

RESEARCH PAPER



Evaluation of influenza vaccination coverage in Shanghai city during the 2016/17 to 2020/21 influenza seasons

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ABSTRACT

Influenza is a common infectious disease resulting in substantial morbidity and mortality globally. The most effective strategy for preventing influenza is annual vaccination; however, the coverage rate of the influenza vaccine in Shanghai has not been well explored or reported. Therefore, this study aimed to determine coverage with the influenza vaccine and access trends in Shanghai city; data from Shanghai immunization information system was analyzed to estimate vaccination coverage during 2016–2017 through 2020–2021 influenza seasons. Vaccination coverage by age groups, immigration status, and districts was accessed. The influenza vaccination coverage (at least one dose) for 2016/2017 to 2020/2021 influenza seasons was 10.8% (95% CI: 10.7–10.8), 12.3% (95% CI: 12.3–12.4), 10.1% (95% CI: 10.0–10.1), 20.1% (95% CI: 20.0–20.2) and 50.8% (95% CI: 50.7–50.8) respectively. Although we found significantly higher vaccination coverage in females, children from 6 months to 17 years, and residents, it is still low in all subgroups of the population in Shanghai. Therefore, taking effective steps to promote influenza vaccination in Shanghai is recommended.

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Introduction

Influenza is a group illnesses that range in severity, and can lead to hospitalization and death.^{1,2} The World Health Organization (WHO) estimates that 3,000,000–5,000,000 severe cases and 290,000–650,000 respiratory disease-related deaths occur annually.^{3,4} In China, human influenza viruses were associated with an average of 2.5 excess influenza-like-illness (ILI) consultations per 1000 person-years in 30 provinces each year from 2006 to 2015; this had a considerable impact on population morbidity, with a consequent healthcare and economic burden.⁵

Several studies^{6–8} and long-term practices in many countries have shown that influenza vaccination is the most effective way to prevent influenza; the vaccine significantly reduces the risk of influenza and associated serious complications. The WHO and the Chinese Centers for Disease Control and Prevention have recommended that individuals without contraindications aged ≥ 6 months should get seasonal influenza vaccination.^{3,9,10}

Currently, the influenza vaccine is not included in the National Immunization Program; therefore, it is optional and self-funded in China. The overall coverage rate of influenza vaccination is only 2–3%,¹¹ which is well below the target recommended by the WHO. Some areas of China have implemented policies providing free influenza vaccinations to specific groups such as the elderly, medical workers, and students, which has significantly increased the vaccination coverage in the target population. Despite Shanghai being one of the world's largest seaports and a major industrial and commercial center of China, no free vaccination programs have been implemented. People can get the “current year” influenza vaccines from September to April of the following year in immunization clinics at their own expense. The coverage rate of the influenza vaccination in

Shanghai has yet to be reported. Therefore, determining the influenza vaccination coverage would be useful for immunization programs targeting interventions and help to improve the full influenza vaccination coverage. This study aimed to quantify the influenza vaccination coverage from 2016/2017 to 2020/2021, overall, and stratified by gender, age, immigration status, and districts.




Methods

Data source

Data on influenza vaccinations were obtained from the Shanghai immunization information system, which contains vaccination data for all citizens living in Shanghai. Demographic information (such as gender, date of birth, address, and immigration status) as well as vaccination type and data were retrieved from this database. Population data used in this study were obtained from the Shanghai statistics yearbooks of 2016–2020. The main indicators used include the population by age, districts, and immigration status. Anonymized individual records of the target population were extracted from the Shanghai immunization information system. Data were encrypted and stored in specific computers, and all researchers signed confidentiality agreements. Immigration status of participants was classified as resident and migrant in this study. Migrant population included population from other provinces or from abroad.

Statistical analysis

Data were organized and analyzed by Microsoft Excel 2020 and SPSS 17.0 (SPSS Inc, Chicago, IL, USA) software. Using the influenza vaccination population and the total population in

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Shanghai from 2016 to 2020, the influenza vaccination coverage (at least one dose) was estimated. The coverage rates of influenza vaccination during different influenza seasons to 50.8‰ were calculated separately, in addition to the 95‰ confidence intervals (95‰ CI) during each period. The 95‰ confidence intervals were calculated using SPSS software (version 17.0), using the following equation: $(p-Z\alpha_{/2}S_p, p+Z\alpha_{/2}S_p)$, where $Z\alpha_{/2} = 1.96$ and S_p is the standard deviation. The influenza vaccination coverage was estimated among strata defined by gender, age, immigration status, and district. Tests for linear trends across periods (2016/2017 to 2020/2021) were performed using a weighted linear regression on the season-specific estimates, using season number as the independent variable and the inverse of the estimated variance of the influenza vaccination coverage as the weights. We adopted the χ^2 test to examine whether the coverage of influenza vaccination was significantly different across the subgroups. A significance level of 0.05 was used.

Results

Overall coverage of influenza vaccinations

During the 2016/2017 through 2020/2021 influenza seasons, the number of people that received an influenza vaccination was 2,522,076 with an average of 504,415 vaccines per season. The total number of population in each influenza seasons were about 24.2 million, 24.2 million, 24.2 million, 24.3 million and 24.9 million respectively (Table 1).

The influenza vaccination coverage (at least one dose) for the 2016/2017 to 2020/2021 influenza seasons was 10.8‰ (95‰ CI: 10.7–10.8), 12.3‰ (95‰ CI: 12.3–12.4), 10.1‰ (95‰ CI: 10.0–10.1), 20.1‰ (95‰ CI: 20.0–20.2), and 50.8‰ (95‰ CI: 50.7–50.9), respectively. The coverage

increased from 10.8‰ in the 2016/2017 influenza season to 50.8‰ in the 2019/2020 influenza season, and the average annual increase was 0.805 ($p < 0.001$) based on the slope of the trend test. The coverage increased from 2016/2017 to 2020/2021 in both females and males, all age groups, and in both residents and migrants. We observed a significant increase in the coverage of influenza vaccination across the different districts. The coverage rate of influenza vaccination also increased year by year in each district. From 2016/2017 to 2020/2021, the total coverage of influenza vaccination in Jingan, Putuo, Hongkou, Yangpu, Baoshan, Songjiang, Qingpu, Fengxian and Chongming districts was lower than the average rate of Shanghai city (Table 2).

Influenza vaccination coverage across subgroups

The influenza vaccination coverage was 22.5‰ for females and 19.5‰ for males in the 2016–2020 influenza seasons. Influenza vaccination coverage among people aged 0.5–17 years, 18–59 years, and ≥ 60 years increased significantly from 93.9‰, 0.9‰ and 4.1‰, respectively, in the 2016/2017 influenza season to 30.98‰, 17.6‰ and 37.5‰, respectively, in the 2020/2021 influenza season. For all influenza seasons, the difference is in favor of the female gender and youngest age (Table 2).

The influenza vaccination coverage was 21.6‰ for residents and 19.7‰ for migrants from 2016/2017 to 2020/2021. There was a significant difference in influenza coverage between strata defined by immigration status. The coverage rate of residents in 2016/2017 and 2017/2018 was lower than of the migrants, while the coverage rate of residents in 2018/2019, 2019/2020, and 2020/2021 was higher than of migrants (Table 2).

Table 1. The number of individuals vaccinated against the seasonal influenza and its percentage over the total target population (in brackets) in Shanghai city during the 2016/2017 through to the 2020/2021 influenza seasons.

	2016-2017 (N=24197000)	2017-2018 (N=24183300)	2018-2019 (N=24237800)	2019-2020 (N=24281400)	2020-2021 (N=24871000)	Total
Gender						
Female	133,386 (51.2)	149,948 (50.3)	116,506 (47.8)	229,551 (47.2)	576,751 (46.8)	1,206,141 (47.8)
Male	127,001 (48.8)	148,055 (49.7)	127,112 (52.2)	257,017 (52.8)	656,749 (53.2)	1,315,935 (52.2)
Age group						
0.5–17 years	221,871 (85.2)	236,051 (79.2)	149,657 (61.4)	282,886 (58.1)	736,372 (59.7)	1,626,837 (64.5)
18–59 years	15,260 (5.9)	27,744 (9.3)	46,204 (19.0)	101,940 (21.0)	284,565 (23.1)	475,713 (18.9)
≥ 60 years	23,256 (8.9)	34,208 (11.5)	47,757 (19.6)	101,743 (20.9)	212,563 (17.2)	419,527 (16.6)
Immigration status						
Residents	142,485 (54.7)	142,425 (47.8)	155,514 (63.8)	314,425 (64.6)	803,773 (65.2)	1,558,622 (61.8)
Migrants	117,902 (45.3)	155,578 (52.2)	88,104 (36.2)	172,143 (35.4)	429,727 (34.8)	963,454 (38.2)
Districts						
Huangpu	4737 (1.8)	8636 (2.9)	5742 (2.4)	14,829 (3.1)	44,511 (3.6)	78,455 (3.1)
Xuhui	15,122 (5.8)	19,565 (6.6)	15,575 (6.4)	35,895 (7.4)	85,832 (7.0)	171,989 (6.8)
Changning	6369 (2.5)	7368 (2.5)	12,816 (5.3)	26,608 (5.4)	63,900 (5.2)	117,061 (4.6)
Jingan	8523 (3.3)	15,007 (5.0)	9653 (4.0)	25,813 (5.3)	54,540 (4.4)	113,536 (4.5)
Putuo	5855 (2.3)	7463 (2.5)	6897 (2.8)	19,904 (4.1)	55,885 (4.5)	96,004 (3.8)
Hongkou	2229 (0.9)	3669 (1.2)	3991 (1.6)	10,531 (2.2)	33,803 (2.7)	54,223 (2.2)
Yangpu	3414 (1.3)	5659 (1.9)	9284 (3.8)	24,155 (5.0)	59,137 (4.8)	101,649 (4.0)
Minhang	50,312 (19.3)	53,903 (18.1)	34,416 (14.1)	59,113 (12.2)	123,893 (10.0)	321,637 (12.8)
Baoshan	13,916 (5.3)	12,973 (4.4)	11,021 (4.5)	22,256 (4.6)	75,496 (6.1)	135,662 (5.4)
Jiading	25,918 (10.0)	30,429 (10.2)	21,230 (8.7)	41,390 (8.5)	91,726 (7.4)	210,693 (8.4)
Pudong	63,400 (24.4)	65,977 (22.1)	68,355 (28.1)	126,834 (26.1)	326,613 (26.5)	651,179 (25.8)
Jinshan	10,532 (4.0)	12,554 (4.2)	15,482 (6.4)	17,379 (3.6)	49,052 (4.0)	104,999 (4.2)
Songjiang	19,826 (7.6)	22,420(7.5)	14,382(6.0)	22,857 (4.7)	72,962 (5.9)	152,447 (6.0)
Qingpu	17,438 (6.7)	18,202 (6.1)	6519 (2.7)	16,722 (3.4)	33,936 (2.8)	92,817 (3.7)
Fengxian	9384 (3.6)	9724 (3.3)	4494 (1.8)	10,371 (2.1)	41,691 (3.4)	75,664 (3.0)
Chongming	3412 (1.3)	4454 (1.5)	3761 (1.5)	11,911 (2.5)	20,523 (1.7)	44,061 (1.8)
Total	260,387 (100.0)	298,003 (100.0)	243,618 (100.0)	486,568 (100.0)	1,233,500 (100.0)	2,522,076 (100.0)

Table 2. Influenza vaccination coverage (%) in of the target population and 95% confidence intervals for Shanghai city during the 2016/2017 through 2020/2021 influenza seasons. Trend over seasons is provided as slope (annual percent change) of linear trend analysis.

	Coverage (95% CI)					Total	Trend test	
	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021		slope	p
Gender ^a								
Male	10.6 (10.5–10.7)	11.9 (11.9–12.0)	9.5 (9.4–9.5)	19.1 (19.0–19.1)	46.4 (46.3–46.5)	19.5 (19.4–19.5)	0.861	<0.001
Female	11.0 (10.9–11.0)	12.7 (12.7–12.8)	10.7 (10.7–10.8)	22.3(22.1–22.4)	55.4 (55.3–55.6)	22.5 (22.5–22.6)	0.872	<0.001
Age group ^a								
6 months –17 years	93.9 (93.6–94.3)	99.8 (99.4–10.0)	63.3 (63.0–63.6)	119.3 (118.9–119.8)	309.8 (309.2–310.4)	137.4 (137.2–137.6)	0.803	<0.001
18–59 years	0.9 (0.9–1.0)	1.7 (1.7–1.8)	2.9 (2.8–2.9)	6.3 (6.3–6.4)	17.6 (17.5–17.6)	5.9 (5.9–6.0)	0.922	<0.001
≥60 years	4.1 (4.1–4.2)	6.1 (5.9–6.1)	8.5 (8.4–8.5)	18.0 (17.9–18.1)	37.5 (37.3–37.6)	14.8 (14.8–14.9)	0.927	<0.001
Immigration status ^a								
Residents	9.9 (9.9–10.0)	9.9 (9.8–10.0)	10.8 (10.7–10.8)	21.7 (21.7–21.8)	17.6 (17.5–17.6)	21.6 (21.5–21.6)	0.884	<0.001
Migrants	12.0 (11.9–12.1)	15.9 (15.8–16.0)	9.1 (9.0–9.1)	17.6 (17.5–17.7)	44.0 (43.8–44.1)	19.7 (19.6–19.7)	0.818	<0.001
Districts ^a								
Huangpu	6.7 (6.5–6.9)	12.2 (12.0–12.4)	8.8 (8.5–9.0)	22.7 (22.3–23.0)	68.0 (67.4–68.6)	23.2 (23.0–23.4)	0.824	<0.001
Xuhui	13.3 (13.1–13.5)	17.1 (16.9–17.4)	14.3 (14.1–14.5)	33.1 (32.8–33.4)	79.0 (78.5–79.5)	31.0 (30.9–31.2)	0.838	<0.001
Changning	8.8 (8.6–9.0)	10.1(10.0–11.4)	18.5 (18.2–18.8)	38.3 (37.9–38.8)	91.9 (91.3–92.6)	33.1 (32.9–33.3)	0.886	<0.001
Jingan	7.5 (7.3–7.7)	13.2 (13.0–13.5)	9.1 (8.9–9.2)	24.2 (23.9–24.5)	51.2 (50.8–51.6)	20.8 (20.7–20.9)	0.861	<0.001
Putuo	4.3 (4.2–4.4)	5.5 (5.4–5.6)	5.4 (5.2–5.5)	15.5 (15.3–15.7)	43.5 (43.2–43.9)	14.6 (14.5–14.7)	0.839	<0.001
Hongkou	2.5 (2.4–2.6)	4.1 (4.0–4.2)	4.4 (4.2–4.5)	13.1 (13.0–13.4)	42.3 (41.9–42.8)	12.6 (12.5–12.7)	0.837	<0.001
Yangpu	2.5 (2.4–2.6)	4.1 (4.0–4.2)	7.1 (6.9–7.2)	18.4 (18.2–18.6)	45.0 (44.6–45.3)	15.2 (15.1–15.3)	0.889	<0.001
Minhang	19.7 (19.6–19.9)	21.1 (20.9–21.3)	13.6 (13.4–13.7)	23.2 (23.0–23.4)	48.6 (48.3–48.9)	25.3 (25.2–25.3)	0.700	<0.001
Baoshan	7.0 (6.8–7.1)	6.5 (6.4–6.6)	5.4 (5.3–5.5)	10.9 (10.8–11.0)	36.9 (36.6–37.2)	13.4 (13.3–13.5)	0.761	<0.001
Jiading	16.8 (16.6–17.0)	19.7 (19.4–19.9)	13.4 (13.2–13.6)	26.0 (25.8–26.3)	57.6 (57.3–58.0)	26.8 (26.7–26.9)	0.777	<0.001
Pudong	12.0 (11.9–12.1)	12.4 (12.3–12.5)	12.6 (12.5–12.7)	22.9 (22.8–23.0)	58.7 (58.5–59.0)	24.0 (23.9–24.1)	0.818	<0.001
Jinshan	13.7 (13.4–14.0)	16.3 (16.0–16.6)	19.7 (19.3–20.0)	21.6 (21.3–21.9)	60.8 (60.3–61.4)	26.7 (26.5–26.8)	0.808	<0.001
Songjiang	11.9 (11.8–12.0)	13.5 (13.3–13.6)	8.4 (8.3–8.6)	13.0 (12.8–13.1)	41.3 (41.0–41.6)	17.8 (17.7–17.9)	0.689	<0.001
Qingpu	15.4 (15.1–15.6)	16.0 (15.8–16.2)	5.4 (5.3–5.5)	13.7 (13.5–13.9)	27.8 (27.5–28.0)	15.7 (15.6–15.8)	0.444	<0.001
Fengxian	8.2 (8.1–8.4)	8.5 (8.4–8.7)	3.9 (3.8–4.0)	9.0 (8.8–9.2)	36.1 (35.8–36.5)	13.2 (13.1–13.3)	0.685	<0.001
Chongming	4.7 (4.5–4.9)	6.1 (5.9–6.3)	5.1 (4.9–5.2)	17.3 (17.0–17.6)	29.8 (29.4–30.4)	12.3 (12.2–12.4)	0.887	<0.001
Total	10.8 (10.7–10.8)	12.3 (12.3–12.4)	10.1 (10.0–10.1)	20.1 (20.0–20.2)	50.8 (50.7–50.9)	20.8 (20.7–20.8)	0.805	<0.001

^asignificant difference ($p < 0.05$) of coverage for influenza vaccination between different subgroups tested by χ^2 test.

Discussion

The disease burden of seasonal influenza is still heavy in China, and the influenza vaccination is one of the most effective measures to prevent influenza.^{12,13} Influenza vaccines protect people from infection and reduce the spread, benefiting those who do not have access to vaccination.¹⁴ However, the influenza vaccine is not included in the National Immunization Program in China.¹⁵ And people have to pay to vaccinate themselves. To the best of our knowledge, no data concerning influenza vaccination coverage among the whole population in Shanghai have been published. Quantifying the influenza vaccination coverage in recent years could help guide public health action to improve full influenza vaccination coverage. Therefore, the goal of this study was to investigate the influenza vaccination coverage in Shanghai from the 2016/2017 to 2020/2021 influenza seasons.

In this study, although the influenza vaccination coverage showed a growth trend in Shanghai city from the 2016/2017 to 2020/2021, it was still extremely low, between 10.8%–50.8%, which is not lower than the target rate recommended by the WHO and that of other high-income countries or even upper-middle-income countries.^{16–20} One more data point demonstrating the low uptake of influenza vaccinations in China is that the influenza vaccine rate among the general population is only about 2.0%.²¹ As of 2014, over 100 countries worldwide already had influenza vaccination policies, with vaccination costs subsidized by the respective governments.¹¹ In contrast, only a handful of large cities in China provide free influenza vaccines for at least one

of the high-risk groups.^{22–26} Despite Shanghai being one of the most developed cities worldwide; it does not provide reimbursement for the influenza vaccination. Our results demonstrate that an effective immune barrier is not being built and there is potential for localized influenza outbreaks. Therefore, we should prioritize strengthening the vaccination rate of influenza in Shanghai.

Studies indicated that appropriate policies may promote influenza vaccination coverage in the short term.²⁷ For instance, vaccination coverage was higher in workplaces with free vaccination policies than in those without a free vaccination policy. Furthermore, the coverage was higher when vaccination is mandatory or encouraged by the workplaces.

Although the influenza vaccination coverage is low in the different populations in Shanghai, we still observed an obvious difference across some sociodemographic factors, such as gender, age, immigration status and regional disparity. The influenza vaccination coverage across all age groups are well below the target set by the WHO, and we found that obvious difference was observed according to age group, with a higher coverage seen in the 0.5–17 years age group. In the 2020/2021 influenza season, to minimize the interference of influenza to the COVID-19 epidemic, Shanghai has increased the publicity and promotion of influenza vaccination among school-age children. As a result, the vaccination coverage for children aged 0.5–17 years was found to be 309.8% in the 2020/2021 influenza season, which is about three times than that of 2019/2020. We also found that vaccination coverage in females

was significantly higher than that in males. The gender difference in influenza vaccination uptake be attributed to women being more aware of health issues and general well-being.²⁷

Immigrant status remained a determinant of the influenza vaccination coverage. The influenza vaccination coverage among residents was found to be significantly higher than among migrants, which may be due to residents being more financially capable and having a higher awareness of influenza. A cross-sectional study shown that influenza vaccine coverage among migrants in Shanghai in the 2019/2020 and early 2020/2021 influenza seasons were 26.3% and 24.4% respectively.²⁸ The result was considerable different from that of our study. The reasons for the differences were as following. First, the estimates of influenza vaccination coverage in their study were based on self-reported information, which may be prone to recall bias. Second, their study used purposive sampling which may led to a selection bias, as the sampling was not random, and their sample size was small.

There are several limitations to this study. First, our data may have slightly underestimated the vaccination rate because not all vaccinations against influenza were reported; some people may not have received the influenza vaccine in Shanghai, so we cannot synchronize their vaccination records. Second, we did not evaluate the receipt of two doses of influenza vaccine.

In summary, we quantitatively reported the influenza vaccination coverage of different population in Shanghai for the first time. Despite the highly recommended influenza vaccine uptake worldwide, our study found that the seasonal influenza vaccination rate was extremely low in Shanghai; therefore, it is necessary to take implement effective strategies to promote influenza vaccination in Shanghai as soon as possible.

Ethics considerations

Anonymized individual records of population were extracted from the Shanghai immunization information system. This study was approved by the ethical review board of Shanghai Municipal Center for Disease Control and Prevention.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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