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Investigation and analysis of children's behavior and outpatient number of respiratory diseases in Shanghai before and after the COVID-19 pandemic

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ABSTRACT

Objective: Alterations in behavioral habits of children were analyzed in Shanghai in the winters prior to and following the COVID-19 pandemic, with the aim of assisting in the prevention of children's respiratory diseases in the post-pandemic era.

Method: This cross-sectional survey was conducted via an offline questionnaire from January 1 to February 28, 2021. The behavioral habits of Shanghainese children in different age groups during the winter of 2019 and 2020 were statistically analyzed using the SPSS 25.0 software. The parameters surveyed and analyzed included the frequency of outdoor activities, self-protection measures (frequency of wearing masks and washing hands after going out), travel history, time to visit since symptom onset, and influenza vaccination status. Lastly, the number of cases of respiratory diseases in the pediatric outpatient department of our hospital was analyzed during the same period.

Result: A total of 1816 questionnaires were investigated and analyzed, and the results revealed that self-protection measures were significantly enhanced in children of all age groups after the COVID-19 pandemic breakout compared with those before the pandemic, whereas the frequency of outdoor activities and traveling were reduced. In the age group over 3 years old, the time to visit since symptom onset was shorter, and the influenza vaccination rate increased following the pandemic. During the same period, the number of cases of children with respiratory diseases in our outpatient department was significantly decreased compared with that prior to the COVID-19 pandemic.

Conclusion: The COVID-19 pandemic has had a significant impact on self-protection measures, outdoor activities, and other children's behaviors in all age groups in Shanghai. These changes in habits were correlated with a lower incidence and transmission of respiratory diseases in children. Overall, this study lays a theoretical basis for the prevention of childhood illnesses in the post-pandemic era.

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1. Introduction

Cases of coronavirus (On February 11, 2020, the World Health Organization officially named it coronavirus disease 2019) infection were detected and spread rapidly in Wuhan, China. On March 11, 2020, the World Health Organization officially declared the COVID-19 outbreak a pandemic [1]. Meanwhile, the first-level response was issued by provinces and cities of China on January 23, 2020. Suspension of on-site work and schooling was imposed to limit the transmission of the disease. On September 2020, the spread of COVID-19 was effectively controlled in China (A total of 39 cases of locally confirmed COVID-19-induced pneumonia were reported in Shanghai from the 1st of January to the December 31, 2021), and preventive and control measures shifted from the emergency state to the normal state. Consequently, there were no COVID-19 case outbreaks in the winters of 2019 and 2020 in China. However, the enhanced personal-protective measures and improved medical advice-seeking behavior and lifestyle following the pandemic outbreak may have persisted. Therefore, this study was conducted to analyze alterations in children's behavioral habits in Shanghai in the winters prior to and following the COVID-19 pandemic.

According to research, social distancing, face masks, and personal hygiene can prevent the spread of COVID-19 in the general population [2,3]. However, the majority of studies were conducted on adults, and research regarding children was predominantly focused on habits related to diet, sleep, and weight fluctuations during home quarantine [4–6]. Indeed, articles concerning changes in children's habits and medical advice-seeking behavior caused by the pandemic are scarce. Thus, changes in lifestyle and medical advice-seeking behavior of children were analyzed in the two winters before and after the outbreak of COVID-19. Combined with data regarding outpatients of respiratory diseases, the correlation between changes in behavior and the number of outpatient visits owing to respiratory infections in children after the pandemic was explored in order to provide a reference for the prevention of COVID-19 and other related respiratory infections among children.

2. Materials and methods

2.1. Study design and samples

This was a cross-sectional study conducted via an offline questionnaire survey for pediatric outpatients in Changhai Hospital from January 1 to February 28, 2021. A total of 1816 outpatients in the Pediatrics Department of the Changhai Hospital were investigated. The inclusion criteria were as follows: 1. Patients aged between 15 months and 16 years (date of birth: April 1, 2004 to October 1, 2019) at the time of the survey, 2. Voluntary participation in this study. Exclusion criteria were as follows: 1. Patients younger than 12 months or older than 16 years, 2. History of malignancy, immunodeficiency, congenital respiratory abnormalities, connective tissue disease, and other related chronic diseases. Since the backtracking timepoint of the survey was 15 months prior to the time of filling out the survey, the children in this study were all older than 15 months. All survey activities were detailed and authorized by the parents or guardians of these children. The number of pediatric respiratory disease-related outpatient cases in our hospital during the same period was determined.

In this study, all 1816 children (1001 males and 815 females) were long-term residents of Shanghai, and their ages ranged from 15 months to 16 years. The annual pediatric outpatient visits of our hospital account for approximately 5% of all children's outpatient services in Shanghai and is equivalent to serving the children of a city with a population of one million. The number of children in all age groups was sufficiently large, which is representative of Shanghai children.

2.2. Questionnaire data

The offline questionnaire was filled out by their guardian for children under 12 years old. Contrastingly, teenagers aged 13–16 years filled out the questionnaire by themselves. Concerning children aged 12 years or younger, both parents were requested to fill out the questionnaire on their behalf. Regarding children older than 12 years, the child was requested to initially fill out the questionnaire, and their parents subsequently cross-checked their answers. Following the respondents' submission, the researcher inspected the integrity of the received questionnaire and complemented the missing answers with supplementary follow-up questions. It took roughly 15 min to complete the questionnaire.

The questionnaire in this study comprised the following questions: firstly, basic information about the children (gender, age, etc.) was collected. Next, data on changes in children's behavioral habits before and after the pandemic were gathered; the following questions were included in this section: How often do you go outside each week (including parks, indoor and outdoor playgrounds, neighborhood activity areas, shopping malls, etc.)? How often do you wear a mask outside each week? How often do you wash your hands after going out each week? How often do you use public transport (including taxis, buses, subways, and bicycle sharing) each week? (Answers to all questions included: 0–3 times/week, 4–6 times/week, $\geq$7 times/week). The third section consisted of collecting information regarding changes in healthcare habits: time of initial visit following disease onset? ($\leq$12 h, 12–24 h, 24–48 h, $\geq$48 h). Fourthly, information on the influenza vaccination status of all children before and after the outbreak was collected: did you receive the influenza vaccine? (yes or no). The last question was based on domestic/foreign travel history (yes or no).

All survey participants agreed to participate in the anonymous offline survey. After being informed of the purpose of the study and of their right to withdraw from the survey at any time, the participants consented to participate. At the end of this study, all participant questionnaires were securely stored at the Pediatric Department of Changhai Hospital.

The questionnaire items included gender, frequency of outdoor activities, self-protection measures (frequency of washing hands after going out and wearing masks outdoors), frequency of public transport use, domestic and overseas travel history, influenza

vaccination status, and time to visit since symptom onset in the winters before and after the COVID-19 (From October 1, 2019, to December 31, 2019, and October 1, 2020, to December 31, 2020, respectively).

3. Outcomes

According to their age in Shanghai, China, children were divided into an early childhood group (15–36 months), a preschool group (37–84 months), and a school-age group (≥85 months). Changes in children's lifestyle and hygiene habits (frequency of outdoor activities, self-protection measures (frequency of washing hands after going out and wearing masks outdoors), frequency of public transport use, domestic and overseas travel history, influenza vaccination status, and time to visit) in Shanghai before and after the pandemic were analyzed, and differences in behavioral habits in children of different ages were compared.

3.1. Statistical analysis

All statistical analyses were conducted by SPSS 25.0 software. Discrete variables were expressed as counts and percentages, while categorical variables were compared by the Chi-squared test and Curve analysis of correlations. $P < 0.05$ was considered statistically significant.

4. Results

4.1. General data analysis

The gender distribution of children in all groups is illustrated in Fig. 1. Among the 1816 children who participated in the survey, 1001 were male and 815 were female. There was no significant gender difference between the two groups ($p = 0.206$), and the age ranged from 15 months to 16 years. Regarding the different age groups, there were 263 children (132 boys and 131 girls) aged from 15 to 36 months, 991 children (558 boys and 433 girls) aged from 37 to 84 months, and 562 children aged ≥85 months (311 boys and 251 girls). Likewise, there was no significant difference in gender among the groups.

5. Analysis of behavioral changes in different age groups before and after COVID-19

The statistics and analysis of changes in behavioral habits of children in Shanghai before and after COVID-19 are presented in Tables 1–3 and Fig. 2(A-H).

Comparing behaviors before and after the pandemic uncovered significant differences in the frequency of outdoor activities, the frequency of wearing masks, the frequency of washing hands after going out, and the history of domestic and overseas travel in children aged 15–36 months in Shanghai ($p < 0.01$). In comparison, the frequency of public transport use, time to first hospital visit in case of illness, and influenza vaccination rates were comparable before and after the COVID-19 pandemic ($p > 0.05$). More specifically, the vaccination rates of influenza vaccine before and after the pandemic were 106/263 (40.3%) and 104/263 (39.5%), respectively.

In the preschool (37–84 months) and school-age (≥85 months) groups, significant differences were identified in the frequency of outdoor activities, frequency of wearing masks, frequency of washing hands after going out, frequency of public transport use, time to first hospital visit in case of illness, and history of domestic and overseas travel before and after the pandemic ($p < 0.01$). Notably, the vaccination rates of influenza vaccine in the 37–84 months old group were significantly increased from 261/991 (26.3%) before the pandemic to 304/991 (30.7%) after the pandemic ($p = 0.032$). At the same time, the vaccination rates in the ≥85 months group was significantly increased from 83/562 (14.7%) before the pandemic to 118/562 (20.9%) after the pandemic ($p < 0.01$).

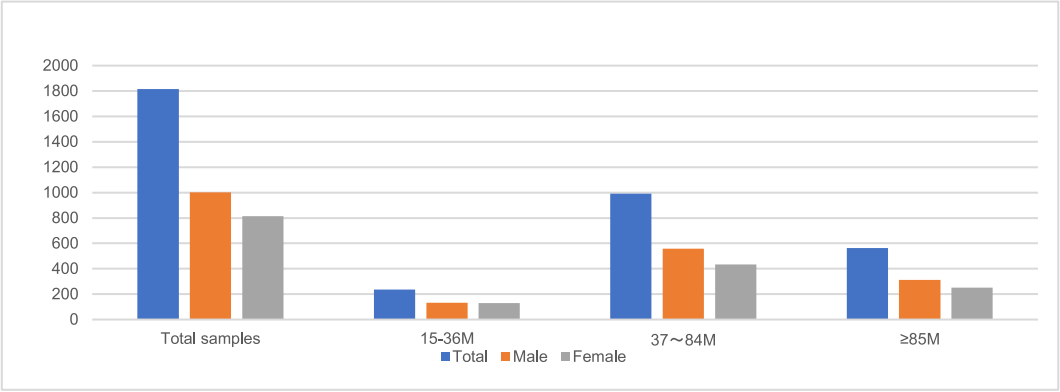


Fig. 1. Gender distribution of children in different age groups (The abscissa in the figure represents different age groups, the ordinate represents the number of people, the blue represents the total number of males and females, the orange represents the number of males, and the gray represents the number of females.).

Table 1
Analysis of changes in behavior habits of children aged 15–36 months in Shanghai before and after the COVID-19.

time items		before the COVID-19 (n = sample)	after the COVID-19 (n = sample)	χ2	P
frequency of outdoor activities (times/week)	0–3	209	237	12.037	0.002
	4–6	35	19		
	≥7	19	7		
frequency of wearing masks outdoors (times/week)	0–3	201	24	276.636	<0.001
	4–6	26	16		
	≥7	36	223		
frequency of washing hands after going out (times/ week)	0–3	196	58	149.807	<0.001
	4–6	15	21		
	≥7	52	184		
frequency of public transport (times/week)	0–3	258	258	0.607	1
	4–6	4	3		
	≥7	1	2		
the time of first hospital visit in case of illness (hours)	0–12	52	66	4.799	0.187
	12–24	133	117		
	24–48	72	68		
	>48	6	12		
whether to vaccinate against influenza	yes	106	104	0.032	0.859
	no	157	159		
whether there were domestic tourism	yes	99	43	30.251	< 0.001
	no	164	220		
whether there were overseas tourism	yes	47	25	7.788	0.005
	no	216	238		

Table 2
Analysis of changes in behavior habits of children aged 37–84 months in Shanghai before and after the COVID-19.

time items		before the COVID-19 (n = sample)	after the COVID-19 (n = sample)	χ2	P
frequency of outdoor activities (times/week)	0–3	762	908	87.228	< 0.001
	4–6	163	72		
	≥7	66	11		
frequency of wearing masks outdoors (times/week)	0–3	823	16	1403.248	< 0.001
	4–6	48	43		
	≥7	120	932		
frequency of washing hands after going out (times/ week)	0–3	778	204	675.218	< 0.001
	4–6	57	120		
	≥7	156	667		
frequency of public transport (times/week)	0–3	960	981	13.883	0.001
	4–6	23	4		
	≥7	8	6		
the time of first hospital visit in case of illness (hours)	0–12	179	297	43.31	< 0.001
	12–24	420	398		
	24–48	343	261		
	>48	49	35		
whether to vaccinate against influenza	yes	261	304	4.577	0.032
	no	730	687		
whether there were domestic tourism	yes	247	169	18.51	< 0.001
	no	744	822		
whether there were overseas tourism	yes	247	105	69.655	< 0.001
	no	744	886		

6. Analysis of the number of children with respiratory tract infections in our outpatient department before and after the pandemic

The number of children with respiratory tract infections (including upper respiratory tract infections, pneumonia, and bronchitis) in the different age groups of the pediatric outpatient department of our hospital during the winter of 2019 and 2020 are displayed in Fig. 3. 20,083 cases of pediatric respiratory tract infections were noted during the winter before the COVID-19 pandemic in 2019 whilst 8791 cases were diagnosed during the winter after the pandemic in 2020, reflecting a 56.2% decrease in the number of cases. More specifically, a total of 7779 children aged 15–36 months, 6597 children aged 37–84 months, and 5707 children aged ≥85 months were diagnosed with respiratory tract infections in our hospital before the pandemic. On the other hand, a total of 3148 children aged 15–36 months (a decrease of 59.5%), 3348 children aged 37–84 months (a decrease of 49.2%), and 2295 children aged ≥85 months (a decrease of 59.8%) were diagnosed with respiratory tract infection at our hospital after the pandemic. Indeed, the number of respiratory tract infections in the three age groups was significantly lower after COVID-19.

Table 3
Analysis of changes in behavior habits of children aged ≥85 months in Shanghai before and after the COVID-19.

time items		before the COVID-19 (n = sample)	after the COVID-19 (n = sample)	χ2	P
frequency of outdoor activities (times/week)	0–3	489	535	23.558	< 0.001
	4–6	57	24		
	≥7	16	3		
frequency of wearing masks outdoors (times/week)	0–3	456	10	799.152	< 0.001
	4–6	35	11		
	≥7	71	541		
frequency of washing hands after going out (times/ week)	0–3	424	79	431.021	< 0.001
	4–6	34	79		
	≥7	104	404		
frequency of public transport (times/week)	0–3	513	542	13.884	0.001
	4–6	36	12		
	≥7	13	8		
the time of first hospital visit in case of illness (hours)	0–12	100	161	34.761	< 0.001
	12–24	211	224		
	24–48	198	158		
	>48	53	19		
whether to vaccinate against influenza	yes	83	118	7.419	0.006
	no	479	444		
whether there were domestic tourism	yes	248	60	157.327	< 0.001
	no	314	502		
whether there were overseas tourism	yes	114	31	53.901	< 0.001
	no	448	531		

7. Discussion

COVID-19 refers to the disease caused by SARS-CoV-2, which is spread via respiratory droplets [7,8]. As is well documented, infected respiratory particles, such as droplets and aerosols, are the dominant route of transmission [9]. The persistence time of the virus on contaminated surfaces considerably varies from minutes up to a few days [9,10]. Attributable to its high variability in terms of the incubation period, a quarantine of 14 days combined with fever surveillance is insufficient to minimize the transmission of the virus [11]. Thus, there is an urgent need to develop strategies to effectively prevent and block the transmission of the SARS-CoV-2 virus among individuals through social behavior, especially in children with immature immune systems.

According to the recommendations from WHO and other guidelines, social distancing and eye, nose, and mouth protection, as well as hand hygiene, are the most effective ways to prevent the transmission of COVID-19 in the general population [12–15]. Meanwhile, wearing surgical face masks could prevent the transmission of SARS-CoV-2 and influenza viruses among individuals [16–18]. Likewise, avoiding large-scale gatherings, as well as wearing masks and regular hand washing, can efficiently curb the transmission of the SARS-CoV-2 virus among the general population. Besides, these methods are effective for the prevention of other respiratory viruses, bacteria, and mycoplasma. Our research focused on respiratory diseases caused by non-COVID-19 pathogens.

The frequency of outdoor activity and self-protection measures (wearing masks and washing hands after going out) of Shanghai children in the winters before and after the outbreak of the COVID-19 pandemic were examined. Furthermore, the number of respiratory disease-related pediatric outpatient visits was also compared before and after the pandemic. On the one hand, the analysis demonstrated that the frequency of outdoor activities decreased after the pandemic. On the other hand, the frequency of mask-wearing and hand-washing significantly increased after the COVID-19 outbreak. Additionally, the number of respiratory disease-related pediatric outpatient visits was significantly lower compared to the same period before the pandemic. School-based and teacher-implemented health education can help school-age children develop good hygiene habits. At the same time, family members (especially parents) play a pivotal role in promoting healthy habits (mask-wearing and hand-washing) in preschool children [19]. In short, good hygiene habits will prevent the spread of respiratory pathogens and reduce the incidence of respiratory infections.

According to prior research, short-term intervention, such as lockdown, quarantine, and isolation, played a positive role in slowing down the transmission of SARS-CoV-2 among individuals [20,21]. The population shift included small-scale mobility and large-scale cross-regional migration. The frequency of public transport (intra-regional mobility) and traveling (inter-regional mobility) of children before and after the pandemic was investigated, and the frequency of traveling was found to decrease in all age groups after the pandemic, which reduced the inter-regional mobility of children and subsequently viral transmission among children. Interestingly, the frequency of public transport use was significantly decreased in children over 37 months old, whereas no significant difference was observed in the 15–36 months group. In China, the enrollment age for kindergarten is 3 years old, and toddlers younger than 3 years are usually taken care of at home and thus do not need to regularly take public transport. This might have contributed to the frequency of public transport use being unaltered in this group. Our research corroborated that reducing personnel mobility played a beneficial role in reducing the spread of respiratory pathogens among children, which is consistent with the findings of previous studies in adults [22,23].

In addition, the pattern of medical advice-seeking behavior and the influenza vaccination rate of children aged 36 months and above were found to have been influenced by the pandemic. After the lockdown was lifted, parents were more likely to see a doctor as

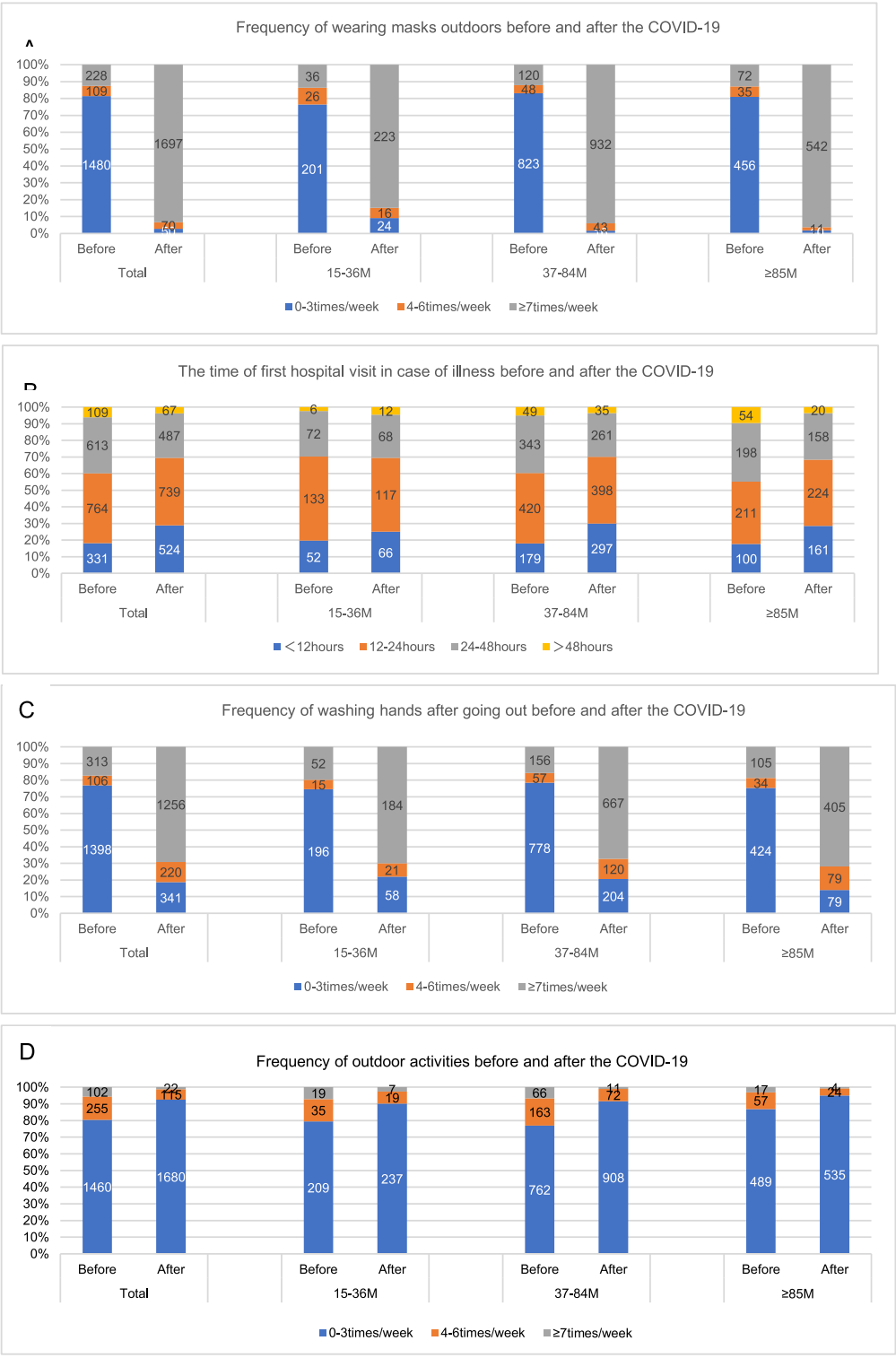


Fig. 2. The statistics and analysis of changes in behavior habits of children in Shanghai before and after the COVID-19 (All abscissas in the figure represent all age groups (adjacent histograms represent the differences between the same groups before and after the epidemic), and the ordinate represents the percentage of different behavior habits among groups. The meanings of different colors in each figure are as follows: A: Blue means the frequency of wearing masks outdoors 0–3 times/week, orange means the frequency of wearing masks outdoors 4–6 times/week, and gray means the frequency of wearing masks outdoors≥7 times/week. B : Blue means the time of first hospital visit<12 h , orange means the time of first hospital visit 12–24 h , gray means the time of first hospital visit 24–48 h , yellow means the time of first hospital visit>48 h. C : Blue means the

frequency of washing hands 0–3 times/week , orange means the frequency of washing hands 4–6 times/week , gray means the frequency of washing hands≥7 times/week. D : Blue means the frequency of outdoor activities 0–3 times/week , orange means the frequency of outdoor activities 4–6 times/week , gray means the frequency of outdoor activities≥7 times/week. E : Blue means the inoculate influenza vaccination , orange means didn't inoculate influenza vaccination. F : Blue means don't take domestic tourism , orange means take domestic tourism. G : Blue means the frequency of taking public transport 0–3 times/week , orange means the frequency of taking public transport 4–6 times/week , gray means the frequency of taking public transport≥7 times/week. H : Blue means don't take overseas tourism , orange means take overseas tourism.).

soon as possible, and the time to first hospital visit upon symptom onset was significantly decreased. As anticipated, the influenza vaccination rate also increased. This observation indicates that the pandemic exerted a positive impact on enhancing medical advice-seeking behavior and willingness to immunization. This also implies that the awareness of health preservation of parents in Shanghai was enhanced in the post-pandemic era, which was not mentioned in earlier COVID-19-related behavioral studies. Unlike older children, the parents of 15–36 months babies were always inclined to seek medical advice as early as possible (usually within 24 h), irrespective of before or after the pandemic.

According to data regarding pediatric outpatients in the winters of 2019 and 2020, the number of children with respiratory infections in the winter of 2020 decreased by 56.2% after the pandemic, reflecting that adjustments in children's behavior and habits owing to the COVID-19 pandemic may significantly affect the incidence of respiratory infection. Lower outdoor activity frequency, increased health awareness, and better personal hygiene reduce the risk of exposure to pathogens and is conducive to cutting off viral transmission in children. This was further corroborated in our subsequent statistical analysis of behavioral change and changes in the number of respiratory infection cases in children.

It is worthwhile mentioning that the boost in self-protection measures can not only lower the transmission of respiratory pathogens among children but may also exert adverse effects. For instance, prolonged use of masks may impair gas exchange, thereby leading to a decline in blood oxygen saturation [24,25]. However, injuries are not inducible by short-term mask-wearing, and the impact of long-term mask-wearing on the growth, development, and organ function of children remains to be elucidated. Our study also established that large-scale and regional lockdowns had a strong and permanent influence on the economy, education, and medical care [26]. COVID-19 lockdown measures were associated with negative general mental health outcomes among children [27,28]. Herein, the outdoor activities of children significantly decreased after the outbreak due to the lockdown policy. The effects of long-term lack of play and communication with their peers on children's physical and psychological development warrant further investigations. Noteworthily, the intestinal microbiome is partially established through hand-to-mouth contact in the early life of children [29]. Frequently washing hands is a recommended practice for epidemic prevention, but this may also eliminate beneficial bacteria from the skin surface, and thus, the increased frequency of hand washing may influence the gut microbiome. Hence, the long-term effects of hand washing on the microbiome and its multifarious functions in children deserve to be further studied.

Our large-scale study analyzed changes in children's behavioral habits before and after the COVID-19 epidemic in China. To the best of our knowledge, the present study is one of the few studies to explore changes in children's behavioral habits during the epidemic in order to provide valuable evidence on mitigating or interrupting the spread of respiratory infections among children. However, due to the geographical limitations and the survey being conducted chiefly in healthy children, additional research is necessitated to determine whether the results are representative of children in other areas and those with underlying diseases. In addition, studies on the early prevention using prophylactic drugs in patients with underlying diseases have been reported in adults [30], but there are no relative studies in Chinese children that could be followed up.

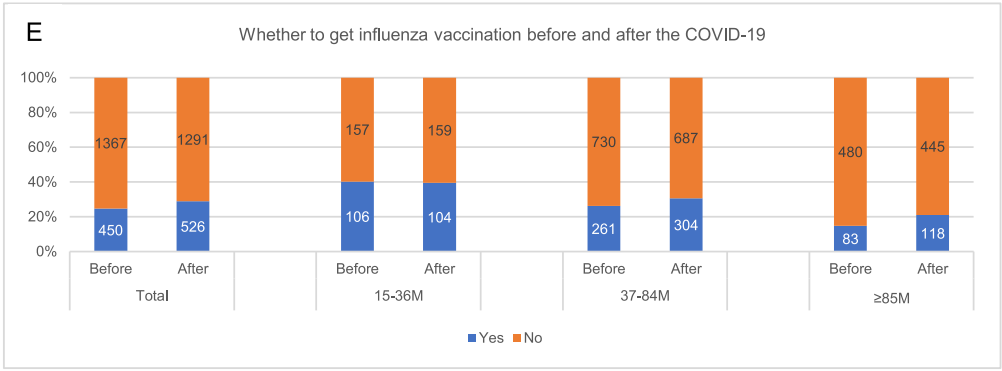
The observations of this cross-sectional study infer that the hygiene awareness and behavioral habits of children in Shanghai were significantly improved compared with those before the COVID-19 outbreak. These factors reduced the number of outpatient cases of respiratory infectious diseases. Wearing masks in public places, promoting hand hygiene, fewer gatherings, and popularizing vaccination can impede the transmission of respiratory pathogens in both children and adults. These experiences provide effective preventive methods for reducing the transmission of respiratory pathogens in children in the post-pandemic era in China and globally. The decreasing incidence of respiratory infection will save large amounts of social and medical resources, reduce the family's financial burden, improve children's health, and have great implications for social development. At the same time, pediatricians are recommended to follow up and closely monitor possible adverse effects with regard to these behavioral changes in the post-pandemic era.

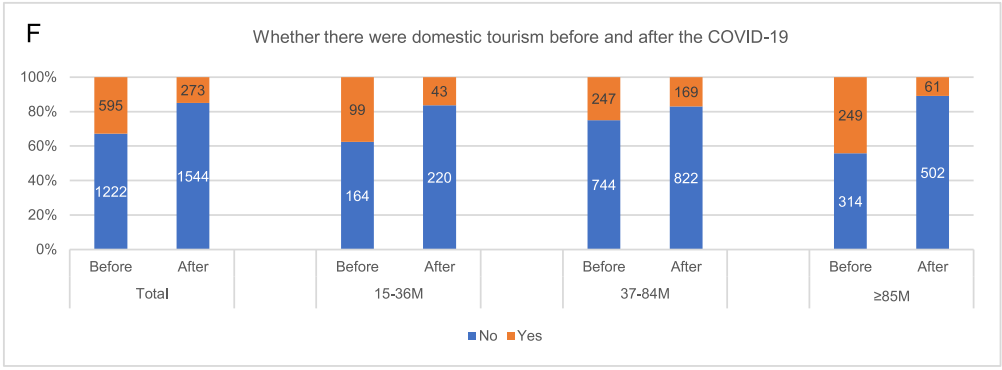
Ethics approval and consent to participate

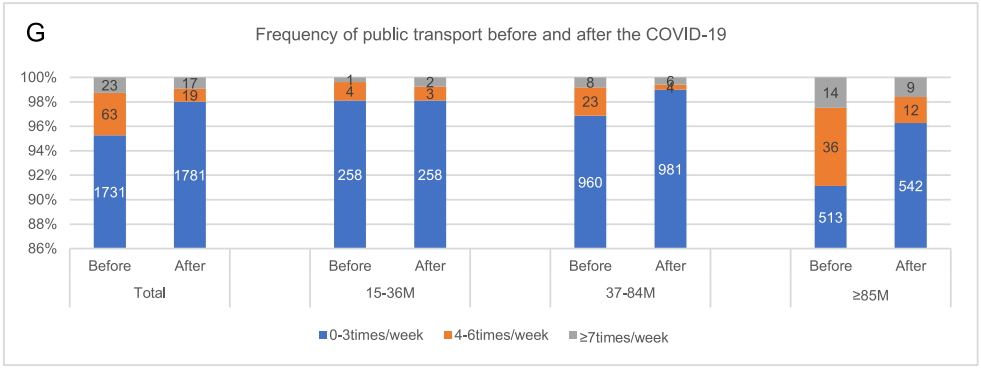
Informed consent was received from all patients before starting the work and the study was approved by the ethics committee of First Affiliated Hospital of Naval Military Medical University (CHEC2022-131). All the methods in this study were performed in accordance with the relevant guidelines and regulations.

Author contribution statement

Fei Xie: Performed the experiments; Wrote the paper. Tengguang Cai: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data. Bobo Jin: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data. Lu Gan; Bin Cai: Contributed reagents, materials, analysis tools or data. Yu Gao; Shiyan Cao: Performed the experiments. Lei Lei; Lin Zhou: Conceived and designed the experiments; Performed the experiments; Wrote the paper.







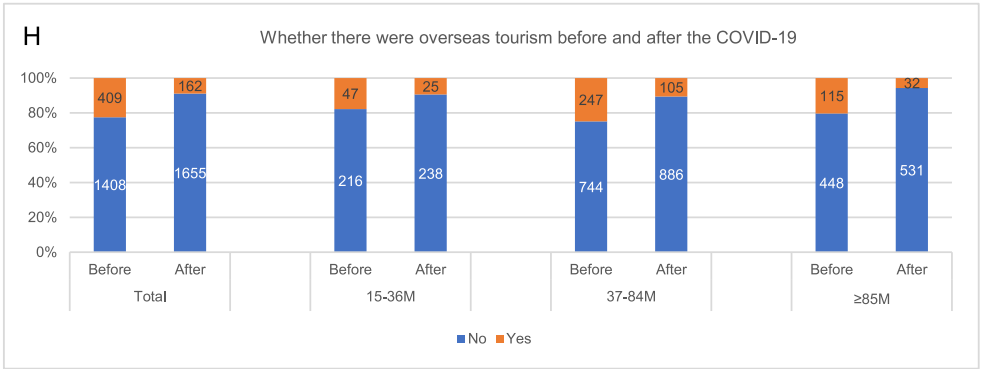


Fig. 2. (*continued*).

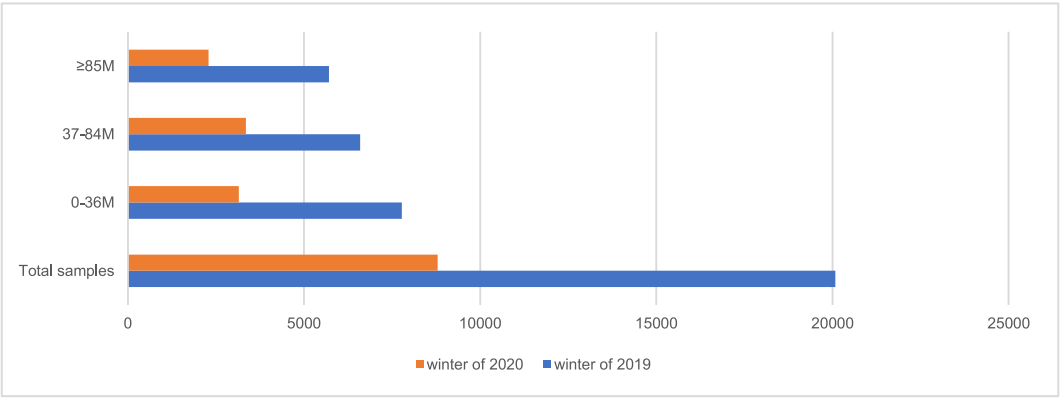


Fig. 3. The numbers of children in different age groups with respiratory diseases in the pediatric outpatient department in the winter of 2019 and 2020 (In the figure, the abscissa represents the number of patients, and the ordinate represents the distribution of different age groups. Blue represents the winter of 2019 and orange represents the winter of 2020.).

Data availability statement

The authors are unable or have chosen not to specify which data has been used.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We thank all the medical staff members involved in this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e19592.

References

[1] World Health Organization, Corona Virus Disease 2019 (COVID-19). Situation Report-51 March 11, 2020 [cited 2020 Mar 13].
[2] European Centre for Disease Prevention and Control, Guidelines for the Use of Non-pharmaceutical Measures to Delay and Mitigate the Impact of 2019-nCoV Feb 10, 2020 [cited 2020 Mar 18].
[3] R.M. Anderson, H. Heesterbeek, D. Klinkenberg, et al., How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet 10228 (395) (2020) 931–934, https://doi.org/10.1016/S0140-6736(20)30567-5.
[4] H. Chtourou, K. Trabelsi, C. H'Mida, et al., Staying physically active during the quarantine and self-isolation period for controlling and mitigating the COVID-19 pandemic: a systematic overview of the literature, Front. Psychol. (11) (2020) 1708, https://doi.org/10.3389/fpsyg.2020.01708.
[5] S. Fazeli, I.M. Zeidi, C.Y. Lin, et al., Depression, anxiety, and stress mediate the associations between internet gaming disorder, insomnia, and quality of life during the COVID-19 outbreak Addict, Behav. Rep. (12) (2020), 100307, https://doi.org/10.1016/j.abrep.2020.100307.
[6] Edyta Łuszczki, Anna Bartosiewicz, Iwona Pezdan-Śliż, et al., Children's Eating Habits, Physical Activity, Sleep, and Media Usage before and during COVID-19 Pandemic in Poland Nutrients 7 (13) (2021) 2447, https://doi.org/10.3390/nu13072447.
[7] M. Jayaweera, H. Perera, B. Gunawardana, J. Manatunge, Transmission of COVID-19 virus by droplets and aerosols: a critical review on the unresolved dichotomy, Environ. Res. 188 (2020), 109819, https://doi.org/10.1016/j.envres.2020.109819.
[8] R. Zhang, Y. Li, A.L. Zhang, et al., Identifying airborne transmission as the dominant route for the spread of COVID-19, Proc. Natl. Acad. Sci. U.S.A. 26 (117) (2020) 14857–14863, https://doi.org/10.1073/pnas.2009637117.
[9] N. Van Doremalen, T. Bushmaker, D.H. Morris, et al., Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1, N. Engl. J. Med. 16 (382) (2020) 1564–1567, https://doi.org/10.1056/NEJMc2004973.
[10] S.Y. Ren, W.B. Wang, Y.G. Hao, et al., Stability and infectivity of coronaviruses in inanimate environments World, J Clin Cases 8 (8) (2020) 1391–1399, https://doi.org/10.12998/wjcc.v8.i8.1391.
[11] Q. Li, X. Guan, P. Wu, et al., Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia, N EngI J Med (382) (2020) 1199–1207, https://doi.org/10.1056/NEJMoa2001316.
[12] World Health Organization, Coronavirus Disease (COVID-19) Advice for the Public Updated June 4, 2020. (Accessed 26 June 2020).
[13] World Health Organization, Interim Recommendations on Obligatory Hand Hygiene against Transmission of COVID-19 1 April 2020, 2021. Available from: https://www.who.int/publications/m/item/interim-recommendations-on-obligatory-hand-hygiene-against-transmission-of-covid-19.
[14] D.K. Chu, E.A. Akl, S. Duda, et al., COVID-19 Systematic Urgent Review Group Effort (SURGE) study authors. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19, a systematic review and meta-analysis Lancet 10242 (395) (2020) 1973–1987, https://doi.org/10.1016/S0140-6736(20)31142-9.

[15] Alexandra TeslyaI, Thi Mui Pham, Noortje G. Godijk, et al., Impact of self-imposed prevention measures and short-term government-imposed social distancing on mitigating and delaying a COVID-19 epidemic: a modelling study, PLoS Med. 7 (17) (2020), e1003166, https://doi.org/10.1371/journal.pmed.1003166. Article.
[16] H. Wang, M.B. Chen, W.Y. Cui, et al., The efficacy of masks for influenza-like illness in the community, A protocol for systematic review and meta-analysis Medicine (Baltimore) 23 (99) (2020), https://doi.org/10.1097/MD.0000000000020525. Article e20525.
[17] N.H.L. Leung, D.K.W. Chu, E.Y.C. Shiu, et al., Respiratory virus shedding in exhaled breath and efficacy of face masks, Nat. Med. (26) (2020) 676–680, https://doi.org/10.1038/s41591-020-0946-9.
[18] C.R. MacIntyre, A.A. Chughtai, A rapid systematic review of the efficacy of face masks and respirators against coronaviruses and other respiratory transmissible viruses for the community, healthcare workers and sick patients, Int. J. Nurs. Stud. (108) (2020), 103629, https://doi.org/10.1016/j.ijnurstu.2020.103629.
[19] J.B. Tidwell, A. Gopalakrishnan, A. Unni, et al., Impact of a teacher-led school handwashing program on children's handwashing with soap at school and home in Bihar, India, PLoS One 2 (15) (2020), https://doi.org/10.1371/journal.pone.0229655. Article e0229655.
[20] H. Lau, V. Khosrawipour, P. Kocbach, et al., The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China, J. Trav. Med. 7 (27) (2020), https://doi.org/10.1093/jtm/taaa037. Article taaa037,.
[21] European Centre for Disease Prevention and Control, Coronavirus Disease 2019 (COVID-19) Pandemic: Increased Transmission in the EU/EEA and the UK-seventh Update March 25, 2020 [cited 2020 Apr 26].
[22] R.J. Hatchett, C.E. Mecher, M. Lipsitch, Public health interventions and epidemic intensity during the 1918 influenza pandemic, Proc. Natl. Acad. Sci. U.S.A. 18 (104) (2007) 7582–7587, https://doi.org/10.1073/pnas.0610941104.
[23] T.D. Hollingsworth, D. Klinkenberg, H. Heesterbeek, et al., Mitigation strategies for pandemic influenza A: balancing conflicting policy objectives, PLoS Comput. Biol. 2 (7) (2011) 1–11, https://doi.org/10.1371/journal.pcbi.1001076.
[24] American Academy of Pediatrics. Cloth face coverings for children during COVID-19 Accessed April 9 (2020).
[25] Riccardo Lubrano, Silvia Bloise, Alessia Testa, et al., Assessment of respiratory function in infants and young children wearing face masks during the COVID-19 pandemic, JAMA Netw 3 (4) (2021), e210414, https://doi.org/10.1001/jamanetworkopen.2021.0414. Article.
[26] G. Bonaccorsi, F. Pierri, M. Cinelli, et al., Economic and social consequences of human mobility restrictions under COVID-19, Proc. Natl. Acad. Sci. U.S.A. 27 (117) (2020) 15530–15535, https://doi.org/10.1073/pnas.2007658117.
[27] E. Morgül, A. Kallitsoglou, C.A. Essau, Caregiver worry of infection and family Co-existence difficulty and association with change in children's internalizing and externalizing symptoms during the initial COVID-19 lockdown in the UK and Turkey, Psychol. Rep. (27) (2023), 332941221149183, https://doi.org/10.1177/00332941221149183.
[28] S. Singh, D. Roy, K. Sinha, et al., Impact of COVID-19 and lockdown on mental health of children and adolescents: a narrative review, with recommendations Psychiatry Res (293) (2020), 113429, https://doi.org/10.1016/j.psychres.2020.113429.
[29] L.F. Stinson, Establishment of the early-life microbiome: a DOHaD perspective, J Dev Orig Health Dis 3 (11) (2020) 201–210, https://doi.org/10.1017/S2040174419000588.
[30] Arto Yuwono Soeroto, Theo Audi Yanto, Andree Kurniawan, et al., Efficacy and safety of tixagevimab-cilgavimab as pre-exposure prophylaxis for COVID-19, A systematic review and meta-analysis Rev Med Virol 8 (2023), https://doi.org/10.1002/rmv.2420. Article e2420.