed with medical staff on giving your child the flu vaccination? Can you describe the specific content of the communication? Did they influence your opinion and final decision on the flu vaccination?

Did parents around you give their children the flu vaccination? Did it affect you?

Past experience

What is your opinion on the past vaccination experience? (Hints—attitude on the vaccination service provider; if transportation to the POV is convenient; whether the time of vaccination and your working hours conflict?)

Did your children receive other vaccines you had to pay for? Have you received any publicity or recommendations for other self-paid vaccines? What about your opinion on the vaccine? What was the most important factor that led you to choose or not choose vaccination for your children?

Decision-making

In general, what are the main considerations for you to vaccinating/not to vaccinating your child against flu? What has had the most impact on your decision? (Hints - the child is sick with allergies or fever at the time, he/she does not have time, the safety and effectiveness of the vaccine itself, the price of the vaccine, the distance to the vaccination site, the influence of family and friends, religious beliefs, social culture, etc.)

Other supplementary questions

Do you have anything else to add to our discussion today?

Where do you think vaccination services need to be improved? How to improve? Any suggestions?

Thank you for your participation!

INTERVIEW TOPIC GUIDE FOR Health professionals, version 2 (For interviews with Healthcare Workers in Chapter 5)

Oct 11th 2018

BASIC INFORMATION

Date of visit: _____ Place: _____ Interviewer: _____

Interviewee: Socio-demographic characteristics

Name: _____

Gender: (1) male (2) female

Age: _____yeas old

Do you have children aged < 6 years? (1) Yes (2) No

Profession:

(1) physician (2) nurse (3) public health workers (4) others, please specify _____;

Education level:

(1) high school or below (2) three-year college

(3) undergraduate degree (4) postgraduate degree

Ethnicity:

(1) Han (2) Hui (3) Zhuang (4) Uyghurs (5) Yi

(6) Zang (7) Miao (8) Mongol (9) Dai (10) Other _____

Religion:

(1) None; (2) Buddhism; (3) Muslim; (4) Christian;

(5) Taoism; (6) Catholic; (7) others, please specify

Topic guide

Experience of providing immunisation services

How long have you been providing immunisation services?

What is your role in providing immunisation services? Could you describe some details of your daily work? Such as timetable or regular meeting, etc. (Probes: current, past)

What training have you received on immunisation? (Probes: when, where, what was covered, who provided the training; Compulsory and optional; free or not free;)

Have you ever had any questions or concerns about any of the vaccination services that are offered at your workplace? If yes, what were your questions and concerns and what did you do about them? (Probes: seek advice/support from line managers or staff from CDC)

Are Category II vaccines available at your workplace? If yes, what Category II vaccines are available? Have you ever recommended some Category II before?

If Yes: Who do you recommend these vaccines to and how did you do that? Can you give an example for us? (Probes: effectiveness of different vaccine, economic or health situation of the recipient)

If Not: Could you please tell me why you don't?

Are there vaccines that you recommend for residents that you do not believe are in the residents' best interest, or are not sure if they are in their best interest?

If yes, please state which vaccines? why you do not believe it is (they are) in the best interest of the residents?

What works well in how immunisation programs are delivered in your workplace and what could be improved?

Information and consultation about immunisation services

How are you involved in counselling residents about vaccination?

What information sources do you draw on to provide this advice? Is this the information source you trust the most? If not, which do you trust most? (Fellow health professionals, health authorities, CDC staff, medical press, internet, pharmaceutical companies, friends and family, others -please specify)?

What kind information is available to residents about childhood immunisation at your workplace? Or what resources are residents directed to?

What do you think about the quality and amount of advice/information given to residents?

How long would you like to talk with residents about immunisation at one time? How often do you talk with them?

Did you communicate or discuss the vaccination knowledge or information with you colleagues? Do you have different views about vaccination? How do you deal with this?

Resident views on vaccination

What are the most common questions residents ask you about vaccinations? What is their most common concern? What are the common rumors/stories that are circulated about vaccines in your area?

Have you ever had a resident who was hesitant or opposed being vaccinated or having their child vaccinated? Could you describe what happened, why was the resident hesitant or opposed and how did you respond?

How did you answer his/her questions/concerns?

Did you have adequate information/resources that help you to address these concerns? How did you access this information?

At last, did they take that vaccine?

How did this event influence on your views on vaccination? (Pos or Neg?)

Personal views about vaccination

How confident are you that the benefits of vaccination outweigh the risks?

Do you have concerns about giving shots to children or adults? If yes, which vaccine and what are your concerns? (Probes: Safety, effectiveness, post-vaccination reactions)

Would you be willing to talk about your experience of receiving vaccines or having your children vaccinated? If yes:

What was the vaccination decision-making process like for individually or as a parent?

Have you had any doubts or concerns about vaccines that are recommended for yourself (e.g. influenza) or for your child(ren)? If yes, what concerns and which vaccines did they relate to?

Vaccination incidents

What do you know about the vaccine incidents over the past few years? *(Prompts: Changchun Changsheng in 2018, Shandong in 2016, Hepatitis B vaccine event in 2015)*

How did you find out about these incidents? What was your response/opinion? *(Do you believe or not? How do you make judgments?) (Probes – fake news, or real problem from vaccine producing-such as unqualified vaccine-, procurement, delivering and services, regulation)*

Were there any responses to these incidents at your workplace? *(Probes: questions/concerns from residents, changes of work content)*

What is the response from government, CDC, manufactory, recipients? How do you think their response?

How do the vaccine incidents influence your confidence or perceptions on vaccine? *(Probes – vaccine itself and its producing -vaccine quality-, procurement, delivering and services, regulation)*

Have these incidents changed your immunisation related practice? *(Probes: uncertainty about recommending vaccines)* How change?

How should vaccine incidents be managed and prevented?

Moving forward

Do you think there is a need to improve vaccination confidence and uptake among residents, and if so, how do you think it could be improved? (Probes: improved communication materials, government action regarding quality of manufacturing)

Do you think there is a need to improve vaccination confidence among health care professionals, and if so, how do you think it could be improved? (Probes: Tools, training, information, who is responsible for providing these).

Have you any suggestions for local or national governments?

Thank you

APPENDIX III. STUDY TOOLS QUESTIONNAIRE

中国疫苗信心调查-儿童家长

参与者知情同意书

2021 年 4 月

调查相关信息 (For questionnaire survey for caregivers in Chapter 3)

感谢您能够参与填写这份关于疫苗的问卷。我们是来自复旦大学、伦敦卫生与热带医学院以及中国疾病预防与控制中心的研究团队，我们希望了解更多关于医疗服务提供者对当前疫苗和中国免疫规划项目的信心。我们希望从您推荐和管理疫苗的经历中获取了解信息。如果您同意参与我们的研究，您需要在接下来的问卷调查。您在问卷中提供给我们的信息将有助于制定促进疫苗接种及免疫服务实施的策略。

参与这项研究是完全自愿的。你可以决定是否参加。如果您决定参与研究，您提供给我们的任何信息都将被严格保密。我们也不会告知任何人您参与了这项研究。除研究团队人员之外，没有任何人能够看到您所完成的问卷，或者识别出您个人的回答。当我们汇报研究结果时，我们将确保每个人不会被识别出来。您也可以在任何时候选择退出，不需要任何理由。

知情同意

如果您愿意参加这项研究，请在方框内打勾：

我确认已经阅读并理解了调查背景信息。我有机会思考所提供的信息，询问有关研究的问题，并且已经获得了这些问题的满意回答； ☐

我明白我的参与是自愿的，并且我可以在任何时候无条件退出访谈； ☐

我同意参与这项研究； ☐

我同意对访谈进行录音； ☐

我同意在研究报告中匿名引用我所提供的信息； ☐

我同意将我的访谈中的匿名数据存储于复旦大学科研管理数据库中。 ☐

参与者姓名_____ **日期**_____ **签名**_____

调查者姓名_____ **日期**_____ **签名**_____

如果您有任何关于本研究的问题，您可以与本项目负责人涂诗意博士联系或侯志远博士联系，电话是 021-33565182、33563935。您也可以与复旦大学公共卫生学院伦理委员会联系，电话是 021-54237262，这个机构代表您的利益。

请填写下列关于您的住址的信息。

一、填表人特征 Characteristics of the respondents

	项目	答案
	您自己（儿童家长）的性别： (1) 男； (2) 女	
	您自己（儿童家长）的年龄：_____ 岁	
	您与所监护的 6 岁或 6 岁以下的孩子之间的关系： (1) 父亲； (2) 母亲；(3)祖父；(4) 祖母； (5) 其他（请说明）：	
	孩子是否为独生子女？： (1) 是； (2) 否	
	若第四题选“否”，那孩子有_____个亲兄弟姐妹？	
	若不是独生子女，这个孩子(指调查当日被送至卫生机构或是幼儿园)是第_____个孩子	
	孩子的出生年月(岁)： _____年_____月	
	您的教育水平: (1) 未接受正式教育； (2) 小学； (3) 初中； (4) 高中或专科学校；(5) 专科； (6) 本科； (7) 研究生	
	家庭成员数量（一起生活的）：	
	你是否有宗教信仰？（单选） 无； (2) 佛教； (3) 伊斯兰教； (4) 基督新教； (5) 道教； (6) 天主教； (7) 其他，请具体说明	
	您是否患有高血压、糖尿病、心脏病等慢性病？ (1)有； (2)无	

二、疫苗信心

	请表明您对下列观点的同意/不同意程度（在右侧对应态度下打✓）

	观点	非常 不同意	比较 不同意	中立/ 不知道	比较 同意	非常 同意
(1)	**接种疫苗对孩子来说是重要的。**					
(2)	**总体来说，我认为疫苗是安全的。**					
(3)	**总体来说,我认为疫苗是有效的。**					
(4)	**接种疫苗与我的宗教信仰不冲突** （如果没有宗教信仰，请选择“非常同意”）					
(5)	**我信任医生或者护士给我的疫苗相关信息和建议。**					

四、流感疫苗接种情况

	您认为您的孩子在秋冬季感染流感的可能性有多大? (1)非常大； (2)比较大； (3)一般/不知道； (4)比较小； (5)非常小		
	与往年秋冬季相比，您认为新冠疫情期间孩子患流感的风险是否有变化？ (1)风险变得非常大；(2)风险变大；(3)一般/不知道；(4)风险变小；(5)风险变得非常小		
	如果您的孩子患上流感，您认为出现严重后果（肺炎等严重并发症）的可能性有多大？ (1)非常大； (2)比较大； (3)一般/不知道； (4)比较小； (5)非常小		
	您认为给家中儿童接种流感疫苗能够有效避免感染吗？ (1)一定会； (2)可能会； (3)不确定； (4)可能不会； (5)一定不会		
	总体来说，您是否认为流感疫苗是重要的 （若选择(3)、(4)、(5),请跳至题24） (1)完全不同意；(2)不同意；(3)中立/不清楚；(4)同意；(5)完全同意		
	若选择“完全不同意”或者“不同意”,原因（多选）：	**是**	**否**
(1)	最好通过孩子的自身免疫力来抵抗疾病；	☐	☐

(2)	疫苗效果不好(孩子在接种后依然得流感)；	☐	☐
(3)	流感会自己痊愈的；	☐	☐
(4)	有比流感疫苗更加有效的应对方法	☐	☐
	总体来说，您是否认为流感疫苗是安全的 （若选择(3)、(4)、(5),请跳至题26） (1)完全**不**同意； (2)**不**同意； (3)中立/不清楚； (4)同意； (5)完全同意		
	若选择为“完全不同意”或者“不同意”，原因选择（多选）：	**是**	**否**
(1)	接种流感疫苗会让孩子得流感；	☐	☐
(2)	接种流感疫苗会有副反应；	☐	☐
(3)	儿童对流感疫苗过敏；	☐	☐
(4)	流感疫苗与其他疫苗会相互作用，会对儿童健康产生负面影响	☐	☐

请试着回忆你对流感及对应疫苗的观点及过往经历，并判断您的观点是否与下列陈述一致:

	观点	完 全 **不**同意	**不**同意	中立/不清楚	同意	完全同意
(1)	太忙/接种疫苗服务的时间与工作**时间冲突**，没时间带孩子接种流感疫苗					
(2)	您所在的社区或者乡镇的卫生机构表示**没有流感疫苗提供**					
(3)	流感疫苗**太贵**					
(4)	对之前在当地卫生机构接种疫苗或其他医疗服务的经历感到**不满意**					
(5)	从家里来接种点，**交通不方便**					
(6)	**身边大多数家长**都带孩子接种流感疫苗					
(7)	我的孩子身体比较**虚弱**/经常感冒					

	是否因为以下状况，产生担心，焦虑或是恐惧的情绪？（选项“低”，“中”，“高”分别代表情绪值的高低）	低	中	高	无感觉
(1)	想起孩子因为**不接种**流感疫苗而对健康产生负面影响				
(2)	想起孩子因为**接种**疫苗而对健康产生负面影响				

	您的孩子是否在去年流感季（2020 年 9 月之后）接种了流感疫苗？ （若选择(2)、(3)，请跳至题 30） (1)是；(2)否；(3)记不清了			
	在去年流感季，您在决定是否给孩子接种流感疫苗的时候，是否受到过下列主体的影响，主要是哪方面的影响？ **建议接种 不建议接种 无影响**			
（1）	医务人员	☐	☐	☐
（2）	家庭成员或朋友	☐	☐	☐
（3）	疾控中心或政府机构	☐	☐	☐
（4）	网络，包括社交媒体或者网络媒体	☐	☐	☐
（5）	其它，请说明主体和影响；	☐	☐	☐
（6）	以上主体都没有影响**（若选该选项请直接选择“无影响”）**	☐	☐	☐
	您是否打算今年流感季（2021 年 9 月之后）给孩子接种流感疫苗? (1)一定会；(2)可能会；(3)不确定；(4)可能**不会**；(5)一定**不会**			
	您的孩子是否在 19 年流感季（2019 年 10 月-2020 年 3 月）接种了流感疫苗？ (1)是；(2)否；(3)记不清了			
	您的孩子出生后是否至少接种了一次流感疫苗？ （1）是 （2）否 （3）记不清了			

您现在的职业是：

(1)国家公务员 (2)专业技术人员 (3)企业职员 (4)企业管理人员 (5)工人 (6)农民 (7)现役军人 (8)自由职业者 (9)个体经营者 (10)其他

您目前居住在_____省_____市_____区/县_____乡镇/街道

您在上述居住地是否拥有户口？

(1) 有户口

(2) 没有，请填写户口在哪个省份和城市：在_____省_____市_____区/县

在过去的一年里您家庭的总收入：

(1) 少于 1 万　(2) 1-2 万　(3) 2-5 万

(4) 5-10 万　(5) 10-20 万　(6) 20 万以上

感谢您完成此问卷。

Parents/caregivers Survey

Informed Consent

4,2021

Information about the survey (For questionnaire survey for caregivers in Chapter 3)

Thank you for participating in this questionnaire survey on vaccination. We are a group of researchers from Fudan University, the London School of Hygiene & Tropical Medicine in England and China CDC who are interested in understanding the public attitudes towards vaccination and their experiences with immunisation services. You were invited to take part in this questionnaire since you have responsibilities for a child/children aged 6 or under. Information you share in this questionnaire will help us improve both communication regarding vaccines between health facilities and parents/caregivers, as well as the delivery of immunisation services.

You will participate in this questionnaire on a voluntary basis. Information you share in the questionnaire will be strictly confidential. Responses will be kept anonymous when report the survey results. You are free to withdraw at any time without giving a reason.

If you have any questions or concerns before completing the questionnaire, please contact the leading researchers at Fudan University:

Contact details

Dr. Shiyi Tu Telephone: 021-33565182 Email: sytu@fudan.edu.cn

Dr. Zhiyuan Hou Telephone: 021-33563935 Email: zyhou@fudan.edu.cn

Opt-in consent

If you are willing to take part in this survey, please tick the box. ☐

The respondent will need to tick this box before proceeding to the questionnaire to confirm their willingness to complete the survey.

Questionnaire

Please add the following details about where you live.

Province_____city/county_____

Characteristics of the respondents

	Items	**Answers**
1	Caregivers' gender: (1) male (2) female	
2	Caregivers' age: _____ years	
3	Relationship with child(ren) aged 6 and under for whom I am responsible: (1) father (2) mother (3) grandfather (4) grandmother (5) other (please state)	
4	Is the child the only child in your family? ： (1) Yes； (2) No	
5	If the child has siblings, how many?	
6	The parity of this child	
7	Child's birth date: _____year _____month	
8	Education level: (1) No formal schooling (2) Elementary school (3) middle school (4) high school or vocational school (5) Three-Year College (6) undergraduate degree (7) postgraduate degree	
9	Numbers of family members（living together）：	
10	Religion: None (2) Buddhism (3) Muslim (4) Christian (5) Taoism (6) Catholic (7) other, please specify	
11	Are you suffering from any chronic diseases such as hypertension, diabetes or heart disease? (1) Yes (2) No	

Vaccine confidence

	Please indicate to what extent you agree/disagree with the following statements.					
12	**Statements**	**Strongly disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
(1)	Vaccines are important for my children to have					
(2)	Overall, I think vaccines are safe					
(3)	Overall, I think vaccines are effective					
(4)	Vaccines are compatible with my personal or religious beliefs					
(5)	I trust the advices and information on vaccination from health professionals					

Influenza vaccination status

19	How likely is your child to get the flu in fall or winter? (perceived susceptibility) (1)Completely impossible；(2)Impossible；(3)Neutral/Not sure；(4)Possible；(5) Completely possible
20	Is there any change in children's risk of influenza during COVID-19 compared to previous autumn and winter？(Impact of Covid-19 on susceptibility of influenza) (1) The risk becomes very high; (2) Risk Increased; (3) Neutral/Not sure; (4) Risk reduced ;(5) The risk becomes very low
21	If your child has the flu, what do you think the chances are of serious consequences (severe complications such as pneumonia)? (perceived severity) (1)Completely impossible；(2)Impossible；(3)Neutral/Not sure；(4)Possible；(5)Completely possible
22	Do you think vaccinating children will help children avoid being infected? (perceived benefit/confidence on effectiveness) (1)Completely not；(2)Not；(3)Neutral/Not sure；(4)Possible；(5) Certainly
23	Overall, I think influenza vaccine is important for my children to have (confidence on complacency) (1)Strongly disagree；(2)Disagree；(3)Neither agree nor disagree；(4)Agree；(5)Strongly agree

24	If (1) or (2), Why?	Yes	No
(1)	It's better to have natural immunity against influenza	☐	☐
(2)	Vaccines do not work (children still catch a cold after being vaccinated)	☐	☐
(3)	Flu is self-limiting for most people	☐	☐
(4)	There is other useful treatment if my child gets flu	☐	☐
25	Overall, I think influenza vaccine is safe (confidence on safe) (1)Strongly disagree；(2)Disagree；(3)Neither agree nor disagree；(4)Agree；(5)Strongly agree		
26	If (1) or (2), Why：	Yes	No
(1)	The vaccine may give them flu	☐	☐
(2)	There will be side effects of the influenza vaccine	☐	☐
(3)	Child had allergy to chicken products	☐	☐
(4)	This flu vaccine would have negative effect in interaction with other vaccines to be taken up by the child	☐	☐

27 Please try to recall your views and past experiences on influenza and corresponding vaccines and determine whether your views are consistent with the following statements:

	Statement	**Strongly disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
(1)	Time for vaccination service conflicts with working time /being too busy or having difficulty taking time off work (perceived barrier: Accommodation)					
(2)	There is a lack of availability of the influenza vaccine in my local hospital, community health centre or health institute (perceived barrier: availablity)					
(3)	Influenza Vaccine costs too much (perceived barrier: affordability)					
(4)	Not satisfied with past					

	vaccination service/ healthcare service (perceived barrier: acceptibility)					
(5)	Transportation to the POV is not very convenient (perceived barrier: Accessibility)					
(6)	Most of the parents you know take their children for flu shots (Descriptive social norm)					
(7)	My child catching colds frequently (Cue to action: Internal type-self perception)					
28	When you think about (the possibility of your child to contract seasonal influenza/ adverse effects of vaccines), do you feel: worry, anxiety or fear? (Emotion)	low	Moderate	high	No feeling	
(1)	Think of the negative health effects of not getting the flu shot					
(2)	Think of the negative health effects of getting the flu shot					
29	Did your child get a flu shot in the last flu season (after September 2020)? (If you choose "No" or cannot remember clearly, please skip to Question 31) (1)Yes; (2) no; (3) I can't remember					
30	During this year's flu season, when deciding whether or not to give your child a flu shot, have you been influenced by the following factors, mainly in what ways (Cue to action: external type/subjective social norm):					
		Recommendation		Recommend no vaccination		No influence
(1)	Healthcare professionals	☐		☐		☐
(2)	Family members or friends	☐		☐		☐
(3)	Government or CDC	☐		☐		☐
(4)	Social media and internet	☐		☐		☐

	media			
（5）	Others；	☐	☐	☐
（6）	None of the above subjects has any influence (if this option is selected, please directly select "No influence")	☐	☐	☐
31	Do you plan to give your child a flu shot in the next flu season (October 2021 - March 2022)? (1) Certainly; (2) Possible; (3) Not sure; (4) Probably not; (5) Definitely not			
32	Did your child get a flu shot during the 2019 flu season (October 2019 - March 2020)? (1) Yes; (2)No; (3) Can't remember			
33	Does your child get at least one flu shot after birth? (1)Yes; (2)No; (3) Can't remember			

Your present occupation is:

(1) civil servant; (2) professional technicians; (3) company employees;(4) company managers; (5) workers; (6) farmers; (7) soldiers; (8) freelancers; (9) self-employed; (10) others, please specify

36. Do you have Hukou in your residence?

(1) Yes

(2) No，my hukou is in：_____Province_____City_____county

37.The total income of your family in the past year: _____

(1) less than 10,000 yuan; (2) 10,000-20,000 yuan; (3) 20,000-50,000 yuan;

(4) 50,000-100,000 yuan; (5) 100,000-200,000 yuan; (6) more than 200,000 yuan

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