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NEW ALLELE ALERT

Genomic Full-Length Sequence of the HLA-DRB1*03:19 Allele Was Identified in a Chinese Bone Marrow Donor by PacBio Sequencing

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ABSTRACT

Genomic full-length sequence of HLA-DRB1*03:19 was identified in a Chinese individual by PacBio sequencing.

The HLA complex, around 4 million bases in length, is located on chromosome 6, 6p21.3. The HLA genes within this region are known to be highly variable [1]. There are currently 41,003 HLA and related alleles described by the HLA nomenclature and included in the IPD-IMGT/HLA Database [2]. Up to December 2024, 3787 *HLA-DRB1* alleles have been identified and included in the IPD-IMGT/HLA Database (http://www.ebi.ac.uk/imgt/hla/). *HLA-DRB1*03:01* is well expressed in the Chinese population, and the allele frequency is 3.69% [3]. The HLA-DRB1*03:19 allele was first identified in July 2016 but only contained the sequences of exon 2 and exon 3.

Here we report the full-length sequence of the *HLA-DRB1*03:19* allele, which was identified during HLA typing of a Chinese bone marrow donor using PacBio sequencing, a third-generation sequencing platform. The test has been done with the donor's informed consent. The variant was initially recognised by high-resolution HLA-typing technique with SBT kit (Genome Diagnostics BV, Utrecht, The Netherlands). Genomic DNA was extracted from peripheral-blood leukocytes according to the manufacturer's instructions for DNA isolation kits (Life Technologies), and further molecular testing was performed. In brief, group-specific amplification was performed using primers located in the 5′untranslated (UT) and 3′UT regions, followed by Sanger sequencing using generic primers in both forward and reverse directions by means of cycle sequencing [4]. The sequencing results of HLA-DRB1 in this sample did not fully match any allele combination. In order to determine the reason for this difference, the third-generation sequencing (Pacific BioSciences) was used. The library was added to the sequencing chip and sequenced using a PacBio Sequel II high-throughput gene sequencer. The excitation wavelength of the instrument could excite the group to emit fluorescence, and the fluorescence signal was recorded. Subsequently, we used the official PacBio software, Circular Consensus Sequencing (CCS), to process the HiFi data. Then we partitioned the library based on the presence or absence of barcodes. Following this, we conducted backposting, mutation detection, clustering, typing, and haplotype verification of the results [5]. Finally, the full-length sequence of the HLA-DRB1*03:19 allele was confirmed.

The genomic full-length sequence of the HLA-DRB1*03:19 included all exons and introns, a total of 13,383 bp in length. The overlapping nucleotide sequence was found to be concordant with the available HLA-DRB1*03:19 sequence in the IPD-IMGT/HLA Database. The sequence of the 5′-upstream region, all introns, and exons 1, 4, 5, and 6 of HLA-DRB1*03:19 was first reported here. Compared with HLA-DRB1*03:01:01:03, the novel HLA-DRB1*03:19 has 2 nucleotide changes from DRB1*03:01:01:03; the first change is a T missing at nucleotide 2686 in intron 1, and the second at nucleotide 8280 in exon 2, where C>A (codon CTC>ATC) resulting in a coding change: residue 96 Leucine is changed to Isoleucine. (Figure 1).

```
                                                                                                       -315
DRB1*03:01:01:03    TTGTCAAGTG GGAAATGAAT GCTCTTACAA GGCTCAAACT TGTGAACACA TCACTGACCA GCACAGAGCT AAAATAATTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       -235
DRB1*03:01:01:03    GGGCTAAAAA TACCGCCCCA ATTAAAGTGT TTTACATGCA ACTGGTTCAA ACCTTTCAAG TACTAAAAAC AATCCTGTAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       -155
DRB1*03:01:01:03    AGAAGGAAAT TCTGTTTCAG AAGAGGACCT TCATACAGCA TCTCTGACCA GCAACTGATG ATGCTATTGA ACTCAGATGC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        -75
DRB1*03:01:01:03    TGATTCGTTC TCCAACACTA GATTACCCAA TCCAGGAGCA AGGAAATCAG TAACTTACTC CCTATAACTT GGAATGTGGG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     |Exon16
DRB1*03:01:01:03    TGGAGGGGTT CATAGTTCTC CCTGAGTGAG ACTTGCCTGC TGCTCTGGCC CCTGGTCCTG TCCTGTTCTC CAGC|ATGGTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----|------
                                                                                                         86
DRB1*03:01:01:03    TGTCTGAGGC TCCCTGGAGG CTCCTGCATG GCAGTTCTGA CAGTGACACT GATGGTGCTG AGCTCCCCAC TGGCTTTGGC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                   |Intron1                                                             166
DRB1*03:01:01:03    TGGGGACACC AGAC|GTAAGT GCACATTGTG GGTGCTGAGC TACTATGGGG TGGGGAAAAT AGGGAGTTTT GTTAACATTG
DRB1*03:19          ---------- ----|------ ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        246
DRB1*03:01:01:03    TGCCCAGGCC ATGTACCTTA AGAAATTGTG ACGTATTTTT CAGAGATTGC CCATCTTTAT CATATGGATC CCAAATAATT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        326
DRB1*03:01:01:03    TCCCCACCAC AAAAGGAGCT TGGCTACTTG CCCACTCCAT GAGACTTGTG TAAGGGGCCT CCATACAGGT CATTTCTACT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        406
DRB1*03:01:01:03    CAAATCTCCA CCAATAAAAC CTTTGCATCA CATGTCCTCA GGGTCTTTAG AGGATTTAGA AATAAGGATG CTAAAATAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        486
DRB1*03:01:01:03    TTCCCCATAC AGCACTTGCC TTTATTATGT TGACTTATGT CAGACAAAGG AGGTTTTTTC TGAAAATTTT GTGGAAGTCA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        566
DRB1*03:01:01:03    AGGGAATTTA AAGGGTCTCT CCTAAACGAT CCTGGGTTAT GTCACCCACA GGACCTTTGG TGTTGGCCCC TCTTCCTCAT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        646
DRB1*03:01:01:03    ATGTGAGGAT GGACCCAGTG GCCTCCCCAT TATCTACTTT CTTTTCTTTC TGAACTCCAA TGTTTATAAA GCCTGTACCC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        726
DRB1*03:01:01:03    CTGTAGTGTA TGTAGGTTGT CTGACAGAAG TTATACTTAG TGCTCTTTCT TTCTTGTGGG GAAAAATCCC TGGAACTGAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        806
DRB1*03:01:01:03    GCTGAGATCT TTAGTACTTG GAGTCACCTT ACAGATACAG AGCATTTATG AGGTATTCTT TGGTGCCTAA AGAACTTAAG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        886
DRB1*03:01:01:03    GCATCCTCTG AAAACCTGGC CCAGGTTAGT GTTTATTATG AATCTCTTTT AACCTTTCTA TACTTGTTTC TCCTACATCT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        966
DRB1*03:01:01:03    CCTAAGTGCT CCAACTAGAC ATGACAGAAG AGATTTAACT AACGTAGTAT GAGTTATATA AAATTCTATT TTTGTAAGTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1046
DRB1*03:01:01:03    AAAAATAATC AAATATCAAA AATTTAATAA TGTTCAAACT ATATACTCTG TGTGGGGTTA CCGAGACAAT GTGGACATTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1126
DRB1*03:01:01:03    TTCACATCTC ATAGGGCTGA AAGTCAATGG GCAAGTCCTG GGAACTCATT GTCTTACTGG GGTCTTGTCC TAAATTTCAT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1206
DRB1*03:01:01:03    AGGTTCACCC ATCATGCCCT CAACTTTCCT TAATTAGCCA TGTCTGCTTA CCTCTTCCTC CAGTTTCTCT CTTATTTTTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1286
DRB1*03:01:01:03    CCCAGCTATG TTGTTATCAT TTCCAGAAAT CTCTAAAGCT TGCACAGATC CTTAGCACTA TGAGATCCAT TGAAAGAGAT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1366
DRB1*03:01:01:03    AGTTTTTTTC TTTTTGAGAT AGGGCCTGGC TCTGTCACCC AGGCTGTAGC TCAGTGGTGC GATCGAGGCT CACTGCAACC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1446
DRB1*03:01:01:03    TCTGCCTCCC ACGCTCAAGT GATCCTCCCT CCTCAGGCTC CAGAGTAGCT GGGAATACAG GCAGGCAACC ACGCCCAGCT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1526
DRB1*03:01:01:03    AATTTTTGTA ATTTTGGTAG AAATGAGATT TTGCCATGTT GCCCAGGCTG GTCTTAAACT GCTGGACTCA AGCAATCCTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1606
DRB1*03:01:01:03    CTGCCTTGGC CTCCCAACAT GCTAGGATTA TAGATGTGAG CCACTGTGCC CAGGCAAAAA GAGATGACTC TCAATAAAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1686
DRB1*03:01:01:03    AAAGTCCTTT TTCTTAAATC ACTGTTTCTT TATCTGTGAA TTCTTCTTCC AACTAGAAGG AGGAGAAAGA AGTTTGCCTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1766
DRB1*03:01:01:03    TATTTCTCAC CAGGAGGAGA AGGGGTCTAG TGTGACATCA GAATGAAAGA GTGCTGGAGT TTGAGCCCCT TCTTGCTTTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1846
DRB1*03:01:01:03    CAAGATCCCC ACAGTTATCA CTTCCCATAC CCTGGTTTAT TCATGTAAAC CACACTTATT TTTCTTAGCA GCTACTGTGT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       1926
DRB1*03:01:01:03    ACTCGGCTCC ATTCTAGGTT CAGATCATTC TATTTGATTA AGACAGAGAG GGTCCCGACT CTCATGGAAG TTACACAACA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       2006
DRB1*03:01:01:03    ATAGAGGAGA CAGACACTAA CCCAATAAGC ATTTAACAAA GAATAAAATA TTAGAGAGTC ATAGTGCACT GAAGAAAAGA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       2086
DRB1*03:01:01:03    CATCAGGTTT GTGAAGAAGA GAGACATGGA TTCACCTACT TTAGTTCATA TGTTTAGGGA GCTCTACCTG AGAAAGTGAC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       2166
DRB1*03:01:01:03    ATTCAGCTGA GACAACAAAA TAAGTAGACA GTCATGAAGA TCTAATGGAC GAAAGCTCCA GAGAGACCAA ATGGGGGGAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
```

FIGURE 1 | Sequence alignment of the full length of DRB1*03:01:01:03 and DRB1*03:19 alleles. Dashes indicate identity with the DRB1*03:01:01:03 sequence. The pipes indicate the exon and intron boundaries. The nucleotide positions are numbered according to the genomic full-length alignment in the IPD-IMGT/HLA Database. Allele DRB1*03:19 showed 2 nucleotide changes from DRB1*03:01:01:03; the first change is a T missing at nucleotide 2686 in intron 1, and the second at nucleotide 8280 in exon 2 where C>A.

```
                                                                                                      2246
DRB1*03:01:01:03   AGCCCTGGTG TGGGAAATTA TGTGGAGAGA GAGAAAGACG GCTAGAGGGG CTGATGTATA GAAAGTAAGG AAATGGAGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2326
DRB1*03:01:01:03   GCAGAAGATG AGGTAGGACA CAGAGAGAAA GTCAGGAGCC TCATCATTAT AGGCTCTGAT GTCCACGGTA AAAAATTTGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2406
DRB1*03:01:01:03   ATTTTATTTT ATTTATTTAT TTATTTATTT ATTTATTTTA TTTATTTATT TATTTATTTT TTTAAGATGG AGTCTCGCTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2486
DRB1*03:01:01:03   TGTTGCCCAG GCTGGAGTGC AGTGGCGTGA TCTCAGCTCA CTGCAAGCTC CACCTCCTGG GTTCATGCCA TTCTCCTGCC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2566
DRB1*03:01:01:03   TCAGCCTCCC TAGTAGCTGG GACTACAGGC ACCTGCCACC ACGCCTGGCT AATTTTTAGT ATTTTTAGTA GTGAGGGCAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2646
DRB1*03:01:01:03   TTTGTCATGT TAACCAGGGT GGTCTCCATC TCCTGACCTC GTGATCCACC TGCCTCAGCC TCCCAAAGTG CTGAGACTAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                          2686                                        2726
DRB1*03:01:01:03   AGGTGTGAGC CACCACGCCT GGCCTATTTT TTTTTTTTTT GAGACGGAGT TTCGTTCTTG TTGCCCAGGC TGGAGTGCAA
DRB1*03:19         ---------- ---------- ---------- ---------* ---------- ---------- ---------- ----------
                                                                                                      2806
DRB1*03:01:01:03   TGGTGCAATC TCGGCTCACT GCAACCTTCG CCTCCCTGGT TCAAGTGATT CTCCTGCCTC AGCTTCCCAA GTATCTGAGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2886
DRB1*03:01:01:03   TTACAGGCAC CCACCACCAT ACCTGGCTAA TTTTTATTTT TTTGTATTTT TAGTAGACAT CGGGTATCAC CATGTTGACC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      2966
DRB1*03:01:01:03   ATGCTGGTCT CGAACTCCTG ACCTCAGATA ATCTGTCTGC CTTGGCCTCC CAAAGTGCTG GGATTACAGG CATGAGCCAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3046
DRB1*03:01:01:03   CGCGGCCGGA CTGAATTTTA TTTAAATAGA TACGAGAAGC TACTGTATGG TTACAAGGAG AGTCAATTTA TATTCAATTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3126
DRB1*03:01:01:03   ATTTTTATTT TATTTTATTT TTTTGGTGAT GGGGTCTTGC TCTGTTGCCC AGGCTAGATT GTAGTGGCAC AATCTCGGCT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3206
DRB1*03:01:01:03   CACTGCAACC TCTGCCTTCT GGGTTCAGGC GATTCTCCTG ACTCAGCCTC CAGAGTAGCT GGGACCACAG GTACATGCCA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3286
DRB1*03:01:01:03   CCACACCTGG CTAAGTTTTT GTATTTTTTA GTAGAGACAG GATTTCACCA TGTTAGCCAG GATGGTCTCG ATCTCCTGAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3366
DRB1*03:01:01:03   CTCGTGATCC ACCCACCTTG GCCTCCCAAA GTGCAGGGAT TACAGGCCTG AGCCACTGCG CCCGGCCTAT ATTCAATTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3446
DRB1*03:01:01:03   TAAAACTAAT TCTAGCTACT CTGTGGGGAT TGGAATGTTG GGGTTCACAA GTGGTCAGGA AGACTATTTA GGAGCACAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3526
DRB1*03:01:01:03   AGGGAATTCT CCAGCGAAAA CAGGCTTGTG GCTTCATGGA GTGCATTAGT GATAAAGACG GTGAAAAAGA TAAAGTGGAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3606
DRB1*03:01:01:03   AGACTTGGCA TGTATTTTTC CTTAGCTTGT TAATGAATTA CTGTAAAGGG GGTAGAACAA TCAAGCTTAT TCCTAAGGAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3686
DRB1*03:01:01:03   TTTGTTTTGA CAAATAAGTG GGTGGTAGTG TTGTTTATTG AGATAGGAAA AACTATGGGA GGAAATTATT TGAAGTGGGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3766
DRB1*03:01:01:03   GGTTGGAAAT AAAAGTTTTG TTTAAATTTG AGATGATTTA TTGACATTTA TGTGGAGCAA TCAGAAGGTC AATGGCATTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3846
DRB1*03:01:01:03   AAGAGACTCA TGGTGAGGCT AGGGCTTCAA GTATTTATGT TGGCGGCATC AATACGTGTA GTGTGTTAAA TTCCAGGGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      3926
DRB1*03:01:01:03   TGGAAGAGGA TACATAGGGA GATGGATTGT GTGGAGAAAA AAGAACAGGG CACAGGCCAG CAAAGGGGGC TGAGAAAGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4006
DRB1*03:01:01:03   CCCAGGGATG TTGGAGAAAA ATCAAGAGAA CATGATGCGT GTACGTCAAG GAAAATAGAT TTTTTTCAAG GAGAAGGGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4086
DRB1*03:01:01:03   AGGCCAATTG TGGTGAGTAC CACTAAGCGG AGGGGGAAGT GAGAACGTGA CAGAGAAGCA AGTGCTGGGT TTGGTGGAGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4166
DRB1*03:01:01:03   TGATATTTGC AGTCAGTGGA GTATCCAGGG AGGAAACTGG ATTGGACAAT TTGAAGAGCG AGTAGAAGTG AGGATGAGGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4246
DRB1*03:01:01:03   TAAGATTGAC TGTTTTGAGT AGAGAGCTTC AGGGAAGGAC TGCACTCTGG GTTCAGGGAG CCAGCTGGAT CAAAAGGAAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4326
DRB1*03:01:01:03   AGGCTAAAGA GGCTGAAGAG AAGCAGGAGG ACCTGTGAAC CAGAGATGCT CAGTCATTAT TAGCGAGGAA ATACTAGAAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4406
DRB1*03:01:01:03   GCCCCTGTGT GCAGTGATGA CTACTCATGC AGAAGGTCAC ACAGCCAATA TTTAACACAG CCAGTATTTC ACACAGCTAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4486
DRB1*03:01:01:03   TATTTATTAG TGACATAGAA TATACCAGTT ATTACTCTAG GTCATGAGAA TGGAGTGATA AATAAAATGA ATCCGGTCGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4566
DRB1*03:01:01:03   CATCAGTATA TGCCATGTAA CATTTTGCAG TGACTGTGTA CCAGGCCTGT GAATTTCAGT ATGCAATTTC AATAATGATC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4646
DRB1*03:01:01:03   CTGCTGTATC TGTGGTGTTT AAAAACATAT ACATCTCTGG AATCTAAAAT TGAGAGGTTA TAAGTAAAAC CCAGTATTAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4726
DRB1*03:01:01:03   AAATTGAGTG CTGGAAATCA GATTGCAGTT TAAATCTGAG CATATAGAAA GTCCCTTTCT TCTATGTCAG CAGATGCCTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      4806
DRB1*03:01:01:03   TTGTGTGAGG TTTAGCTGGA CTGCATTATT AGACATAAAC CAGTGTTTCT GCCCTATGTT TTCAGAATGA CAATTCTTTA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
```

FIGURE 1 | Continued.

```
                                                                                                       4886
DRB1*03:01:01:03    TGAAACTCAT AGAAGAACAG AAGACAACTG CAAAATCATG ATGAAGATAG TAATTGCTTT AGAATTAAGG AATACAAAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       4966
DRB1*03:01:01:03    ATAATGTGAG CTGTAGTTAT AGGGATCATA AAAGTTTAAA TGGGAATGTA TTTGAGTATG TGATCAGTGC TAAGAAGAGT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5046
DRB1*03:01:01:03    CATCATTTAA TTTTACACTT AACAGTAATC TCGTGAGGAT TACGCTATTA TTAAATGCAT TTGATAGATT ACAAAAAGGC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5126
DRB1*03:01:01:03    TTATGGTTGG TAAAAATTGA CCCAAGTAGA AGAGATCATG TTTTTATTCA GGTTTTCTGA TTCTAGAGTT TGAGAGTTTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5206
DRB1*03:01:01:03    TCCATCATTA GTGAGTAGTG ACTATATTGT GTCTGAATTA TTGACAGAAT TTCTGATATT CATATGTACC AGGTTGTTTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5286
DRB1*03:01:01:03    TTAGAGTGGG GATAGAGATG CAAGGGCTGC TAGTTCCGAT GTATTGGGGA AACTTTCATT CATTTTGCAT TTATCATTTT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5366
DRB1*03:01:01:03    AAAAGTTCTG TATGTCTATA ATGGTCATGT GTTGAAGAAC ACAAGGAAGT ATTAAATCAC TCCTTCTTCT AAGGTTTGAC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5446
DRB1*03:01:01:03    TAGCAAGTTG GGCTAGAGTT ACCAAATAAA ATACATGTTC CTAGTGAAAT CTGAATTTCA GATACAAAAC CATAATTTAT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5526
DRB1*03:01:01:03    TGAAAATCCA AATTTAACTG GGCATCCTCT GGTTTTATTT GCCACATCTG TCAACCCTAA GTGTGACACA TGGACATGGA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5606
DRB1*03:01:01:03    TTACAGTGCT AACCATGCAA GCCACGGTGA CAGCAACTTC ACACATGTTT ATTTTTAACT TTCTCTGTAA GAAAGTGCTT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5686
DRB1*03:01:01:03    AGATAATTTA GGGATAAAAA GATAGACATT GCTTGATCCA GGGTGCACAC CTCTCTGCCA CCATTTCTAA AGGGCAAAGG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5766
DRB1*03:01:01:03    GAGATTTCTG CAGGTCTTGC TCACAGTCTG GGGAGCTGCT CATTTTTGTA AAGTGTCTGT ATGAGAATGT CATTTTCTTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5846
DRB1*03:01:01:03    GTTTCCTCCT TTCCGAGGGG ACTTGACTAC AAAACCAAGA GTTCTGCCTC TGGCCAAGGC TGGTAATTTG ATGCCTGCTA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       5926
DRB1*03:01:01:03    GTATTGTTGG GAGTGGGAGA CTGAAAGAAA TGAGTTAGTT GGGGCATTTA ACGGGAATAA AATAGCTGTG GTTGTGACTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6006
DRB1*03:01:01:03    ATTACTACAG ATAATTAGTG GACCAGTGGC AGAGAAATTA AGAAAAAAGA TGATGTGAAT GATAAATGAT ATGATTAGTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6086
DRB1*03:01:01:03    ACTGCTTGGT AAGGCAAGGA AATCATTAAA TCTTGGTTCT CATCAAGTTC ATTTTCTGGA AAGATAGCAC TGTATTGGGA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6166
DRB1*03:01:01:03    GCAGAATTCT ACAAAACCTT CTTTTTACAT AGGACCAAGA TTTTCAACAA ATATTTTTCA ATGCAATTCT CAGCTGCTCC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6246
DRB1*03:01:01:03    ATAACTAATA GTAGCTTGTT CAACACAGAT TTTTTCAGAT GATTCACACC TGTGGTACTT ACCCAGGGAT GGTTCACCAC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6326
DRB1*03:01:01:03    CCCTCCCTTC CCTCTCATCA TCGTTGGGGA ACGGTGACAA TGTTTGGAAC AATTTTTGGT TGTCACAAAC AGGGGTTTCT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6406
DRB1*03:01:01:03    TCTGATATTC AATGAGTAGA AGCCAGGGAC ACTGCTAGAG AACCCACAAT GTTCAGAACA GCCTCTGCCA TCAACAAGGA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6486
DRB1*03:01:01:03    ATTATCTGGT CCAAAATGTC AATAGTGCTG AGGCTAAGAG CACTGGTTCA CACTGTGCTC TTTCTGAAAA TTCTAGACTC
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6566
DRB1*03:01:01:03    ACATCTGTTA TACACTCACC ACACAGTTTA GTCTTTTATT TTTGCTTGTT TCATTATAAA CAATTAGACA GTTGCATAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6646
DRB1*03:01:01:03    TTCAACCACT TTCTTGTTGA ATCCATTTAG TCAATGCAAG CTCAATATTT TCATATTTAT TTTTTGCCTT ATGCAATATT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6726
DRB1*03:01:01:03    TTTCAACATT TTCATGAGTT GTCGGTCATC ACTATCTCTA TTAACTTTCA ACAACTTGCC CTTGTAAGTC ACAAATAGTG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6806
DRB1*03:01:01:03    ATGCTGCTGA AATTATTTCT CACTAACATG CCTCAGATTT CTGTAGTGAT TCTACATTTG ATATTATTCA CAATGTAAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6886
DRB1*03:01:01:03    TGCTTCTATT TATTCATTTC GCTTTTACCC AAGGATTATT TTTAAGTTAT TTTTGTCATT TTCACACTTC AAACATAAAG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       6966
DRB1*03:01:01:03    ACAAAAACAT CAAAAATATA GTGTTTTACA TATGTGCATA TTTTCACACA TATATGTATG TATATTTATA TGTATTGAAA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7046
DRB1*03:01:01:03    GTACAGAAGC ACATGTCACC AATAAGAGCT CTGAGACACC TTCGACCACT TACCCTTATC AGATGAGTTG TGGAAACAAG
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7126
DRB1*03:01:01:03    TTTTTTTAAC TGAATTTCTG AGCTTTGTGG ATTTAGAAAT GCAAAGGAAG GTTTGTGGAC ATTCACAGGG ATCATGATTT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7206
DRB1*03:01:01:03    TATTCTCCTT AAAACTCTTC TGTACTTTCC AATTGTCCTT AGTATAAATC CAAAATCCTA ACACCACCCA AGAGGCTTTT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7286
DRB1*03:01:01:03    CAATACCTGG CTCCTGTGAT TTCTCCGGGC TAATCTGTTA CCCTCCTTCC CCTCAGCCTC TCTGCTTTAG TGAACTTTCT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7366
DRB1*03:01:01:03    CCTAGTTTTT TGAAGAAGTT CATCAATTCA AGCTTTTGTA CATGGGATTT CCTAAACCTG AAATGTGCCT CCCGTTTTGT
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                       7446
DRB1*03:01:01:03    CCAAACAGAC ACGGGCTCCA CTCTGCCCCC TGGCTCACAC CTGCTTAACC TGTCAAGTCA CATCTGAACC GTCACTATTA
DRB1*03:19          ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
```

FIGURE 1 | Continued.

```
                                                                                                      7526
DRB1*03:01:01:03   AGAGGGTCCT TCTCTGGCAC CCTAATGTAA TTGAGATCAT CCTATTATTC TCTGTTCTAG AACTCCACAC TTCCGACATT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      7606
DRB1*03:01:01:03   TCTCATTCCT GTCTAAGCTC TTGTGTGTTT GGTGTTGGGC CATCACTTTC ACTGCTCTTT AAGCTCCCCC AGCGGAGTGG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      7686
DRB1*03:01:01:03   AGAGGTCTGT TTTCCCTCGT TTGGATTCCT AGAGGCAGCG CAGACCAGGC ACAAGGTCAG CACTAAGGAA GGGTTCAGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      7766
DRB1*03:01:01:03   GATGAACGCG GTGGGTGCTG TTTAAGGAAC CGGTAAACAT GTGGGATGAG AGAAGGAGCA GAGTGTCTTT GGGGTGGAGG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      7846
DRB1*03:01:01:03   CTCCCAGGAG GAGGCGGCGC GGGCTGCGGT GCTGGGCGGA TCCTCCTCCA GCTCCTGCTT GGAGGTCTCC AGAACAGGCT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      7926
DRB1*03:01:01:03   GGAGGTAGGG AGGGGGGTCC CAAAAGCCTG GGGATCAGAC GTGGTTTTCC CGCCTGGTCC CCCAGGCCCC CTTTCGCCTC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8006
DRB1*03:01:01:03   AGGAAGACAG AGGAGGAGCC CCTGGGCTGC TGGTGGTGGG CGTTGCGGCG GGGGCCGGTT AAGGTTCCCA GTGCCCGCAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8086
DRB1*03:01:01:03   CCCACCCAGG GAGCCCCGGA TGGCGGCGTC ACTGTCAGTG TCTTCTCAGG AGGCCGCCTG TGTGACTGGA TCGTTCGTGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                           |Exon2                                                                     8166
DRB1*03:01:01:03   CCCCACAGCA CGTTTCTTGG AGTACTCTAC GTCTGAGTGT CATTTCTTCA ATGGGACGGA GCGGGTGCGG TACCTGGACA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8246
DRB1*03:01:01:03   GATACTTCCA TAACCAGGAG GAGAACGTGC GCTTCGACAG CGACGTGGGG GAGTTCCGGG CGGTGACGGA GCTGGGGCGG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                      8280                                            8326
DRB1*03:01:01:03   CCTGATGCCG AGTACTGGAA CAGCCAGAAG GACCTCCTGG AGCAGAAGCG GGGCCGGGTG GACAACTACT GCAGACACAA
DRB1*03:19         ---------- ---------- ---------- ---A------ ---------- ---------- ---------- ----------
                                                            |Intron2                                  8406
DRB1*03:01:01:03   CTACGGGGTT GTGGAGAGCT TCACAGTGCA GCGGCGAGGT GAGCGCGGCG CGGGGCGGGG CCTGAGTCCC TGTGAGCTGG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8486
DRB1*03:01:01:03   GAATCTGAGT GTGTGTGTGT GTGTGTGTGT GTGTGTGTGT GTGTGTGAGA GAGAGAGACA GAGAGACAGA GAGAGAGAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8566
DRB1*03:01:01:03   GCCATCTGTG AGCATTTAGA ATCCTCTCTA TCCTGAGCAA GGAGTTCTGA GGGCACAGGT GTGTGTGTAG AGTGTGGATT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8646
DRB1*03:01:01:03   TGTCTGTGTC TGTGAGGCTG TTGTGGGAGG GGAGGCAGGA GGGGGCTGCT TCTTATTCTT GGAGGACTCT GTGGGGAGGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8726
DRB1*03:01:01:03   GACAAGGGAG GTGGGTGCGG GCGGCTGGAG AGAGAGGTGA CCTTGATTGT CTCGGGTCCT TAGAGATGCA GGGAAGGGAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8806
DRB1*03:01:01:03   ATGTAAGGGG TGTGTGGTTG GGGTGAAGGT TTAGGGGAGG AGAGCTGAGG GGTAAGGAAG GTTTGGGATA ATGTGAGGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8886
DRB1*03:01:01:03   GCCAGTTCCA GACTGTCCCT GGCACACACC CTTCATGTAA TCTCTGAAAT AAAAGTGTGT GCTGTTTGTT TGTAAAAGCA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      8966
DRB1*03:01:01:03   TTAGATTAAT TTCTAGGGGA ATTGAGGAGA CCTCTGAGGC ATCTCTGAAG CTTCTTTAGG TCTAAATTTC TTGCTAGTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9046
DRB1*03:01:01:03   TTTGTTTTTT ATTGTGTATA TTTTTACATA GTAGAAATGA CTGTGAAACT AACTTTTTGA ATTAAAGTTT TAACACAGTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9126
DRB1*03:01:01:03   ACTATTTTAT TATAATGCTA ATAGTTTTCT AGTAGTTACA TATTATTCTT TTATATATAA TAGTTGTGAC ACAACTTACC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9206
DRB1*03:01:01:03   TCACTTTCCA CTTTGTTGAC CTTTATTATG ACATTCACCA AAATTTGAAA ATGTATGTTT CTGGTTAATT TTTAATTTAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9286
DRB1*03:01:01:03   ATTTTTTTCA TTTATAATTC TTTTGAATTA TTTTGACCTA TTTATTGGCC AGTTTTAATA ACTGCTGTAA GAATTCCCTA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9366
DRB1*03:01:01:03   TTGTATTTGG TAGGGAATGG ACAATGATCT ACTGCCTAAT ATCTCGAGGG CTTAGTATTT TTCTCAGTGA CTTTGTGGGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9446
DRB1*03:01:01:03   TCTTTGTACT GTGAGATTAT TAACACTTTA TTGATATTTG ATTCAGCATT TGCTCCAGTT TGTGGTTTGT ATGTTGATTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9526
DRB1*03:01:01:03   TGAAAATTCT TTTCCATGTT AAGAATTTGA ACATTTTTAT ATAATAAAAT ATGTTGCAAA ATTTTTATTA ATGATTTACA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9606
DRB1*03:01:01:03   ATCCATCTTA AATCTGCCAT TTTGTGGTAT TGTTGTCTCC AGGTTTCTCC TTACTTCTAA AAAAAATTGC ATTTATTGAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9686
DRB1*03:01:01:03   AGTCTGCTAG TGTTAGGGAT TTTCCTGGGC ATAAGCACCC CAAGTGACGA GTCCCAGACA CTGCCTTAAT CCAAATGTGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9766
DRB1*03:01:01:03   TTCTGGAAAG AAAAATCATT TTACAATGAT AGGCCTAATA ATAATTAAGC TTGTGTTGCA TGGGAGATGC ATTGATCAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9846
DRB1*03:01:01:03   TAAATGTAAA TATAAGAACT TTCAAAACTA AAATGACGTT CCTTAATCCT TCTCTCTGCT TTATGACTCA TGCTTTTCTG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                      9926
DRB1*03:01:01:03   GGAAAGTAAA AATTTGGAGA ATCATTTCTG TCTGTCCCAC CTTCCCAGGG GCAGAACCAT TTCTGTGGTG TTCTAAGGTG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10006
DRB1*03:01:01:03   TGAGTGCATG GCGGTAGTAT TCCTAAAAAT TCATATTCGG TTTCGTCATG TACCCAACTC TGTCCCGTTA TCTATCAACA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10086
DRB1*03:01:01:03   TTGTTTTAAA TCATATATTT CTGTCAAGGT GTACAAGGAT GATAAATAGG TGCCAAGTGG AGCACCCAAG TGTGATGAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
```

FIGURE 1 | Continued.

```
                                                                                                     10166
DRB1*03:01:01:03   CCCCTCACAG TGGAATGGAG TGTGAAGCTT TATGACCTCA TAAATTGAAG GTTATCTTCA GGCATTGTTT TATATATTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10246
DRB1*03:01:01:03   ACATGCATTA ATCCTCATAT AATCCCAAGA GGTAAATTAG TATAATTATC CTTCATTATA GGTGACAAAG TTGAGACACA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10326
DRB1*03:01:01:03   GAAGAATCAA ACTCTTAAGG CAGACCTTGG ATTTGAACCA GGCAACCTGG CTCAGATATC AGTTTTAATT ACTACACTCT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10406
DRB1*03:01:01:03   GTACTTTCAA AGATTTGTAA ACACTTTGAC AATGCATGAC AATTTCAAGC TATGAAGAAA CAAACACAAT TTTTCACAAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10486
DRB1*03:01:01:03   ATCTCTCAAA TCTAATAGGT CCTCACTATC AAGATTAAGT TCCAGGCTGA TGACACTGTA AGGCCACATG GCCAGCTGTG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10566
DRB1*03:01:01:03   CTGGAGGCCT GGTCAAGGTC AGAGCCTGGG TTTGCAGAGA AGCAGACAAA CAGCCAAACA AGGAGACTTA CTCTGTCTTC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                       Exon3                                         10646
DRB1*03:01:01:03   ATGACTCATT CCCTCTACCT TTTTTCTCCT AGTCCATCCT AAGGTGACTG TGTATCCTTC AAAGACCCAG CCCCTGCAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10726
DRB1*03:01:01:03   ACCATAACCT CCTGGTCTGT TCTGTGAGTG GTTTCTATCC AGGCAGCATT GAAGTCAGGT GGTTCCGGAA TGGCCAGGAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10806
DRB1*03:01:01:03   GAGAAGACTG GGGTGGTGTC CACAGGCCTG ATCCACAATG GAGACTGGAC CTTCCAGACC CTGGTGATGC TGGAAACAGT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                    Intron3
DRB1*03:01:01:03   TCCTCGGAGT GGAGAGGTTT ACACCTGCCA AGTGGAGCAC CCAAGCGTGA CAAGCCCTCT CACAGTGGAA TGGAGTGAGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     10966
DRB1*03:01:01:03   AGCTTTCTGA CTTCATAAAT TTCTCACCCA CCAAGAAGGG GACTGTGCTC ATCCCTGAGT GTCAGGTTTC TCCTCTCCGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11046
DRB1*03:01:01:03   CATCCTATTT TCATTTGCTC CATGTTCTCA TCTCCATCAG CACAGGTCAC TGGGGGTAGC CCTGTAGGTG TTTCTAGAAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11126
DRB1*03:01:01:03   CACCTGTACC TCCTGGAGAA GCAGTCTCGC CTGCCAGGCA GGAGAGGCTG TCCCTCTTTT GAACCTCCCC ATGATGTCAC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11206
DRB1*03:01:01:03   AGGTCAGGGT CACCCACCCT CCCCGGGCTC CAGGCACTGC CTCTGGGTCT GAGACTGAGT TTCTGGTGCT GTTGATCTGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11286
DRB1*03:01:01:03   GTTATTTGTT GTGATCTGGG AAGAGGAGAA GTGTAGGGGC CTTCCTGACA TGAGGGGAGT CCAATCTCAG CTCTGCCTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11366
DRB1*03:01:01:03   TATTAGCTCT GTCACTCTAG ACAAACTACT TAGCCTCATT GAGTCTCAGG CTTTCTGTGG ATCAGATGTT GAACTCTTGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11446
DRB1*03:01:01:03   CTTACATCAA GGCTGTAATA TTTGAATGAG TTTGATGTCT GAACCTTGTA ACTGTTCAGT GTGATTTGAA ATCCTTTTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11526
DRB1*03:01:01:03   TCTCCAGAAA TGGCTAGTTA TTTTAGTTCT TGTGGGTCAG ACTTCTTCCC CATTTTCAAA GCTCTGAATC TTAGAGTCTC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                             Exon4                   11606
DRB1*03:01:01:03   AATTAAAGAG GTTCAATTTG GAATAAACAC TAAACCTGGC TTCCTCTCTC AGGAGCACGG TCTGAATCTG CACAGAGCAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11686
DRB1*03:01:01:03   GATGCTGAGT GGAGTCGGGG GCTTTGTGCT GGGCCTGCTC TTCCTTGGGG CCGGGCTGTT CATCTACTTC AGGAATCAGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                       Intron4                                                                       11766
DRB1*03:01:01:03   AAGGTGAGGA GCCTTTGGTA GCTGGCTCTC TCCATAGGCT TTTCTGGAGG AGGAACTATG GCTTTGCTGA GGTTAGTTCT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11846
DRB1*03:01:01:03   CAGTATATGA GTGGCCCTGA ATAAAGCCTT TCTTTCCCCA AACGGCTCTA ATGTCCTGCT AATCCAGAAA TCATCAGTGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     11926
DRB1*03:01:01:03   ATGGTTACTA TGTGAAAGCA TAATAGCTTG TGGCCTGCAG AGACAAGAGG AAGGTTAACA AGTAGGGGTC CTTTGGTTTG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12006
DRB1*03:01:01:03   AGATCTTGGA GCAGATTAAG GAAGAGCCAC TAAGACTAAT GGAATTACAC TGGATCCTGT GACAGACACT TTACCCTTCA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12086
DRB1*03:01:01:03   TGGGTCACAT GGTCTGTTTC TGCTCCTCTC TGCCCTGGCT GGTGTGGGTT GTAGTGACAG AGAACTCTCC GGTGGGAGAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                        Exon5
DRB1*03:01:01:03   CTGGGGCTGG GACATTGTGT TGGAAGACAG ATTTGCTTCC ATAAATTTTA AGTGTATATA TTTTCCTCTT TTTCCCAGGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                            Intron5                                                  12246
DRB1*03:01:01:03   CACTCTGGAC TTCAGCCAAG AGGTAATACC TTTTAATCCT CTTTTAGAAA CAGATACGGT TTCCCTAGTG AGAGGTGAAG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12326
DRB1*03:01:01:03   CCAGCTGGAC TTCTGGGTCG GGTAGGGACT TGCAGAACTT TCCTGTCTTA GGAGAGGTTT CTAAATGCAC CAATCAGTGC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12406
DRB1*03:01:01:03   TCTGTAAAAA CACACCAATT GGCACTCTGT GGCTAGATAG ATGTTTGTAA AATGGACTAA TCAGCACTCT GTAAAATGGA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12486
DRB1*03:01:01:03   GCAATCCACA CTCTGTAAAA TGGACCAATC AATGCTCTTT AAAATGGACC AATCAGCAGG ACATGGGCGG GGACAAATAA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12566
DRB1*03:01:01:03   GGGAATACAA GCTGGCCACC CCAGCCAGCA GCAGCAACCC GCTCAGGTCG CCTTCCATGC TGTGGAAGCT TTGTTCTTTT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12646
DRB1*03:01:01:03   GCTCTTCACA ATAAATCTTG CTGTTGCTCA CTCTTCGGGT CTGTGCCACC TTTAAGAGCT GTAACACTCA CTGTGAAGAT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12726
DRB1*03:01:01:03   TCGCGGCTTC ATTCTTGAAG TCAGCGAAAC CACGAACCCA CCGGAAGGAA CAAACTCTGG ACACACTAGA ATTGATGGTA
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

                                                                                                     12806
DRB1*03:01:01:03   GAGGTGATAA GGCATGAGAC AGAAATAATA GGAAAGACTT TGGATCCAAA TTTCTGATCA GGCAATTTAC ACCAAAACTC
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12886
DRB1*03:01:01:03   CTCCTCTCCA CTTAGAAAAG GCCTGTGCTC TGTGGGACTA TTGGCTCTGG GAGACTCAGG AACTTGTTTT TCTTCTTCCT
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                                                                                                     12966
DRB1*03:01:01:03   GCAGTGCTCT CATCTGAGTC CCTGAAAGAG AGGAAAAGAA ACTGTTAGTA GAGTCAGGTT GAAAACAACA CTCTCCTCTG
DRB1*03:19         ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
                               Exon6     12990
DRB1*03:01:01:03   TCTTTTGCAG GATTCCTGAG CTGA
DRB1*03:19         ---------- ---------- ----
```

FIGURE 1 | Continued.

The complete HLA typing of the donor is as follows: HLA-A*02:06:01, 24:02:01:01; -B*13:02:01, 39:01:01:01; -C*03:04, 06:02; -DQB1*02:01, 03:01; -DRB1*03:19, 11:01.

The sequence data has been submitted to GenBank and the IPD-IMGT/HLA Database (PQ811753-HWS10100124); the name was officially assigned by the World Health Organisation (WHO) Nomenclature Committee for Factors of the HLA System. This follows the agreed policy that, subject to the conditions stated in the most recent Nomenclature Report [6], names will be assigned to new sequences as they areidentified.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The genomic full-length sequence of the new allele is available at GenBank (accession number PQ811753) and submitted to the IPD-IMGT/HLA Database (submission number HWS10100124).

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