**Additional file 7**

**The composition of 105 haplotypes identified from 624 *pvmdr1* gene sequences**

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| **Table1 The composition of multiple mutation loci in 105 haplotypes identified from 624 *pvmdr1* CDSs in *P. vivax* strains** | | | | | | | | |
|  |  | **Multiple mutants of different degrees** | | **Frequency** | | | | |
| **Order** | **Haplotype** | **Types** | **Multiplicity** | **No. of all CDSs**  **（n=624）** | **2014（n=283）** | **2020（n=140）** | **2021（n=119）** | **2022（n=82）** |
| 1 | Hap\_87 | G698S/M908L/T958M | 3 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 2 | Hap\_8 | G698S/M908L/T958M/S1358S | 4 | 17(2.7%) | 17(6.0%) | 0 | 0 | 0 |
| 3 | Hap\_12 | T529T/G698S/M908L/T958M | 4 | 5(0.8%) | 5(1.8%) | 0 | 0 | 0 |
| 4 | Hap\_56 | K44K/G698S/M908L/T958M | 4 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 5 | Hap\_64 | G698S/M908L/T958M/K1393N | 4 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 6 | Hap\_90 | G698S/M908L/T958M/F1076L | 4 | 1(0.2%) | 0 | 1(0.7%) | 0 | 0 |
| 7 | Hap\_7 | G698S/M908L/T958M/Y976F/F1076L | 5 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 8 | Hap\_17 | S513R/T529T/G698S/M908L/T958M | 5 | 4(0.6%) | 4(1.4%) | 0 | 0 | 0 |
| 9 | Hap\_21 | T529T/G698S/M908L/T958M/K1393N | 5 | 8(1.3%) | 8(2.8%) | 0 | 0 | 0 |
| 10 | Hap\_26 | S513R/T529T /A861E /M908L /T958M | 5 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 11 | Hap\_28 | G698S/ L845F /M908L /T958M/ F1076L | 5 | 9(1.4%) | 6(2.1%) | 2(1.4%) | 1(0.8%) | 0 |
| 12 | Hap\_30 | K44K /G698S/ M908L/ T958M /F1076L | 5 | 3(0.5%) | 2(0.7%) | 1(0.7%) | 0 | 0 |
| 13 | Hap\_32 | S513R/ T529T /M908L/ T958M/ F1076L | 5 | 4(0.6%) | 4(1.4%) | 0 | 0 | 0 |
| 14 | Hap\_33 | S513R/ T529T /M908L/ T958M /K1393N | 5 | 7(1.1%) | 7(2.5%) | 0 | 0 | 0 |
| 15 | Hap\_35 | L493L/T529T /G698S/ M908L/ T958M | 5 | 1(0.2%) | 1(0.3%) | 0 | 0 | 0 |
| 16 | Hap\_40 | T529T/ G698S /M908L/ T958M /F1076L | 5 | 66(10.6%) | 8(2.8%) | 29(20.7%) | 19(16.0%) | 10(12.2%) |
| 17 | Hap\_57 | T529T/ G698S /M908L/T958M/S1358S | 5 | 6(1.0%) | 2(0.7%) | 0 | 0 | 4(4.9%) |
| 18 | Hap\_93 | K44K/T529T/M908L/T958M/F1076L | 5 | 1(0.2%) | 0 | 1(0.7%) | 0 | 0 |
| 19 | Hap\_95 | T529T/M908L/T958M/F1076L/K1393N | 5 | 9(1.4%) | 0 | 0 | 4(3.4%) | 5(6.1%) |
| 20 | Hap\_2 | S513R/T529T/G698S/M908L/T958M/S1358S | 6 | 32(5.1%) | 3(1.1%) | 21(15.0%) | 4(3.4%) | 4(4.9%) |
| 21 | Hap\_10 | T248T/T529T/G698S/M908L/T958M/F1076L | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 22 | Hap\_13 | L310L/S513R/T529T/G698S/M908L/T958M | 6 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 23 | Hap\_18 | K44K/T529T/G698S/M908L/T958M/F1076L | 6 | 11(1.8%) | 9(3.2%) | 0 | 1(0.8%) | 1(1.2%) |
| 24 | Hap\_20 | L493L/T529T/G698S/M908L/T958M/F1076L | 6 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 25 | Hap\_23 | S513R/T529T/G698S/M908L/T958M/K1393N | 6 | 35(5.6%) | 24(8.5%) | 6(4.3%) | 4(3.4%) | 1(1.2%) |
| 26 | Hap\_29 | T529T/G698S/L845F/M908L/T958M /F1076L | 6 | 9(1.4%) | 9(3.2%) | 0 | 0 | 0 |
| 27 | Hap\_31 | T529T/G698S/A861E/M908L/T958M/K1393N | 6 | 4(0.6%) | 4(1.4%) | 0 | 0 | 0 |
| 28 | Hap\_34 | G698S/M908L/T958M/Y976F/F1076L/K1393N | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 29 | Hap\_36 | K44K/S513R/G698S/ M908L /T958M /K1393N | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 30 | Hap\_37 | S513R/T529T/A861E/M908L/ T958M /K1393N | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 31 | Hap\_46 | K44K/G698S/M908L/T958M /F1076L /E1396E | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 32 | Hap\_47 | S513R/T529T /G698S/ A861E /M908L/ T958M | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 33 | Hap\_51 | T529T/G698S/M908L/T958M/F1076L/K1393N | 6 | 2(0.3%) | 1(0.4%) | 0 | 1(0.8%) | 0 |
| 34 | Hap\_53 | L493L/T529T/G698S/M908L/T958M/S1358S | 6 | 4(0.6%) | 4(1.4%) | 0 | 0 | 0 |
| 35 | Hap\_55 | G172G/S513R/T529T/M908L/T958M/F1076L | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 36 | Hap\_62 | K44K/G698S/L845F/M908L/T958M/F1076L | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 37 | Hap\_71 | S513R/T529T/G698S/M908L/T958M/L1067L | 6 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 38 | Hap\_73 | L493L/G698S/M908L/T958M/F1076L/E1396E | 6 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 39 | Hap\_74 | T409M/T529T/G698S/M908L/T958M/S1358S | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 40 | Hap\_76 | S513R/T529T/K672N/M908L/T958M/F1076L | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 41 | Hap\_77 | S513R/T529T/G698S/M908L/T958M/K997R | 6 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 42 | Hap\_79 | T529T/G698S/M908L/T958M/F1076L/E1396E | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 43 | Hap\_85 | K44K/G698S/M833I/M908L/T958M/F1076L | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 44 | Hap\_89 | K44K/G698S/M908L/T958M/L1212L/N1431S | 6 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 45 | Hap\_91 | P8L/L310L/T529T/M908L/T958M/F1076L | 6 | 58(9.3%) | 0 | 19(13.6%) | 24(20.2%) | 15(18.3%) |
| 46 | Hap\_92 | T529T/G698S/A861E/M908L/T958M/F1076L | 6 | 1(0.2%) | 0 | 1(0.7%) | 0 | 0 |
| 47 | Hap\_96 | S513R/T529T/G698S/M908L/T958M/F1076L | 6 | 2(0.3%) | 0 | 0 | 1(0.8%) | 1(1.2%) |
| 48 | Hap\_97 | S513R/T529T/M908L/T958M/F1076L/S1358S | 6 | 2(0.3%) | 0 | 0 | 1(0.8%) | 1(1.2%) |
| 49 | Hap\_99 | T529T/G698S/M908L/T958M/F1076L/S1358S | 6 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 50 | Hap\_101 | T409M/T529T/M908L/T958M/F1076L/K1393N | 6 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 51 | Hap\_104 | K44K/L310L/T529T/M908L/T958M/F1076L | 6 | 1(0.2%) | 0 | 0 | 0 | 1(1.2%) |
| 52 | Hap\_4 | K44K/T529T/G698S/L845F/M908L/T958M/F1076L | 7 | 47(7.5%) | 2(0.7%) | 10(7.1%) | 14(11.8%) | 21(25.6%) |
| 53 | Hap\_6 | S513R/T529T/G698S/M908L/T958M/Y976F/F1076L | 7 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 54 | Hap\_9 | T409M/T529T/G698S/M908L/T958M/F1076L/K1393N | 7 | 29(4.7%) | 11(3.9%) | 8(5.7%) | 4(3.4%) | 6(7.3%) |
| 55 | Hap\_11 | K44K/T529T/G698S/A861E/M908L/T958M/F1076L | 7 | 45(7.2%) | 12(4.2%) | 15(10.7%) | 17(14.3%) | 1(1.2%) |
| 56 | Hap\_19 | L493L/G698S/L845F/M908L/T958M/A1049A/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 57 | Hap\_24 | K44K/T529T/G698S/M908L/T958M/ F1076L/ S1450L | 7 | 52(8.3%) | 17(6.0%) | 16(11.4%) | 13(10.9%) | 6(7.3%) |
| 58 | Hap\_25 | S513R/T529T/G698S/M908L/T958M /S1358S /S1450L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 59 | Hap\_27 | L493L/T529T/ G698S /L845F /M908L /T958M/ S1358S | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 60 | Hap\_39 | L493L/T529T/G698S/L845F /M908L /T958M /F1076L | 7 | 4(0.6%) | 4(1.4%) | 0 | 0 | 0 |
| 61 | Hap\_43 | K44K/G520D/T529T /G698S/M908L /T958M/ F1076L | 7 | 5(0.8%) | 5(1.8%) | 0 | 0 | 0 |
| 62 | Hap\_44 | T529T/G698S/L845F/M908L/T958M/F1076L/R1422R | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 63 | Hap\_48 | K44K/S513R/T529T/G698S/M908L/T958M/K1393N | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 64 | Hap\_49 | G172G/T529T/G698S/M908L/T958M/S1258S/ S1259F | 7 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 65 | Hap\_52 | K44K/L493L/T529T/G698S/M908L/T958M/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 66 | Hap\_54 | K44K/N312N/T529T/G698S/M908L/T958M/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 67 | Hap\_59 | S513R/T529T/G698S/M908L/T958M/F1076L/K1393N | 7 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 68 | Hap\_61 | N312N/L493L/T529T/G698S/M908L/T958M/K997R | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 69 | Hap\_63 | T529T/V651V/G698S/L845F/M908L/T958M/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 70 | Hap\_65 | K44K/G698S/M908L/T958M/F1076L/L1212L/N1431S | 7 | 6(1.0%) | 6(2.1%) | 0 | 0 | 0 |
| 71 | Hap\_66 | K44K/E399E/T529T/G698S/M908L/T958M/S1358S | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 72 | Hap\_68 | T529T/G698S/L845F/M908L/T958M/F1076L/K1393N | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 73 | Hap\_69 | S513R/T529T/G698S/A861E/M908L/T958M/K1393N | 7 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 74 | Hap\_72 | Y181Y/T529T/G698S/L845F/M908L/T958M/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 75 | Hap\_75 | K44K/S553S/G698S/L845F/M908L/T958M/F1076L | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 76 | Hap\_80 | S513R/T529T/G698S/M908L/T958M/F1076L/E1396E | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 77 | Hap\_81 | L493L/G698S/S786G/M908L/T958M/F1076L/K1393N | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 78 | Hap\_83 | T529T/G698S/M908L/T958M/F1076L/C1285C/E1396E | 7 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 79 | Hap\_84 | T529T/G698S/L845F/M908L/T958M/F1076L/S1450L | 7 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 80 | Hap\_86 | K44K/T529T/G698S/M833I/M908L/T958M/F1076L | 7 | 8(1.3%) | 1(0.4%) | 3(2.1%) | 3(2.5%) | 1(1.2%) |
| 81 | Hap\_94 | P8L/L310L/T529T/G698S/M908L/T958M/F1076L | 7 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 82 | Hap\_98 | K44K/S513R/T529T/G698S/M908L/T958M/S1358S | 7 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 83 | Hap\_100 | S513R/T529T/M908L/T958M/L1022L/F1076L/K1355K | 7 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 84 | Hap\_106 | K44K/L310L/T529T/L845F/M908L/T958M/F1076L | 7 | 1(0.2%) | 0 | 0 | 0 | 1(1.2%) |
| 85 | Hap\_5 | L493L/T529T/G698S/L845F/M908L/T958M/F1076L/  E1233E | 8 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 86 | Hap\_22 | K44K/S513R/T529T/G698S/A861E/M908L/T958M/  F1076L | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 87 | Hap\_41 | S513R/T529T/G698S/A861E/M908L/T958M/F1076L/ K1393N | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 88 | Hap\_42 | I443I /L493L/ T529T /G698S/ M908L/ T958M/ F1076L/ K1393N | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 89 | Hap\_45 | S513R/T529T/G698S/A763V/M908L/T958M/F1076L/  S1268I | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 90 | Hap\_50 | K44K/G520D/T529T/ G698S /M908L /T958M/ F1076L/ S1450L | 8 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 91 | Hap\_58 | N312N/T529T/G698S/L845F/M908L/T958M/F1070F/  F1076L | 8 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 92 | Hap\_60 | T529T/G698S/A861E/M908L/T958M/Y976F/F1076L/  K1393N | 8 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 93 | Hap\_67 | K44K/F185L/T529T/G698S/M908L/T958M/F1076L/  S1450L | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 94 | Hap\_82 | K44K/T529T/G698S/L845F/M908L/T958M/F1076L/  S1450L | 8 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 95 | Hap\_103 | S513R/T529T/G698S/M908L/T958M/F1076L/S1358S/  K1393N | 8 | 1(0.2%) | 0 | 0 | 0 | 1(1.2%) |
| 96 | Hap\_105 | K44K/T529T/G698S/F842I/L845F/M908L/T958M/  F1076L | 8 | 1(0.2%) | 0 | 0 | 0 | 1(1.2%) |
| 97 | Hap\_3 | K44K/T529T/G698S/L845F/M908L/T958M/F1076L/  L1120L/S1450L | 9 | 7(1.1%) | 7(2.5%) | 0 | 0 | 0 |
| 98 | Hap\_15 | P8L/K44K/G520D/T529T/G698S/L845F/M908L/  T958M/F1076L | 9 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 99 | Hap\_16 | P8L/K44K/T529T/G698S/L845F/M908L/T958M/  F1076L/S1450L | 9 | 3(0.5%) | 3(1.1%) | 0 | 0 | 0 |
| 100 | Hap\_38 | K44K /S513R /T529T /G698S /L845F/ M908L/ T958M/ F1076L/ S1450L | 9 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 101 | Hap\_70 | G32C/K44K/L493L/T529T/G698S/L845F/M908L/  T958M/F1076L | 9 | 2(0.3%) | 2(0.7%) | 0 | 0 | 0 |
| 102 | Hap\_88 | P437S/L493L/T529T/G698S/L845F/M908L/T958M/  F1076L/E1233E | 9 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |
| 103 | Hap\_102 | K44K/G698S/L845F/M908L/T958M/F1076L/L1120L/  L1278L/S1450L | 9 | 1(0.2%) | 0 | 0 | 1(0.8%) | 0 |
| 104 | Hap\_14 | K44K/G520D/T529T/G698S/A861E/M908L/T958M/  F1076L/T1348T/S1450L | 10 | 23(3.7%) | 13(4.6%) | 7(5.0%) | 2(1.7%) | 1(1.2%) |
| 105 | Hap\_78 | K44K/T529T/G698S/A861E/M908L/T958M/F1076L/  T1348T/K1393N/S1450L | 10 | 1(0.2%) | 1(0.4%) | 0 | 0 | 0 |