A community-based cross-sectional immunisation survey in parents of primary school students

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Immunisation is a very important aspect of child health. Invasive pneumococcal and influenza diseases have been major vaccine-available communicable diseases. We surveyed demographics and attitudes of parents of primary school students who received pneumococcal conjugate vaccination (PCV) and compared them with those who did not receive pneumococcal vaccination. The survey was carried out in randomly selected primary schools in Hong Kong. Questionnaires were sent to nine primary schools between June and September 2014. Parents of 3,485 children were surveyed, and 3,479 (1,452 PCV immunised, 2,027 un-immunised) valid questionnaires were obtained. Demographic data were generally different between the two groups. PCV-immunised children were more likely to be female (57.0 vs. 52.2%, P = 0.005), born in Hong Kong (94.2 vs. 92.3%, P = 0.031), have a parent with tertiary education (49.2 vs. 31.8, P < 0.0005), from the higher-income group (P = 0.005), have suffered upper respiratory infections, pneumonia, otitis media or sinusitis (P = 0.019), and have doctor visits in preceding 12 months (P = 0.009). They were more likely to have received additional immunisations outside the Hong Kong Childhood Immunization Programme (64.0 vs. 30.6%, P < 0.0005) at private practitioner clinics (91.1 vs. 83.5%, P < 0.0005). Un-immunised children were more likely to live with senior relatives who had not received PCV. Their parents were less likely to be aware of public education programme on PCV and influenza immunisation, and children were less likely to have received influenza vaccination. The major reasons for PCV immunisations were parent awareness that pneumococcal disease could be severe and vaccines were efficacious in prevention. The major reasons for children not being immunised with PCV were concerns about vaccine side effects, cost, vaccine not efficacious or no recommendation by family doctor or government. In conclusion, PCV unimmunised children were prevalent during the study period. Reportedly, they were generally less likely to have received influenza and other childhood vaccines, and more likely to live with senior relatives who had not received PCV and influenza. These observations provide important demographic data for public health policy in childhood immunisation programme.

INTRODUCTION
Immunisation is a very important aspect of child health. Invasive pneumococcal and influenza diseases have been major communicable diseases for which vaccines are available.1–4 The Hong Kong Childhood Immunization Programme was launched in 2007, and universal pneumococcal conjugate vaccination (PCV) in children was implemented in 2009.5–7 However, certain vaccine-preventable diseases, notably pneumococcal and influenza infections, are still not under control. The influenza and pneumococcal vaccine coverage rates were generally low.8 This study evaluated the knowledge and practices of immunisation associated with these diseases among local parents. With such an understanding, public health effort in education and therapeutics for our patients can be targeted.

RESULTS
A total of 6,469 questionnaires were sent to nine primary schools between June and September 2014. Parents of 3,485 children were surveyed, and 3,479 (1,452 PCV immunised and 2,027 un-immunised) valid questionnaires were obtained (Table 1). Nine out of 10 parents believed that PCV is important for the health of their children, but only 42% of children had received PCV. Four out of 10 children lived with senior relatives (grandparents), but 7 out of 10 of these senior relatives had not received PCV. Twelve percent of children had a history of chronic conditions including premature (5.7%, < 37 weeks gestation), asthma (5.4%) and congenital heart disease (0.7%). In terms of demographics and parental attitudes, PCV-immunised children were generally very different from their un-immunised counterparts (Tables 1 and 2). They were more likely to be female (57.0 vs. 52.2% female, P = 0.005), born in Hong Kong (94.2 vs. 92.3%, P = 0.031), have a parent with tertiary education (49.2 vs. 31.8, P < 0.0005), from the higher-income group (HK$60,000+ per month, P = 0.005), live in Hong Kong Island or Kowloon peninsula, have suffered from UTI, pneumonia, otitis media or sinusitis (P = 0.019) and have doctor visits in the preceding 12 months (P = 0.009). They were more likely to have received additional immunisations outside the Hong Kong Childhood Immunization Programme (64.0 vs. 30.6%, P < 0.0005) at private practitioner clinics (91.1 vs. 83.5%, P < 0.0005). The parents of PCV-immunised children generally believed that PCV, chickenpox, hepatitis A and B virus, rotavirus, influenza, encephalitis and Hemophilus influenzae B immunisation were important for their child. These parents were also more likely to be aware that Streptococcal pneumoniae (SP) infection could be...
fatal (90.9% vs. 71.5%, \( P < 0.0005 \)), and that it could cause meningitis, pneumonia, otitis media and septicemia. Un-immunised children were more likely to live with senior relatives who had not received PCV. Their parents were less likely to be aware of public education programme on PCV, as well as in influenza immunisation, and less likely to have received influenza vaccination (16.4% vs. 30.8%, \( P < 0.0005 \)). Generally, the majority of informants did not know which PCV their child had received (Table 3). Private practitioners, family doctors and paediatricians were generally important sources of vaccine information. The major reasons for PCV immunisations were parental awareness of the severity of SP disease, PCV being effective in prevention and recommendations by the paediatrician or government. The major reasons for children not being immunised with PCV were concerns about vaccine side effects, cost, vaccine not efficacious and no recommendation by the private practitioner or the government (Table 4).

A binomial logistic regression was performed to ascertain the effects of child’s gender, birth year, Hong Kong born, residing with grandparents, history of respiratory tract-related infections, history of immunisation in Hong Kong, history of influenza immunisation, parents’ highest education, monthly household income, knowledge on the risk of death caused by Pneumococcus, predicted risk of cross-infectivity and knowledge on a local propaganda ‘Left influenza and Right pneumococcus immunization’ on the likelihood that the child has received Pneumococcal vaccine. Child of female gender (odds ratio (OR): 1.22; 95% confidence interval (CI): 1.05–1.43; \( P = 0.01 \)), later birth year (OR: 1.42; 95% CI: 1.35–1.49; \( P < 0.0005 \) for every level increase), with history of influenza immunisation (OR: 2.11; 95% CI: 1.75–2.53; \( P < 0.0005 \)), higher parental education (OR: 1.19; 95% CI: 1.01–1.40; \( P = 0.038 \) for every

### Table 1. Demographic data for the pneumococcal vaccine survey

|                        | Overall       | Vaccinated    | Not vaccinated | \( P \) value |
|------------------------|---------------|---------------|---------------|--------------|
|                        | N  %          | N  %          | N  %          |              |
| Total                  | 3,485 100.0% | 1,455 41.8%  | 2,030 58.2%  |              |
| Gender (n = 3,479)     |               |               |               |              |
| Male                   | 1,593 45.8%  | 624 43.0%     | 969 47.8%     | 0.005        |
| Female                 | 1,886 54.2%  | 828 57.0%     | 1,058 52.2%   |              |
| Missing                | 12 0.3%      | 3 0.2%        | 3 0.1%        |              |
| Birth year             |               |               |               |              |
| Before 2002            | 385 11.1%    | 75 5.2%       | 310 15.3%     | < 0.0005     |
| 2003                   | 497 14.3%    | 118 8.2%      | 379 18.7%     |              |
| 2004                   | 497 14.3%    | 184 12.7%     | 313 15.5%     |              |
| 2005                   | 611 17.6%    | 261 18.0%     | 350 17.3%     |              |
| 2006                   | 753 21.7%    | 371 25.6%     | 382 18.9%     |              |
| 2007                   | 722 20.8%    | 436 30.1%     | 286 14.1%     |              |
| After 2008             | 4 0.1%       | 2 0.1%        | 2 0.1%        |              |
| Missing                | 23 0.6%      | 8 0.5%        | 8 0.4%        |              |
| Birth weight (kg)      |               |               |               |              |
| Mean                   | 3,141 3.39 ± 1.08 | 1,333 3.35 ± 1.04 | 1,808 3.42 ± 1.10 | 0.064        |
| Born in Hong Kong (n = 3,473) |               |               |               |              |
| Yes                    | 3,234 93.1%  | 1,367 94.2%   | 1,867 92.3%   | 0.031        |
| No                     | 239 6.9%     | 84 5.8%       | 155 7.7%      |              |
| Missing                | 19 0.5%      | 4 0.3%        | 8 0.4%        |              |
| Parent or guardian’s highest education (n = 3,470) |               |               |               |              |
| Primary school         | 181 5.2%     | 70 4.8%       | 111 5.5%      | < 0.0005     |
| Secondary school       | 1,933 55.7%  | 665 45.9%     | 1,268 62.7%   |              |
| Tertiary or above      | 1,356 39.1%  | 713 49.2%     | 643 31.8%     |              |
| Missing                | 23 0.6%      | 7 0.5%        | 8 0.4%        |              |
| Monthly household income (n = 3,416) |               |               |               |              |
| \( \leq \) HK$10,000   | 437 12.8%    | 140 9.8%      | 297 14.9%     | < 0.0005     |
| $10,001–19,999         | 869 25.4%    | 291 20.4%     | 578 29.0%     |              |
| $20,000–$39,999        | 855 25.0%    | 325 22.8%     | 530 26.6%     |              |
| $40,000–$59,999        | 512 15.0%    | 242 17.0%     | 270 13.6%     |              |
| \( \geq \) HK$60,000   | 743 21.8%    | 427 30.0%     | 316 15.6%     |              |
| Missing                | 83 2.3%      | 30 2.1%       | 39 1.9%       |              |
| Residence (n = 3,468)  |               |               |               |              |
| HK Island              | 472 13.6%    | 218 15.1%     | 254 12.6%     | 0.031        |
| Kowloon                | 1,657 47.8%  | 710 49.1%     | 947 46.9%     |              |
| New Territories        | 1,235 35.6%  | 474 32.8%     | 761 37.7%     |              |
| Outlying islands       | 8 0.2%       | 4 0.3%        | 4 0.2%        |              |
| Outside Hong Kong      | 96 2.8%      | 41 2.8%       | 55 2.7%       |              |
| Missing                | 23 0.6%      | 8 0.5%        | 9 0.4%        |              |

The bold entries indicate the significant \( P \)-values.
Table 2. Paediatric medical history and parental attitudes

| Overall Vaccinated | Not vaccinated | \( P \) value |
|-------------------|---------------|----------------|
| \( N \) % | \( N \) % | \( N \) % |
| **Total** | 3,485 | 100.0% | 1,455 | 41.8% | 2,030 | 58.2% |
| **Any upper respiratory infection, pneumonia, middle ear infection or sinusitis in the past 6 months** \( (n = 3,478) \) | | | | | | |
| Yes | 2,431 | 69.9% | 954 | 65.5% | 1,476 | 71.8% |
| No | 1,054 | 29.4% | 491 | 34.5% | 563 | 27.2% |
| Uncertain | 23 | 0.7% | 9 | 0.6% | 14 | 0.7% |
| **Any doctor visit** \( (n = 2,417) \) | | | | | | |
| Yes | 2,157 | 89.2% | 941 | 79.3% | 1,216 | 87.8% |
| No | 260 | 10.8% | 261 | 20.7% | 34 | 2.2% |
| **Any hospitalisation** \( (n = 2,403) \) | | | | | | |
| Yes | 75 | 3.1% | 39 | 3.2% | 36 | 2.2% |
| No | 2,328 | 96.9% | 1,001 | 96.8% | 1,327 | 97.8% |
| **Any antibiotic by doctor** \( (n = 2,404) \) | | | | | | |
| Yes | 832 | 34.6% | 381 | 35.3% | 451 | 33.1% |
| No | 1,486 | 61.8% | 628 | 62.7% | 858 | 63.0% |
| Uncertain | 86 | 3.6% | 33 | 3.0% | 53 | 3.9% |
| Missing | 10 | 0.3% | 2 | 0.2% | 5 | 0.3% |
| **Medication without doctor consultation** \( (n = 2,404) \) | | | | | | |
| Yes | 957 | 39.8% | 379 | 36.5% | 578 | 43.2% |
| No | 1,447 | 60.2% | 659 | 63.5% | 788 | 57.7% |
| **Past medical history (more than one choice)** | | | | | | |
| Prematurity \(<\mathbin\text{37 weeks}}\) | 196 | 5.7% | 94 | 5.8% | 102 | 7.2% |
| Asthma | 187 | 5.4% | 68 | 4.7% | 119 | 8.5% |
| Congenital heart disease | 24 | 0.7% | 12 | 0.8% | 12 | 0.9% |
| Chronic lung disease | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Congenital immunodeficiency | 2 | 0.1% | 0 | 0.0% | 2 | 0.1% |
| Cochlear implant | 1 | 0.0% | 0 | 0.0% | 1 | 0.1% |
| Others | 105 | 3.0% | 53 | 3.7% | 52 | 3.8% |
| **Immunisation in Hong Kong** \( (n = 3,467) \) | | | | | | |
| Yes | 3,072 | 88.6% | 1,309 | 90.5% | 1,763 | 87.3% |
| Partly | 312 | 9.0% | 110 | 7.6% | 202 | 10.0% |
| No | 83 | 2.4% | 28 | 2.0% | 55 | 2.7% |
| Missing | 25 | 0.7% | 8 | 0.6% | 17 | 0.9% |
| **Child immunised according to Hong Kong Childhood Immunization Programme for 0–18 months** \( (n = 3,374) \) | | | | | | |
| Yes | 3,120 | 92.5% | 1,322 | 93.4% | 1,798 | 91.8% |
| Partly | 184 | 5.5% | 73 | 5.2% | 111 | 5.7% |
| No | 70 | 2.1% | 20 | 1.4% | 50 | 2.6% |
| Missing | 86 | 2.4% | 32 | 2.2% | 58 | 3.2% |
| **Immunisations at (more than one)** | | | | | | |
| Total | 3,260 | 1,384 | 1,876 | 1,091 | 785 | 523 |
| GP clinic | 1,111 | 34.1% | 470 | 34.0% | 641 | 44.2% |
| Private hospital | 218 | 6.7% | 91 | 6.7% | 127 | 8.7% |
| MCH clinic | 2,665 | 81.7% | 1,322 | 90.4% | 1,343 | 89.1% |
| Others | 85 | 2.6% | 30 | 2.2% | 55 | 2.9% |
| **Any additional immunisation beyond Hong Kong Childhood Immunization Programme** \( (n = 3,447) \) | | | | | | |
| Yes | 1,535 | 44.5% | 922 | 64.0% | 613 | 36.6% |
| Partly | 1,912 | 55.5% | 519 | 36.0% | 1,393 | 82.5% |
| No | 46 | 1.3% | 14 | 1.0% | 32 | 2.0% |
| Missing | 1,517 | 911 | 606 | 83.5% | | |
| **Additional immunisation at (more than one)** | | | | | | |
| Total | 1,336 | 88.1% | 830 | 91.1% | 506 | 83.5% |
| GP clinic | 218 | 6.7% | 91 | 10.4% | 127 | 20.9% |
| Private hospital | 125 | 8.2% | 41 | 4.5% | 84 | 13.9% |
| **Importance of immunisation for your child's health** | | | | | | |
| Pneumococcal conjugate vaccine (PCV; \( n = 3,461 \)) | 2,074 | 59.9% | 1,072 | 74.1% | 1,002 | 49.8% |
| Very important | 1,027 | 29.7% | 331 | 22.9% | 696 | 34.6% |
| Important | 185 | 5.3% | 23 | 1.6% | 162 | 8.0% |
| Fair | 17 | 0.5% | 0 | 0.0% | 17 | 0.8% |
| Not important | 158 | 4.6% | 21 | 1.5% | 137 | 6.8% |
| Uncertain | 31 | 0.9% | 8 | 0.5% | 23 | 1.2% |
| Missing | | | | | | |
| Chickenpox \( (n = 3,457) \) | 1,741 | 50.4% | 872 | 60.4% | 869 | 43.1% |
| Very important | 1,276 | 36.9% | 462 | 32.0% | 814 | 40.4% |
| Important | 315 | 9.1% | 85 | 5.9% | 230 | 11.4% |
| Fair | 36 | 1.0% | 11 | 0.8% | 25 | 1.2% |
| Not important | 89 | 2.6% | 13 | 0.9% | 76 | 3.8% |
| Uncertain | 34 | 1.0% | 12 | 0.8% | 22 | 1.2% |
| Missing | | | | | | |
| Hepatitis A \( (n = 3,446) \) | 1,753 | 50.9% | 809 | 56.2% | 944 | 47.0% |
| Very important | 1,169 | 33.9% | 450 | 31.3% | 719 | 35.8% |
| Important | 326 | 9.5% | 128 | 8.9% | 198 | 9.9% |
| Fair | 32 | 0.9% | 9 | 0.6% | 23 | 1.1% |
| Not important | 166 | 4.8% | 43 | 3.0% | 123 | 6.1% |
| Uncertain | 48 | 1.4% | 16 | 1.1% | 32 | 1.7% |
| Missing | | | | | | |
| Hepatitis B \( (n = 3,450) \) | 2,021 | 58.6% | 938 | 65.1% | 1,083 | 53.9% |
| Very important | | | | | | |

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| Table 2. (Continued) |
|----------------------|
| **Overall** | **Vaccinated** | **Not vaccinated** | **P value** |
| N | % | N | % | N | % |
| Important | 1,078 | 31.2% | 402 | 27.9% | 676 | 33.6% |
| Fair | 201 | 5.8% | 68 | 4.7% | 133 | 6.6% |
| Not important | 13 | 0.4% | 1 | 0.1% | 12 | 0.6% |
| Uncertain | 137 | 4.0% | 31 | 2.2% | 106 | 5.3% |
| Missing | 42 | 1.2% | 15 | 1.0% | 20 | 1.0% |
| Rotavirus oral vaccine (n = 3,446) | | | | | | |
| Very important | 1,543 | 44.8% | 744 | 51.2% | 799 | 39.8% |
| Important | 1,157 | 33.6% | 449 | 31.2% | 708 | 35.3% |
| Fair | 201 | 5.8% | 68 | 4.7% | 133 | 6.6% |
| Not important | 13 | 0.4% | 1 | 0.1% | 12 | 0.6% |
| Uncertain | 137 | 4.0% | 31 | 2.2% | 106 | 5.3% |
| Missing | 42 | 1.2% | 15 | 1.0% | 20 | 1.0% |
| Influenza vaccine (n = 3,447) | | | | | | |
| Very important | 1,025 | 29.7% | 465 | 32.3% | 560 | 27.9% |
| Important | 1,179 | 34.2% | 481 | 33.4% | 698 | 34.8% |
| Fair | 453 | 13.1% | 182 | 12.6% | 271 | 13.5% |
| Not important | 13 | 0.4% | 1 | 0.1% | 12 | 0.6% |
| Uncertain | 258 | 7.5% | 56 | 3.9% | 202 | 10.1% |
| Missing | 48 | 1.4% | 15 | 1.0% | 24 | 1.2% |
| Japanese B virus (n = 3,445) | | | | | | |
| Very important | 1,735 | 50.4% | 788 | 54.8% | 947 | 47.2% |
| Important | 1,108 | 32.2% | 435 | 30.3% | 673 | 33.9% |
| Fair | 349 | 10.1% | 139 | 9.7% | 210 | 10.5% |
| Not important | 35 | 1.0% | 11 | 0.8% | 24 | 1.2% |
| Uncertain | 218 | 6.3% | 74 | 5.1% | 144 | 7.2% |
| Missing | 48 | 1.4% | 15 | 1.0% | 24 | 1.2% |
| Pneumococcal disease (more than one) | | | | | | |
| Meningitis | 1,515 | 44.0% | 794 | 55.1% | 721 | 35.9% |
| Arthritis | 59 | 1.7% | 25 | 1.7% | 34 | 1.7% |
| Pneumonia | 2,216 | 64.3% | 1,057 | 73.4% | 1,199 | 57.7% |
| Otitis media | 541 | 15.7% | 262 | 18.2% | 279 | 13.9% |
| Sinusitis | 138 | 4.0% | 55 | 3.8% | 83 | 4.1% |
| Septicaemia | 317 | 9.2% | 151 | 10.5% | 166 | 8.3% |
| Asthma | 335 | 9.7% | 123 | 8.7% | 212 | 10.5% |
| Do not know | 1,077 | 31.2% | 568 | 45.8% | 509 | 25.0% |
| Missing | 48 | 1.4% | 18 | 1.2% | 31 | 1.6% |
| Do you know SP can kill? (n = 3,458) | | | | | | |
| Yes | 2,751 | 79.6% | 1,311 | 90.9% | 1,440 | 71.5% |
| No | 707 | 20.4% | 132 | 9.1% | 575 | 28.5% |
| Missing | 42 | 1.2% | 12 | 0.8% | 30 | 1.5% |
| Residing with grandparents? (n = 3,471) | | | | | | |
| Yes | 1,550 | 44.7% | 597 | 41.3% | 953 | 47.1% |
| No | 1,921 | 55.3% | 849 | 58.7% | 1,072 | 52.9% |
| Missing | 26 | 0.7% | 9 | 0.6% | 17 | 0.9% |
| Does co-inhabiting grandparent(s) receive PCV? | | | | | | |
| Total | 1,544 | 595 | 949 | 4.5% |
| Yes | 1,147 | 79.9% | 79 | 13.3% | 34 | 1.7% |
| No | 397 | 20.1% | 162 | 26.7% | 255 | 13.2% |
| Missing | 26 | 0.7% | 12 | 0.8% | 15 | 0.8% |
| What do you think about cross-infectivity risk? (n = 3,432) | | | | | | |
| Low | 383 | 11.2% | 162 | 11.3% | 221 | 11.0% |
| Average | 2,038 | 59.4% | 755 | 52.7% | 1,283 | 62.4% |
| High | 1,011 | 29.5% | 515 | 36.0% | 496 | 24.8% |
| Missing | 72 | 2.0% | 23 | 1.6% | 49 | 2.6% |
| Have you heard of propaganda ‘Left influenza and Right pneumococcus immunization’ (n = 3,461) | | | | | | |
| Yes | 215 | 6.2% | 105 | 7.3% | 110 | 5.5% |
| No | 3,246 | 93.8% | 1,339 | 92.7% | 1,907 | 94.5% |
| Missing | 34 | 1.0% | 11 | 0.8% | 13 | 0.6% |
| Child received influenza immunisation? (n = 3,458) | | | | | | |
| Yes | 775 | 22.4% | 444 | 30.8% | 331 | 16.4% |
| No | 2,683 | 77.6% | 997 | 69.2% | 1,686 | 83.6% |
| Missing | 39 | 1.1% | 14 | 1.0% | 25 | 1.2% |
| How much are you willing to pay for catch-up immunisation? (n = 3,442) | | | | | | |
| Not willing | 649 | 18.8% | 176 | 12.3% | 473 | 23.5% |
| HK$100–500 per vaccine | 2,253 | 65.5% | 925 | 64.6% | 1,328 | 66.1% |
| HK$501–1,000 | 436 | 12.7% | 258 | 18.0% | 178 | 8.9% |
| HK$1,001–1,500 | 62 | 1.8% | 43 | 3.0% | 19 | 0.9% |
| HK$1,501–2,000 | 43 | 1.2% | 30 | 2.1% | 13 | 0.6% |
| Missing | 59 | 1.7% | 23 | 1.6% | 36 | 1.8% |

Abbreviations: GP, general practitioner; MCH, Maternal and Child Health; SP, Streptococcus pneumoniae. The bold entries indicate the significant P-values.
CI: 1.14
level increase), higher monthly household income (OR: 1.22; 95%
CI: 1.22; 95% CI: 1.14–1.31; P < 0.0005 for every level increase), parents being knowledgeable on the risk of death caused by Pneumococcus (OR: 1.31; 95% CI: 1.25–1.37; P < 0.0005 for every level increase) were independently associated with increased cross-infectivity (OR: 1.29; 95% CI: 1.13–1.46; P < 0.0005 for every level increase) were independently associated with increased cross-infectivity (OR: 1.29; 95% CI: 1.13–1.46; P < 0.0005 for every level increase).15 In our study, parents reported that the un-immunised children often had senior relatives (usually grandparents) who were also un-immunised. In recent years, the Hong Kong government has advocated and implemented PCV and influenza vaccination in the elderly population. Health education should target both the elderly and the paediatric population to optimise immunisation coverage and to provide more extensive or herd protection to the population at large with these vaccines.2,9

During the winter influenza season, prevention of co-infections with pneumococcal disease continues to be challenging in at-risk population.13–15 In our study, parents reported that the un-immunised children often had senior relatives (usually grandparents) who were also un-immunised. In recent years, the Hong Kong government has advocated and implemented PCV and influenza vaccination in the elderly population. Health education should target both the elderly and the paediatric population to optimise immunisation coverage and to provide more extensive or herd protection to the population at large with these vaccines.2,9

Reportedly, the major reasons for PCV immunisations were that parents were aware that SP disease could be severe and vaccines were efficacious in prevention. The information indicates that public education is important in encouraging or facilitating parents to take up immunisation for their child.3 The major reasons for children who were not immunised with PCV were concerns about vaccine side effects, cost, vaccine not efficacious and no recommendation by the private practitioner, family doctors or government.16 The perceived side effects could be because of publicity of exceedingly rare but exaggerated reports of associated side effects such as Guillain–Barre syndrome, which is not proven to have direct associations with vaccination.17–20

Childhood vaccination in Hong Kong is generally free under a government universal Childhood Immunization Programme.6 Vaccination uptake has generally been excellent for all the conventional vaccines. The low-uptake situation for pneumococcal, influenza or ‘newer’ and more recently introduced vaccines in HK may be primarily because of socioeconomic reasons. General practitioners might not view health promotion programmes as worthwhile, and they are not very familiar with the latest model of health promotion linking to holistic approach of patient care, as reflected in an Australian study.21 A Swiss study has reported general practitioners mentioning low priority of the pneumococcal vaccination in daily practice, as they rarely experienced cases of severe pneumococcal disease in their daily work.22 In Hong Kong, one study has reported that only half of the general practitioner respondents actively recommend pneumococcal vaccination to elderly and only 18.8% would recommend it for middle-aged patients.23 This might explain the

DISCUSSION
Main findings
This survey reveals many important public health issues for childhood immunisations. A majority of parents are aware that SP and influenza can cause serious disease, but less than half of their children were immunised. Alarming, more than half of the children with chronic respiratory disease such as asthma did not receive PCV immunisation. The same phenomenon of low immunisation rates in children with chronic respiratory diseases has been observed by Talbot et al.9 Invasive pneumococcal disease results in higher mortality in children with comorbidity.10 Asthma is a common respiratory disorder among children and is most studied, which is an independent risk factor for invasive and severe pneumococcal disease.11,12 The risk among persons with asthma was at least double compared with that among controls.9

Table 3. Which pneumococcal conjugate vaccine (PCV) and reasons for immunisation

| PCV (more than one) | N (n = 1,455) | % |
|---------------------|---------------|---|
| PCV 7               | 292           | 20.1% |
| PCV 10              | 159           | 10.9% |
| PCV 13              | 181           | 12.4% |
| PCV 23              | 32            | 2.2% |
| Uncertain           | 842           | 57.9% |
| Missing             | 8             | 0.5% |

**Immunisation at (more than one)**

| Option                      | N   | %   |
|-----------------------------|-----|-----|
| GP clinic                   | 998 | 68.6% |
| Private hospital            | 94  | 6.5% |
| MCH clinic                  | 308 | 21.2% |
| Other                       | 50  | 3.4% |
| Missing                     | 24  | 1.6% |

**Know about PCV from (more than one source)**

| Source                        | N   | %   |
|-------------------------------|-----|-----|
| Friends or relatives          | 343 | 23.6% |
| Paediatricist/family doctor   | 718 | 49.3% |
| Television/newspaper/magazine | 507 | 34.8% |
| Government/Department of Health | 467 | 32.1% |
| Other                         | 26  | 1.8% |

**Reasons for PCV immunisation (can choose ≤3)**

| Reason                                      | N   | %   |
|---------------------------------------------|-----|-----|
| Know that PD is serious                     | 1,128 | 77.5% |
| PCV is efficacious for prevention           | 689  | 47.4% |
| Recommended by friends or relatives         | 237  | 16.3% |
| Recommended by paediatricist/family doctor  | 511  | 35.1% |
| Recommended by television/newspaper/magazine | 172  | 11.8% |
| Recommended by Government/Department of Health | 295  | 20.3% |
| Other                                       | 18   | 1.2% |
| Missing                                     | 11   | 0.8% |

Abbreviations: GP, general practitioner; MCH, Maternal and Child Health; PD, pneumococcal disease.

Table 4. Reasons for child not receiving PCV (<3 items)

| Reason                              | N (2,030) | %   |
|-------------------------------------|-----------|-----|
| Concerns about adverse effects      | 507       | 25.0% |
| Too expensive                       | 368       | 18.1% |
| Child immunity already high         | 269       | 13.3% |
| No knowledge about PCV              | 439       | 21.6% |
| Child fear of needle jab            | 70        | 3.4% |
| Uncertain about PCV efficacy        | 490       | 24.1% |
| Difficult-to-temper child           | 7         | 0.3% |
| No immediate risk, unnecessary      | 297       | 14.6% |
| PCV not available then              | 354       | 17.4% |
| No knowledge about SP               | 271       | 13.3% |
| No recommendation by GP             | 416       | 20.5% |
| No recommendation by Government or DH | 450      | 22.2% |
| No reason                           | 284       | 14.0% |
| Other                               | 56        | 2.8% |

Abbreviations: DH, Department of Health; GP, general practitioner; PCV, pneumococcal conjugate vaccine; SP, Streptococcus pneumoniae.
low-uptake rate for ‘non-conventional vaccines’. More public awareness and education efforts, together with strong input efforts from healthcare professionals, would be essential to enhance vaccine uptake.6

Strengths and limitations of this study
A strength of this study is the large sample size and standardised questionnaire to ensure uniformity for data. Limitations include the intrinsic problems associated with the use of questionnaire, possible misinterpretation of questions and the relatively low return rate of filled questionnaires. Despite the small number of schools included in this study, detailed demographic data such as household income, guardian’s highest education, past medical and immunisation history allow comprehensive analysis to be performed. There would be clustering of data at the school level, with nine schools involved in the study. The socioeconomic status of the study population as reflected by parental education level and monthly household income (Table 1) is not markedly different from Hong Kong population as a whole.

Interpretation of findings in relation to previously published work
The same phenomenon of low immunisation rates in children with chronic respiratory diseases has been observed by Talbot et al.9 Invasive pneumococcal disease results in higher mortality in children with comorbidity.10 Asthma is a common respiratory disorder among children and is most studied, which is an independent risk factor for invasive and severe pneumococcal disease.11,12

Similar to previously reported work, the major reasons for children not being immunised with PCV were concerns about vaccine side effects, cost, vaccine not efficacious and no recommendation by the private practitioner, family doctors or government.16 The perceived side effects could be because of publicity of exceedingly rare but exaggerated reports of associated side effects such as Guillain–Barre syndrome, which is not proven to have direct associations with vaccination.17–20

Implications for future research, policy and practice
PCV-un-immunised children and senior relatives (grandparents) were prevalent during the study period. Public education and facilitation of immunisation of PCV and influenza should target for both at-risk groups of children and the elderly.

Conclusions
PCV-un-immunised children were prevalent during the study period. Parents of PCV-un-immunised children had lower education background and lower income. They were less aware of the potential seriousness of invasive pneumococcal disease. Public education and facilitation of immunisation of PCV and influenza should target for both at-risk groups of children and the elderly.

MATERIALS AND METHODS
This study was a community-based cross-sectional survey in which young children were randomly recruited according to the distribution of their primary schools. Parents of participating subjects were of Chinese ethnicity. After informed consent, questionnaires were sent to children’s families in the schools. The survey was carried out in randomly selected primary schools in Hong Kong. On the basis of the assumption that more than 50% children did not receive influenza vaccination or pneumococcal vaccination, a sample size of 3,000 children from Hong Kong would have a power of 80% at a 95% level of confidence to detect a representative significance. As we conservatively expected a participation rate of 80% among all the subjects, this study aimed to recruit 2,880 primary school children. A complete list of primary schools was obtained from the Education Department of Hong Kong. In participating primary schools, all grades of primary students were targeted for the study. Schools were selected from the three major geographic regions of Hong Kong (Hong Kong Island, Kowloon, New Territories and outlying islands). Sample selection was based on a stratified (by districts) randomised sampling frame. We stratified all schools according to the above three geographic regions. We then selected 10 primary schools randomly from each district. According to data obtained from the Education Department of Hong Kong and our past experience of similar school-based study, each primary school would contribute a minimum of four classes in each grade for the study. Assuming class sizes of 30 and a parental co-operation rate of 80%, approximately 2,880 students would be recruited. This sampling method would ensure that our sample can truly be representative of the young children in Hong Kong.

A standard questionnaire in Chinese was used to screen for the medical history of pulmonary diseases. We added items to assess also the participation of the Childhood Immunization Programme. Consent was first obtained from headmasters or principals of all primary schools. Parents in these consented schools were then given standard written questionnaires to be completed at home and collected within 1 week of distribution. The questionnaire was modified from a previously used version, which gathered demographic data, medical history of upper respiratory diseases, awareness vaccine-preventable diseases, severity of certain vulnerable diseases and acceptance of vaccination.

Data entry and statistical analyses
The research assistant conducting the questionnaire survey entered all the data into a database, and an independent research staff validated the accuracy of the entered data. Data were categorised and analysed using SPSS (Statistical package for the social sciences for Windows). Chi-square test was used to compare the prevalence rates between different schools. Logistic regression with adjustment for covariates was used to estimate the possible associations between self-reported influenza and pneumococcal diseases with SPSS v.18 (IBM Corp., New York, NY, USA). P values (two-tailed) less than 0.05 were considered significant. Approval for the clinical research ethics was obtained from The Joint Chinese University of Hong Kong—New Territories East Cluster Clinical Research Ethics Committee. Parents or legal guardians of the children signed consent before they joined this study.

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CONTRIBUTIONS
K-LEH is the principal author. YCKT performed the statistical analyses. LCNC, DKKN, TYM, JYC and AL helped in drafting of the manuscript. TFL is an allergist/infectious disease professor who helped in drafting of the manuscript.

COMPETING INTERESTS
The principal author K-LEH was commissioned by the Hong Kong Society of Paediatric Respirology and Allergy to perform this survey. K-LEH has previously received travel and conference sponsorships from WyethNutrition, Pfizer and GSK. The remaining authors declare no conflict of interest.

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