Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Immunology Letters 250 (2022) 7–14

Contents lists available at ScienceDirect

Immunology Letters

journal homepage: www.elsevier.com/locate/immlet

Correspondence

Sequence similarity suggests molecular mimicry-induced cardiovascular symptoms in multisystem inflammatory syndrome in children (MIS-C)

ARTICLE INFO

Keywords
Multisystem inflammatory syndrome in children
Severe acute respiratory syndrome coronavirus 2
Coronavirus disease 2019
Group A streptococcus
Molecular mimicry

To the Editor,

Cardiovascular symptoms are the hallmark of multisystem inflammatory syndrome in children (MIS-C) [1]. The pathophysiology includes cardiomyocyte invasion, endothelium injury and microvascular injury [2]. Molecular mimicry is a suspected mechanism of MIS-C pathogenesis after severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. Several 6-mer or 7-mer viral peptides were revealed to mimic human proteins, which may result in autoimmune reaction in various tissues [3,4]. However, potential cardiovascular molecular mimicking targets of SARS-CoV-2 are rarely reported.

Group A streptococcus (GAS) is the pathogen with bacterial components mimicking epitopes of human cardiovascular system [5]. We compared target protein sequences of GAS with SARS-CoV-2 via PSI-BLAST (https://www.ebi.ac.uk/Tools/sss/psiblast/) UniProtKB COVID19 database with default parameters. Human myosin heavy chain 6 (MYH6) and proteins in human heart valve proteomes, which were studied in GAS autoimmune reaction [6,7], were included. The FASTA formatted protein sequences were obtained by UniProt (https://www.uniprot.org/). Based on this strategy, we identified eight 6-mer or 7-mer consecutively identical peptides (Table 1).

The comparison with Basic Local Alignment Search Tool (BLAST) in SARS-CoV-2 studies needs more evidence to illustrate its autoimmune property [8]. We applied NetMHCcons-1.1 to confirm the class I human leukocyte antigen (HLA) affinity of the above-mentioned peptides [9]. The sequences with their three up- and three down- stream amino acids were input, and the "Peptide length" was set to "8–11mer peptides". All alleles in "HLA supertype representative" were selected. As the results in Table 1, some peptides have a certain affinity to different class I HLAs.

The A02, B35, C04 allele group combination has been considered to increase MIS-C susceptibility [10,11]. In our study, the peptide EKMVSLL mimicking MYH6 possesses strong binding affinity to the vast majority of the alleles in A02 and weak binding affinity to nearly 1/3 alleles in B35 and 3/4 alleles in C04 (Table 2), while other peptides do not show this property. Additionally, we found that the previously reported peptide IVDTVSA mimicking mitochondrial alanine-tRNA ligase (AARS2) also possesses a broad affinity to A02, B35, C04 allele group combination [4].

In conclusion, molecular mimicry may contribute to MIS-C cardiovascular symptoms similar to GAS targets.

Abbreviations: MIS-C, multisystem inflammatory syndrome in children; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; GAS, group A streptococcus; MYH6, human myosin heavy chain 6; BLAST, basic local alignment search tool; HLA, human leukocyte antigen; AARS2, mitochondrial alanine-tRNA ligase.

https://doi.org/10.1016/j.imlet.2022.07.002
Received 12 June 2022; Received in revised form 4 July 2022; Accepted 5 July 2022
Available online 7 July 2022

Table 1
Affinity of potential molecular mimicking peptides of SARS-CoV-2 to class I HLA supertype representatives.

Protein name human vs. SARS-CoV-2	Peptide mimicking*										HLA binding [1-log50k; peptide]**
MYH6 [UniProt: P13533] vs. R1AB [UniProt: P0DTD1]	877	**E**	**K**	**M**	**V**	**S**	**L**	**L**	883		HLA-A02:01 [0.671; **KMVSLL**SV]
		E	K	M	V	S	L	L			
	3909	**E**	**K**	**M**	**V**	**S**	**L**	**L**	3915		HLA-A02:01 [0.672; **KMVSLL**SVL]
											HLA-A26:01 [0.439; EAF**EKMVSL**] #
											HLA-A26:01 [0.398; EAF**EKMVSLL**] #
											HLA-B08:01 [0.411; EAF**EKMVSL**] #
											HLA-B39:01 [0.617; **EKMVSLL**SVL]
											HLA-B39:01 [0.405; **MVSLL**SVL] #
											HLA-B40:01 [0.656; F**EKMVSLL**SVL]
											HLA-B40:01 [0.605; F**EKMVSLL**] #
											HLA-B40:01 [0.390; F**EKMVSLL**SV] #
											HLA-B15:01 [0.629; **KMVSLL**SVL] #
											HLA-B15:01 [0.436; **KMVSLL**SV] #
MYH6 [UniProt: P13533] vs. R1AB [UniProt: P0DTD1]	1804	Q	**I**	**A**	**L**	**K**	**G**	**G**	**K**	1811	HLA-A03:01 [0.593; K**IALKGGK**]
		+	I	A	L	K	G	G	K		
	2757	K	**I**	**A**	**L**	**K**	**G**	**G**	**K**	2764	HLA-A03:01 [0.529; VTTK**IALK**] #
CAL1A1 [UniProt: P02452] vs. R1AB [UniProt: P0DTD1]	1116		**L**	**Q**	**G**	**P**	**P**	**G**	1121		HLA-A03:01 [0.529; T**LQGPPG**TGK] #
			L	Q	G	P	P	G			
	5604		**L**	**Q**	**G**	**P**	**P**	**G**	5609		HLA-A03:01 [0.426; ST**LQGPPG**TGK] #
COL14A1 [UniProt: Q05707] vs. R1AB [UniProt: P0DTD1]	666	**T**	**E**	**E**	**V**	**V**	**L**	**K**	672		HLA-A01:01 [0.209; L**TEEVVLK**] #
		T	E	E	V	V	L	K			
	753	**T**	**E**	**E**	**V**	**V**	**L**	**K**	759		HLA-A03:01 [0.488; VL**TEEVVLK**] #
											HLA-A26:01 [0.350; **EVVLK**TGDL] #
											HLA-B40:01 [0.377; **EEVVLK**TGDL] #
											HLA-B40:01 [0.509; **TEEVVLK**TGDL] #
COL14A1 [UniProt: Q05707] vs. R1AB [UniProt: P0DTD1]	1671		**Q**	**G**	**P**	**P**	**G**	**T**	1676		HLA-A03:01 [0.529; TL**QGPPGT**GK] #
			Q	G	P	P	G	T			
	5605		**Q**	**G**	**P**	**P**	**G**	**T**	5610		HLA-A03:01 [0.426; STL**QGPPGT**GK] #
COL6A2 [UniProt: P12110] vs. R1AB [UniProt: P0DTD1]	352		**G**	**P**	**D**	**G**	**Y**	**P**	357		N/A
			G	P	D	G	Y	P			
	192		**G**	**P**	**D**	**G**	**Y**	**P**	197		
CAL6A3 [UniProt: D9ZGF2] vs. R1AB [UniProt: P0DTD1]	912		**K**	**A**	**L**	**N**	**L**	**G**	917		HLA-B58:01 [0.732; **KALNLG**ETF]
			K	A	L	N	L	G			
	701		**K**	**A**	**L**	**N**	**L**	**G**	706		HLA-B15:01 [0.673; KL**KALNLG**ETF]
											HLA-B15:01 [0.562; **ALNLG**ETF] #
											HLA-B15:01 [0.462; **KALNLG**ETF] #
CAL6A3 [UniProt: D9ZGF2] vs. NCAP [UniProt: P0DTC9]	2200		**F**	**G**	**R**	**R**	**G**	**P**	2213		N/A
			F	G	R	R	G	P			
	274		**F**	**G**	**R**	**R**	**G**	**P**	287		

* Sequence of Human and SARS-CoV-2 are placed on the upper and lower sides respectively.
** HLA binding affinity is scored by 1-log50k; 6-mer or 7-mer consecutively identical peptides (bold) with three upstream and three downstream amino acids were included in scoring.
\# Weak binding.

Table 2
Affinity of peptide EKMVSLL to class I HLAs in A02, B35, C04 combination.

Allele groups	Alleles [1-log50k; peptide] * Strong binding		Weak binding
A02	HLA-A02:01 [0.672; **KMVSLLS**VL] [0.671; **KMVSLLS**V]	HLA-A02:139 [0.805; **KMVSLLS**V] [0.670; **KMVSLLS**VL]	HLA-A02:02 [0.618; **KMVSLLS**V]
	HLA-A02:02 [0.746; **KMVSLLS**VL]	HLA-A02:140 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:04 [0.474; **KMVSLLS**VL]
	HLA-A02:03 [0.789; **KMVSLLS**VL] [0.718; **KMVSLLS**V]	HLA-A02:141 [0.848; **KMVSLLS**V] [0.719; **KMVSLLS**VL]	HLA-A02:05 [0.564; **KMVSLLS**VL]
	HLA-A02:04 [0.667; **KMVSLLS**V]	HLA-A02:142 [0.822; **KMVSLLS**V] [0.662; **KMVSLLS**VL]	HLA-A02:06 [0.633; **KMVSLLS**VL]
	HLA-A02:05 [0.702; **KMVSLLS**V]	HLA-A02:144 [0.806; **KMVSLLS**V]	HLA-A02:07 [0.253; **KMVSLLS**VL]
	HLA-A02:06 [0.830; **KMVSLLS**V]	HLA-A02:145 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:08 [0.567; **KMVSLLS**V] [0.437; **KMVSLLS**VL]
	HLA-A02:07 [0.410; **KMVSLLS**V]	HLA-A02:146 [0.656; **KMVSLLS**V]	HLA-A02:10 [0.451; **KMVSLLS**VL]
	HLA-A02:09 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:147 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:14 [0.596; **KMVSLLS**VL]
	HLA-A02:10 [0.660; **KMVSLLS**V]	HLA-A02:148 [0.785; **KMVSLLS**V] [0.674; **KMVSLLS**VL]	HLA-A02:17 [0.366; **KMVSLLS**VL]
	HLA-A02:11 [0.940; **KMVSLLS**V] [0.863; **KMVSLLS**VL]	HLA-A02:149 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:18 [0.253; **KMVSLLS**VL]
	HLA-A02:12 [0.857; **KMVSLLS**V] [0.750; **KMVSLLS**VL]	HLA-A02:150 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:19 [0.544; **KMVSLLS**VL]
	HLA-A02:13 [0.851; **KMVSLLS**V] [0.746; **KMVSLLS**VL]	HLA-A02:151 [0.809; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:20 [0.568; **KMVSLLS**VL]
	HLA-A02:14 [0.739; **KMVSLLS**V]	HLA-A02:153 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:21 [0.609; **KMVSLLS**VL]
	HLA-A02:16 [0.869; **KMVSLLS**V] [0.738; **KMVSLLS**VL]	HLA-A02:154 [0.642; **KMVSLLS**V]	HLA-A02:28 [0.609; **KMVSLLS**VL]
	HLA-A02:17 [0.542; **KMVSLLS**V]	HLA-A02:155 [0.808; **KMVSLLS**V] [0.742; **KMVSLLS**VL]	HLA-A02:33 [0.486; **KMVSLLS**VL]
	HLA-A02:18 [0.410; **KMVSLLS**V]	HLA-A02:156 [0.665; **KMVSLLS**V]	HLA-A02:34 [0.567; **KMVSLLS**VL]
	HLA-A02:19 [0.777; **KMVSLLS**V]	HLA-A02:157 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:35 [0.574; **KMVSLLS**VL]
	HLA-A02:20 [0.753; **KMVSLLS**V]	HLA-A02:158 [0.876; **KMVSLLS**V] [0.770; **KMVSLLS**VL]	HLA-A02:36 [0.518; **KMVSLLS**VL]
	HLA-A02:21 [0.806; **KMVSLLS**V]	HLA-A02:159 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:37 [0.571; **KMVSLLS**VL]
	HLA-A02:22 [0.849; **KMVSLLS**V] [0.735; **KMVSLLS**VL]	HLA-A02:160 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:39 [0.547; **KMVSLLS**VL]
	HLA-A02:24 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:161 [0.842; **KMVSLLS**V] [0.720; **KMVSLLS**VL]	HLA-A02:45 [0.573; **KMVSLLS**VL]
	HLA-A02:25 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:162 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:46 [0.606; **KMVSLLS**VL]
	HLA-A02:26 [0.834; **KMVSLLS**V] [0.709; **KMVSLLS**VL]	HLA-A02:163 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:48 [0.615; **KMVSLLS**VL]
	HLA-A02:27 [0.810; **KMVSLLS**V] [0.677; **KMVSLLS**VL]	HLA-A02:164 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:51 [0.609; **KMVSLLS**VL]
	HLA-A02:28 [0.806; **KMVSLLS**V]	HLA-A02:165 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:54 [0.467; **KMVSLLS**VL]
	HLA-A02:29 [0.804; **KMVSLLS**V] [0.650; **KMVSLLS**VL]	HLA-A02:166 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:55 [0.329; EAF**EKMVSLL**] [0.315; EAF**EKMVSL**]
	HLA-A02:30 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:167 [0.829; **KMVSLLS**V] [0.701; **KMVSLLS**VL]	HLA-A02:56 [0.395; **KMVSLLS**VL]
	HLA-A02:31 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:168 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:57 [0.393; **KMVSLLS**VL]
	HLA-A02:33 [0.671; **KMVSLLS**V]	HLA-A02:170 [0.806; **KMVSLLS**V]	HLA-A02:60 [0.590; **KMVSLLS**VL]
	HLA-A02:34 [0.774; **KMVSLLS**V]	HLA-A02:171 [0.834; **KMVSLLS**V] [0.709; **KMVSLLS**VL]	HLA-A02:61 [0.609; **KMVSLLS**VL]
	HLA-A02:35 [0.790; **KMVSLLS**V]	HLA-A02:172 [0.702; **KMVSLLS**V]	HLA-A02:62 [0.465; **KMVSLLS**VL]
	HLA-A02:36 [0.741; **KMVSLLS**V]	HLA-A02:173 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:64 [0.578; **KMVSLLS**VL]
	HLA-A02:37 [0.770; **KMVSLLS**V]	HLA-A02:174 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:65 [0.367; **KMVSLLS**V] [0.342; **KMVSLLS**VL]
	HLA-A02:38 [0.825; **KMVSLLS**V] [0.724; **KMVSLLS**VL]	HLA-A02:175 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:72 [0.609; **KMVSLLS**VL]
	HLA-A02:39 [0.707; **KMVSLLS**V]	HLA-A02:176 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:78 [0.430; **KMVSLLS**VL]
	HLA-A02:40 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:177 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:79 [0.609; **KMVSLLS**VL]
	HLA-A02:41 [0.800; **KMVSLLS**V] [0.645; **KMVSLLS**VL]	HLA-A02:178 [0.693; **KMVSLLS**V]	HLA-A02:80 [0.513; **KMVSLLS**VL]
	HLA-A02:42 [0.814; **KMVSLLS**V] [0.687; **KMVSLLS**VL]	HLA-A02:179 [0.702; **KMVSLLS**V]	HLA-A02:84 [0.569; **KMVSLLS**VL]
	HLA-A02:44 [0.822; **KMVSLLS**V] [0.662; **KMVSLLS**VL]	HLA-A02:180 [0.806; **KMVSLLS**V]	HLA-A02:87 [0.593; **KMVSLLS**VL] [0.579; **KMVSLLS**V]
	HLA-A02:45 [0.697; **KMVSLLS**V]	HLA-A02:181 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:91 [0.609; **KMVSLLS**VL]
	HLA-A02:46 [0.718; **KMVSLLS**V]	HLA-A02:182 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:92 [0.606; **KMVSLLS**VL]
	HLA-A02:47 [0.819; **KMVSLLS**V] [0.758; **KMVSLLS**VL]		HLA-A02:99 [0.635; **KMVSLLS**VL]
	HLA-A02:48 [0.745; **KMVSLLS**V]		HLA-A02:101 [0.614; **KMVSLLS**VL]
	HLA-A02:49 [0.802; **KMVSLLS**V] [0.697; **KMVSLLS**VL]		HLA-A02:103 [0.333; **KMVSLLS**VL]
	HLA-A02:50 [0.875; **KMVSLLS**V] [0.780; **KMVSLLS**VL]		HLA-A02:106 [0.609; **KMVSLLS**VL]
	HLA-A02:51 [0.806; **KMVSLLS**V]		HLA-A02:108 [0.338; **KMVSLLS**VL]
	HLA-A02:52 [0.806; **KMVSLLS**V] [0.684; **KMVSLLS**VL]		HLA-A02:110 [0.462; **KMVSLLS**VL]
	HLA-A02:54 [0.719; **KMVSLLS**V]		HLA-A02:112 [0.424; **KMVSLLS**VL] [0.381; **KMVSLLS**V]
	HLA-A02:56 [0.567; **KMVSLLS**V]		HLA-A02:114 [0.461; **KMVSLLS**VL]
			HLA-A02:117 [0.558; **KMVSLLS**VL]
			HLA-A02:122 [0.615; **KMVSLLS**VL]
			HLA-A02:126 [0.609; **KMVSLLS**VL]
			HLA-A02:127 [0.601; **KMVSLLS**VL]
			HLA-A02:129 [0.531; **KMVSLLS**VL] [0.500; **KMVSLLS**V]
			HLA-A02:130 [0.253; **KMVSLLS**VL]
			HLA-A02:136 [0.582; **KMVSLLS**V]
			HLA-A02:137 [0.609; **KMVSLLS**VL]
			HLA-A02:143 [0.571; **KMVSLLS**V]
			HLA-A02:144 [0.609; **KMVSLLS**VL]
			HLA-A02:146 [0.504; **KMVSLLS**VL]
			HLA-A02:152 [0.367; **KMVSLLS**V] [0.342; **KMVSLLS**VL]
			HLA-A02:154 [0.494; **KMVSLLS**VL]
			HLA-A02:156 [0.499; **KMVSLLS**VL]
			HLA-A02:169 [0.620; **KMVSLLS**V] [0.434; **KMVSLLS**VL]
			HLA-A02:170 [0.609; **KMVSLLS**VL]

(*continued on next page*)

Table 2 (*continued*)

Allele groups	Alleles [1-log50k; peptide] * Strong binding		Weak binding
	HLA-A02:57 [0.532; **KMVSLLS**V]	HLA-A02:183 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:172 [0.564; **KMVSLLS**VL]
	HLA-A02:58 [0.798; **KMVSLLS**V] [0.703; **KMVSLLS**VL]	HLA-A02:184 [0.757; **KMVSLLS**V]	HLA-A02:178 [0.488; **KMVSLLS**VL]
	HLA-A02:59 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:185 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:179 [0.564; **KMVSLLS**VL]
	HLA-A02:60 [0.764; **KMVSLLS**V]	HLA-A02:186 [0.808; **KMVSLLS**V] [0.742; **KMVSLLS**VL]	HLA-A02:180 [0.609; **KMVSLLS**VL]
	HLA-A02:61 [0.806; **KMVSLLS**V]	HLA-A02:187 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:184 [0.626; **KMVSLLS**VL]
	HLA-A02:62 [0.702; **KMVSLLS**V]	HLA-A02:188 [0.704; **KMVSLLS**V]	HLA-A02:188 [0.548; **KMVSLLS**VL]
	HLA-A02:63 [0.808; **KMVSLLS**V] [0.742; **KMVSLLS**VL]	HLA-A02:189 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:191 [0.344; **KMVSLLS**VL]
	HLA-A02:64 [0.747; **KMVSLLS**V]	HLA-A02:190 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:195 [0.465; **KMVSLLS**VL]
	HLA-A02:66 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:191 [0.475; **KMVSLLS**V]	HLA-A02:217 [0.398; **KMVSLLS**VL]
	HLA-A02:67 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:192 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:219 [0.253; **KMVSLLS**VL]
	HLA-A02:68 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:193 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:224 [0.488; **KMVSLLS**VL]
	HLA-A02:69 [0.935; **KMVSLLS**V] [0.860; **KMVSLLS**VL]	HLA-A02:194 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:229 [0.581; **KMVSLLS**VL]
	HLA-A02:70 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:195 [0.608; **KMVSLLS**V]	HLA-A02:232 [0.564; **KMVSLLS**VL]
	HLA-A02:71 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:196 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:233 [0.635; **KMVSLLS**VL]
	HLA-A02:72 [0.806; **KMVSLLS**V]	HLA-A02:197 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:242 [0.547; **KMVSLLS**VL]
	HLA-A02:73 [0.837; **KMVSLLS**V] [0.725; **KMVSLLS**VL]	HLA-A02:198 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:244 [0.451; **KMVSLLS**VL]
	HLA-A02:74 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:199 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:246 [0.461; **KMVSLLS**VL]
	HLA-A02:75 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:200 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:247 [0.512; **KMVSLLS**VL]
	HLA-A02:76 [0.810; **KMVSLLS**V] [0.666; **KMVSLLS**VL]	HLA-A02:201 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:248 [0.609; **KMVSLLS**VL]
	HLA-A02:77 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:202 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:249 [0.576; **KMVSLLS**VL]
	HLA-A02:78 [0.654; **KMVSLLS**V]	HLA-A02:203 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:254 [0.605; **KMVSLLS**VL]
	HLA-A02:79 [0.806; **KMVSLLS**V]	HLA-A02:204 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:255 [0.160; **KMVSLLS**VL]
	HLA-A02:80 [0.677; **KMVSLLS**V]	HLA-A02:205 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:259 [0.609; **KMVSLLS**VL]
	HLA-A02:81 [0.688; **KMVSLLS**VL] [0.653; **KMVSLLS**V]	HLA-A02:206 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:261 [0.235; **KMVSLLS**VL]
	HLA-A02:84 [0.754; **KMVSLLS**V]	HLA-A02:207 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:264 [0.253; **KMVSLLS**VL]
	HLA-A02:85 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:208 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:86 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:209 [0.808; **KMVSLLS**V] [0.742; **KMVSLLS**VL]	
	HLA-A02:89 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:210 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:90 [0.844; **KMVSLLS**V] [0.695; **KMVSLLS**VL]	HLA-A02:211 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:91 [0.806; **KMVSLLS**V]	HLA-A02:212 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:92 [0.718; **KMVSLLS**V]	HLA-A02:213 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:93 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:214 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:95 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:215 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:96 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:216 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:97 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	HLA-A02:217 [0.553; **KMVSLLS**V]	
	HLA-A02:99 [0.791; **KMVSLLS**V]	HLA-A02:218 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:101 [0.779; **KMVSLLS**V]	HLA-A02:219 [0.410; **KMVSLLS**V]	
	HLA-A02:102 [0.808; **KMVSLLS**V] [0.742; **KMVSLLS**VL]	HLA-A02:220 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:103 [0.402; **KMVSLLS**V]	HLA-A02:221 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:104 [0.849; **KMVSLLS**V] [0.735; **KMVSLLS**VL]	HLA-A02:224 [0.719; **KMVSLLS**V]	
	HLA-A02:105 [0.835; **KMVSLLS**V] [0.721; **KMVSLLS**VL]	HLA-A02:228 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]	
	HLA-A02:105 [0.806; **KMVSLLS**V]		
	HLA-A02:107 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]		
	HLA-A02:108 [0.442; **KMVSLLS**V]		
	HLA-A02:109 [0.828; **KMVSLLS**V] [0.691; **KMVSLLS**VL]		
	HLA-A02:110 [0.548; **KMVSLLS**V]		
	HLA-A02:111 [0.828; **KMVSLLS**V] [0.691;		

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Table 2 (*continued*)

Allele groups	Alleles [1-log50k; peptide] * Strong binding		Weak binding
	KMVSLLSVL]	HLA-A02:229 [0.701; **KMVSLLS**V]	
	HLA-A02:114 [0.640; **KMVSLLS**V]	HLA-A02:230 [0.868; **KMVSLLS**V] [0.774;	
	HLA-A02:115 [0.808; **KMVSLLS**V] [0.742;	**KMVSLLS**VL]	
	KMVSLLSVL]	HLA-A02:231 [0.690; **KMVSLLS**V] [0.499;	
	HLA-A02:116 [0.817; **KMVSLLS**V] [0.680;	**KMVSLLS**VL]	
	KMVSLLSVL]	HLA-A02:232 [0.702; **KMVSLLS**V]	
	HLA-A02:117 [0.692; **KMVSLLS**V]	HLA-A02:233 [0.812; **KMVSLLS**V]	
	HLA-A02:118 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:234 [0.828; **KMVSLLS**V] [0.691;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:119 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:235 [0.828; **KMVSLLS**V] [0.691;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:120 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:236 [0.828; **KMVSLLS**V] [0.691;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:121 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:237 [0.828; **KMVSLLS**V] [0.691;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:122 [0.781; **KMVSLLS**V]	HLA-A02:238 [0.828; **KMVSLLS**V] [0.691;	
	HLA-A02:123 [0.828; **KMVSLLS**V] [0.691;	**KMVSLLS**VL]	
	KMVSLLSVL]	HLA-A02:239 [0.828; **KMVSLLS**V] [0.691;	
	HLA-A02:124 [0.688; **KMVSLLS**VL] [0.653;	**KMVSLLS**VL]	
	KMVSLLSV]	HLA-A02:240 [0.828; **KMVSLLS**V] [0.691;	
	HLA-A02:126 [0.806; **KMVSLLS**V]	**KMVSLLS**VL]	
	HLA-A02:127 [0.793; **KMVSLLS**V]	HLA-A02:241 [0.828; **KMVSLLS**V] [0.691;	
	HLA-A02:128 [0.890; **KMVSLLS**V] [0.758;	**KMVSLLS**VL]	
	KMVSLLSVL]	HLA-A02:242 [0.707; **KMVSLLS**V]	
	HLA-A02:130 [0.410; **KMVSLLS**V]	HLA-A02:243 [0.814; **KMVSLLS**V] [0.668;	
	HLA-A02:131 [0.870; **KMVSLLS**V] [0.772;	**KMVSLLS**VL]	
	KMVSLLSVL]	HLA-A02:244 [0.660; **KMVSLLS**V]	
	HLA-A02:132 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:245 [0.837; **KMVSLLS**V] [0.725;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:133 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:246 [0.640; **KMVSLLS**V]	
	KMVSLLSVL]	HLA-A02:247 [0.646; **KMVSLLS**V]	
	HLA-A02:134 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:248 [0.806; **KMVSLLS**V]	
	KMVSLLSVL]	HLA-A02:249 [0.708; **KMVSLLS**V]	
	HLA-A02:135 [0.594; **KMVSLLS**V] [0.594;	HLA-A02:251 [0.828; **KMVSLLS**V] [0.691;	
	KMVSLLSVL]	**KMVSLLS**VL]	
	HLA-A02:136 [0.621; **KMVSLLS**VL]	HLA-A02:252 [0.828; **KMVSLLS**V] [0.691;	
	HLA-A02:137 [0.806; **KMVSLLS**V]	**KMVSLLS**VL]	
	HLA-A02:138 [0.828; **KMVSLLS**V] [0.691;	HLA-A02:253 [0.868; **KMVSLLS**V] [0.774;	
	KMVSLLSVL]	**KMVSLLS**VL]	
		HLA-A02:254 [0.759; **KMVSLLS**V]	
		HLA-A02:255 [0.319; **KMVSLLS**V]	
		HLA-A02:256 [0.828; **KMVSLLS**V] [0.691;	
		KMVSLLSVL]	
		HLA-A02:257 [0.828; **KMVSLLS**V] [0.691;	
		KMVSLLSVL]	
		HLA-A02:258 [0.868; **KMVSLLS**V] [0.774;	
		KMVSLLSVL]	
		HLA-A02:259 [0.806; **KMVSLLS**V]	
		HLA-A02:260 [0.828; **KMVSLLS**V] [0.691;	
		KMVSLLSVL]	
		HLA-A02:261 [0.369; **KMVSLLS**V]	
		HLA-A02:262 [0.830; **KMVSLLS**V] [0.702;	
		KMVSLLSVL]	
		HLA-A02:263 [0.839; **KMVSLLS**V] [0.705;	
		KMVSLLSVL]	
		HLA-A02:264 [0.868; **KMVSLLS**V] [0.774;	
		KMVSLLSVL]	
		HLA-A02:265 [0.410; **KMVSLLS**V]	
		HLA-A02:266 [0.828; **KMVSLLS**V] [0.691;	
		KMVSLLSVL]	
B35	N/A		HLA-B35:02 [0.341; EAF**EKMVSL**] [0.293; EAF**EKMVSLL**]
			HLA-B35:03 [0.171; EAF**EKMVSL**]
			HLA-B35:04 [0.341; EAF**EKMVSL**] [0.293; EAF**EKMVSLL**]
			HLA-B35:06 [0.265; EAF**EKMVSL**] [0.220; EAF**EKMVSLL**]
			HLA-B35:09 [0.341; EAF**EKMVSL**] [0.293; EAF**EKMVSLL**]
			HLA-B35:11 [0.448; EAF**EKMVSL**]
			HLA-B35:12 [0.341; EAF**EKMVSL**] [0.293; EAF**EKMVSLL**]
			HLA-B35:18 [0.225; EAF**EKMVSL**]
			HLA-B35:09 [0.465; EAF**EKMVSL**] [0.429; EAF**EKMVSLL**]

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Table 2 (*continued*)

Allele groups	Alleles [1-log50k; peptide] * Strong binding	Weak binding
		HLA-B35:22 [0.376; EAF**EKMVSL**] [0.296; EAF**EKMVSLL**] HLA-B35:25 [0.430; EAF**EKMVSL**] HLA-B35:26 [0.344; **EKMVSLL**SVL] HLA-B35:28 [0.499; **KMVSLL**SVL] HLA-B35:29 [0.508; EAF**EKMVSL**] [0.435; EAF**EKMVSLL**] HLA-B35:31 [0.395; EAF**EKMVSL**] HLA-B35:33 [0.258; EAF**EKMVSL**] [0.197; EAF**EKMVSLL**] HLA-B35:34 [0.332; EAF**EKMVSL**] [0.271; EAF**EKMVSLL**] HLA-B35:35 [0.471; EAF**EKMVSL**] [0.430; EAF**EKMVSLL**] HLA-B35:36 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:38 [0.205; EAF**EKMVSL**] HLA-B35:39 [0.332; EAF**EKMVSL**] [0.271; EAF**EKMVSLL**] HLA-B35:44 [0.385; EAF**EKMVSL**] [0.323; EAF**EKMVSLL**] HLA-B35:47 [0.465; EAF**EKMVSL**] [0.429; EAF**EKMVSLL**] HLA-B35:49 [0.492; EAF**EKMVSL**] [0.442; EAF**EKMVSLL**] HLA-B35:55 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:56 [0.215; EAF**EKMVSL**] HLA-B35:59 [0.265; EAF**EKMVSL**] [0.220; EAF**EKMVSLL**] HLA-B35:63 [0.531; F**EKMVSLL**SVL] [0.479; F**EKMVSLL**] [0.421; F**EKMVSLL**SV] HLA-B35:69 [0.519; EAF**EKMVSL**] [0.459; EAF**EKMVSLL**] HLA-B35:70 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:74 [0.247; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:75 [0.282; EAF**EKMVSL**] [0.220; EAF**EKMVSLL**] HLA-B35:81 [0.355; EAF**EKMVSL**] [0.309; EAF**EKMVSLL**] HLA-B35:83 [0.341; EAF**EKMVSL**] [0.293; EAF**EKMVSLL**] HLA-B35:84 [0.248; EAF**EKMVSL**] [0.200; **EKMVSLL**SVL] [0.196; F**EKMVSLL**SVL] [0.192; EAF**EKMVSLL**] HLA-B35:85 [0.135; EAF**EKMVSLL**] [0.125; EAF**EKMVSL**] HLA-B35:87 [0.373; EAF**EKMVSL**] HLA-B35:88 [0.336; EAF**EKMVSL**] [0.284; EAF**EKMVSLL**] HLA-B35:92 [0.456; EAF**EKMVSL**] [0.391; EAF**EKMVSLL**] HLA-B35:93 [0.447; EAF**EKMVSL**] HLA-B35:95 [0.208; **EKMVSLL**SVL] [0.190; EAF**EKMVSL**] [0.177; EAF**EKMVSLL**] HLA-B35:96 [0.321; EAF**EKMVSL**] [0.238; EAF**EKMVSLL**] HLA-B35:98 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:106 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:109 [0.287; EAF**EKMVSL**] [0.226; EAF**EKMVSLL**] HLA-B35:117 [0.381; EAF**EKMVSL**] HLA-B35:127 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:128 [0.256; EAF**EKMVSL**] [0.196; EAF**EKMVSLL**] HLA-B35:136 [0.412; EAF**EKMVSL**] [0.310; EAF**EKMVSLL**]
C04	N/A	

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Table 2 (*continued*)

Allele groups	Alleles [1-log50k; peptide] * Strong binding	Weak binding
		HLA-C04:01 [0.197; AF**EKMVSLL**] [0.172; F**EKMVSLL**]
		HLA-C04:05 [0.163; AF**EKMVSLL**]
		HLA-C04:07 [0.163; AF**EKMVSLL**]
		HLA-C04:08 [0.168; AF**EKMVSLL**]
		HLA-C04:10 [0.177; AF**EKMVSLL**]
		HLA-C04:12 [0.163; AF**EKMVSLL**]
		HLA-C04:14 [0.125; AF**EKMVSLL**]
		HLA-C04:18 [0.163; AF**EKMVSLL**]
		HLA-C04:19 [0.163; AF**EKMVSLL**]
		HLA-C04:20 [0.163; AF**EKMVSLL**]
		HLA-C04:23 [0.141; AF**EKMVSLL**]
		HLA-C04:24 [0.163; AF**EKMVSLL**]
		HLA-C04:25 [0.163; AF**EKMVSLL**]
		HLA-C04:26 [0.163; AF**EKMVSLL**]
		HLA-C04:27 [0.163; AF**EKMVSLL**]
		HLA-C04:28 [0.163; AF**EKMVSLL**]
		HLA-C04:30 [0.163; AF**EKMVSLL**]
		HLA-C04:32 [0.180; AF**EKMVSLL**]
		HLA-C04:33 [0.163; AF**EKMVSLL**]
		HLA-C04:35 [0.163; AF**EKMVSLL**]
		HLA-C04:37 [0.221; AF**EKMVSLL**]
		HLA-C04:38 [0.163; AF**EKMVSLL**]
		HLA-C04:39 [0.163; AF**EKMVSLL**]
		HLA-C04:40 [0.141; AF**EKMVSLL**]
		HLA-C04:41 [0.163; AF**EKMVSLL**]
		HLA-C04:42 [0.151; AF**EKMVSLL**]
		HLA-C04:43 [0.163; AF**EKMVSLL**]
		HLA-C04:44 [0.163; AF**EKMVSLL**]
		HLA-C04:45 [0.163; AF**EKMVSLL**]
		HLA-C04:46 [0.163; AF**EKMVSLL**]
		HLA-C04:47 [0.163; AF**EKMVSLL**]
		HLA-C04:48 [0.178; AF**EKMVSLL**]
		HLA-C04:49 [0.198; AF**EKMVSLL**]
		HLA-C04:50 [0.163; AF**EKMVSLL**]
		HLA-C04:51 [0.163; AF**EKMVSLL**]
		HLA-C04:52 [0.163; AF**EKMVSLL**]
		HLA-C04:53 [0.163; AF**EKMVSLL**]
		HLA-C04:54 [0.277; AF**EKMVSLL**]
		HLA-C04:56 [0.163; AF**EKMVSLL**]
		HLA-C04:57 [0.163; AF**EKMVSLL**]
		HLA-C04:60 [0.163; AF**EKMVSLL**]
		HLA-C04:61 [0.154; AF**EKMVSLL**]
		HLA-C04:62 [0.163; AF**EKMVSLL**]
		HLA-C04:63 [0.163; AF**EKMVSLL**]
		HLA-C04:64 [0.163; AF**EKMVSLL**]
		HLA-C04:65 [0.163; AF**EKMVSLL**]
		HLA-C04:66 [0.163; AF**EKMVSLL**]
		HLA-C04:67 [0.163; AF**EKMVSLL**]
		HLA-C04:69 [0.203; **KMVSLLS**V]
		HLA-C04:70 [0.163; AF**EKMVSLL**]

* HLA binding affinity is scored by 1-log50k; EKMVSLL (bold) with three upstream and three downstream amino acids were included in scoring. Records were excluded when amino acid length in EKMVSLL is shorter than 6.

Funding

This work was supported in part by National Natural Science Foundation of China (81873462).

Declaration of Competing Interest

None.

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