Web-based Supplementary Materials for "Semiparametric Analysis of Correlated and Interval-Censored Event-History Data"

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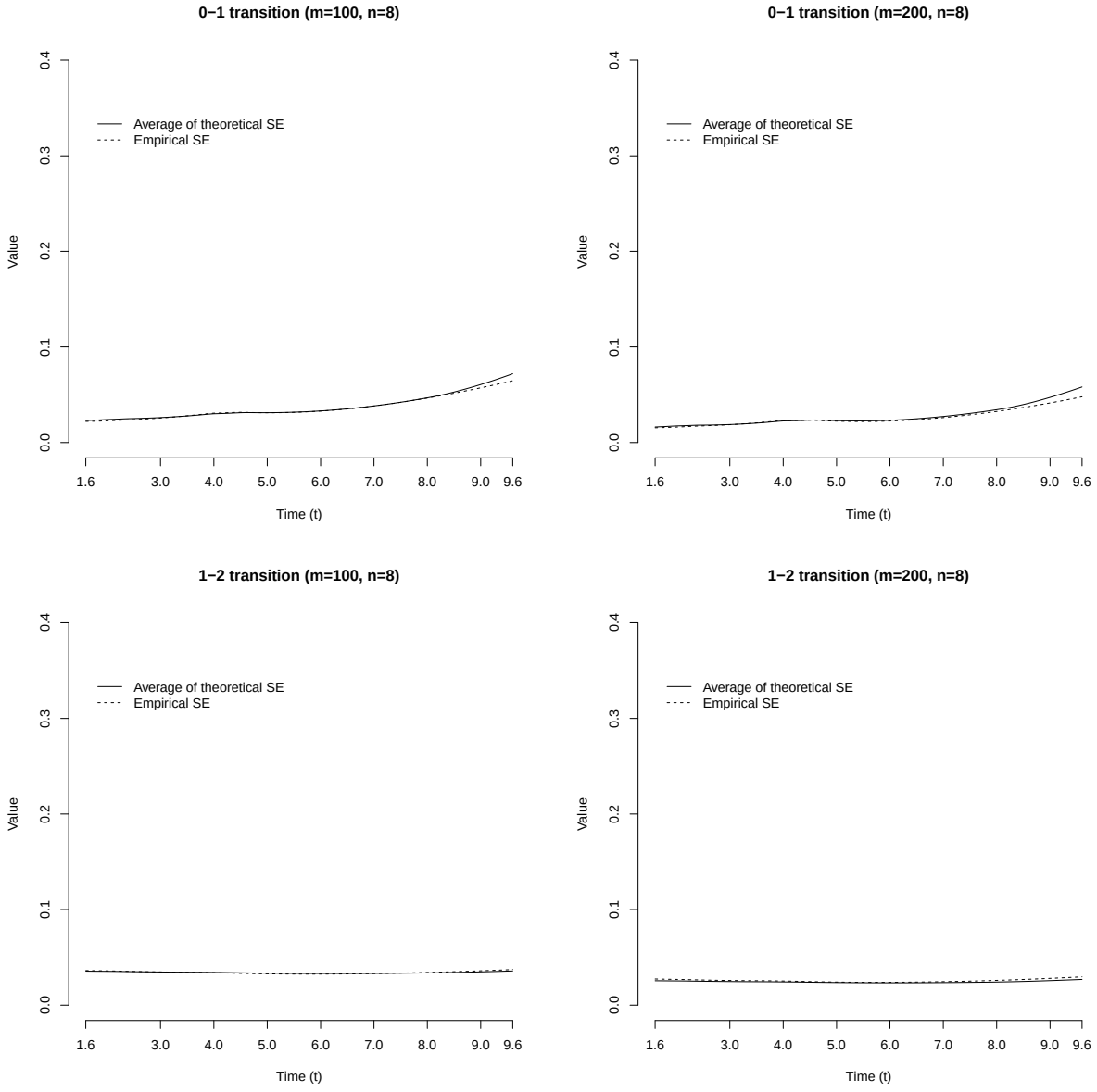
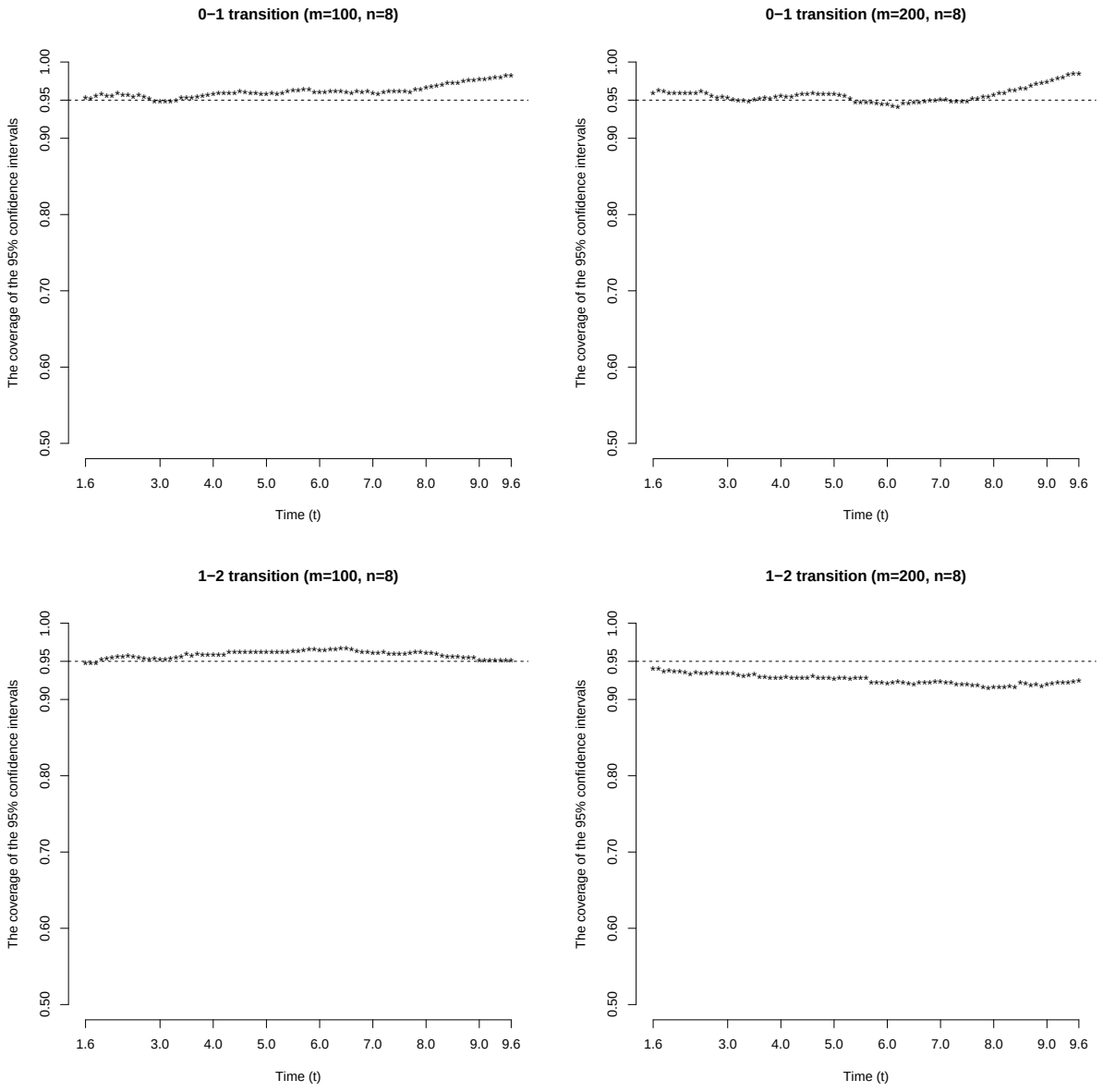
Web Appendix A: Computational Details

The simulation study and data analysis in this paper were performed using the R statistical software (R 3.1.1). We used the `optim` function with the BFGS quasi-Newton option to maximize $l_h(\mathbf{Y}, \boldsymbol{\gamma}|\boldsymbol{\zeta}, \boldsymbol{\nu}^{(s+1)})$ w.r.t. $\boldsymbol{\eta}$ and $l_h(\mathbf{Y}, \boldsymbol{\gamma}^{(s)}|\boldsymbol{\zeta}^{(s)}, \boldsymbol{\nu}) - 2^{-1}\log|-H_h(\boldsymbol{\eta}^{(s)}; \mathbf{Y}, \boldsymbol{\nu})| - (N_{01}+1)\log\theta_{01} - (N_{12}+1)\log\theta_{12}$ w.r.t. $\boldsymbol{\nu}$. In particular, the limited-memory BFGS method was used to maximize $l_h(\mathbf{Y}, \boldsymbol{\gamma}|\boldsymbol{\zeta}, \boldsymbol{\nu}^{(s+1)})$, since it is more suited for the maximization of a function w.r.t. a large number of arguments. We computed the gradient and the hessian matrix of $l_h(\mathbf{Y}, \boldsymbol{\gamma}|\boldsymbol{\zeta}, \boldsymbol{\nu})$ w.r.t $\boldsymbol{\eta}$ using their analytic expressions. In evaluating those expressions, we sometimes encountered the situation where the denominator of a fraction was so close to zero that the software set to zero. Under such a situation, we simply replaced the denominator with 10^{-40}.

Web Appendix B: Additional Simulation Results



Web Figure 1: The comparison between the empirical standard errors and the average theoretical standard errors of the baseline intensity estimators



Web Figure 2: The empirical coverage probabilities of the 95% pointwise confidence intervals for the baseline intensities

Web Appendix C: Additional DDHP Data Analysis Results

Web Table 1: The regression parameter estimates for the saturated model based on the DDHP data

Gender	Molar Type	Quadrant	Transition	Parameter	Estimate	SE	p-value
Male	1st molar	Upper right tooth (54)	$0 \to 1$	$\beta_{1,1,1,01}$	The reference category		
			$1 \to 2$	$\beta_{1,1,1,12}$			
		Upper left tooth (64)	$0 \to 1$	$\beta_{1,1,2,01}$	-0.0200	0.1147	0.8614
			$1 \to 2$	$\beta_{1,1,2,12}$	0.1208	0.1681	0.4724
		Lower left tooth (74)	$0 \to 1$	$\beta_{1,1,3,01}$	0.3410	0.1118	0.0023
			$1 \to 2$	$\beta_{1,1,3,12}$	0.2174	0.1591	0.1719
		Lower right tooth (84)	$0 \to 1$	$\beta_{1,1,4,01}$	0.3580	0.1125	0.0015
			$1 \to 2$	$\beta_{1,1,4,12}$	0.2139	0.1581	0.1762
	2nd molar	Upper right tooth (55)	$0 \to 1$	$\beta_{1,2,1,01}$	1.4652	0.1075	< 0.0001
			$1 \to 2$	$\beta_{1,2,1,12}$	-0.3856	0.1504	0.0104
		Upper left tooth (65)	$0 \to 1$	$\beta_{1,2,2,01}$	1.5330	0.1081	< 0.0001
			$1 \to 2$	$\beta_{1,2,2,12}$	-0.3883	0.1498	0.0095
		Lower left tooth (75)	$0 \to 1$	$\beta_{1,2,3,01}$	1.4061	0.1078	< 0.0001
			$1 \to 2$	$\beta_{1,2,3,12}$	-0.3307	0.1517	0.0293
		Lower right tooth (85)	$0 \to 1$	$\beta_{1,2,4,01}$	1.4426	0.1076	< 0.0001
			$1 \to 2$	$\beta_{1,2,4,12}$	-0.3115	0.1496	0.0373
Female	1st molar	Upper right tooth (54)	$0 \to 1$	$\beta_{2,1,1,01}$	0.1274	0.1617	0.4306
			$1 \to 2$	$\beta_{2,1,1,12}$	0.0096	0.1624	0.9530
		Upper left tooth (64)	$0 \to 1$	$\beta_{2,1,2,01}$	0.2324	0.1608	0.1484
			$1 \to 2$	$\beta_{2,1,2,12}$	0.0483	0.1582	0.7599
		Lower left tooth (74)	$0 \to 1$	$\beta_{2,1,3,01}$	0.1805	0.1612	0.2628
			$1 \to 2$	$\beta_{2,1,3,12}$	0.2544	0.1584	0.1083
		Lower right tooth (84)	$0 \to 1$	$\beta_{2,1,4,01}$	0.2326	0.1606	0.1477
			$1 \to 2$	$\beta_{2,1,4,12}$	0.2647	0.1581	0.0941
	2nd molar	Upper right tooth (55)	$0 \to 1$	$\beta_{2,2,1,01}$	1.5512	0.1569	< 0.0001
			$1 \to 2$	$\beta_{2,2,1,12}$	-0.3185	0.1467	0.0300
		Upper left tooth (65)	$0 \to 1$	$\beta_{2,2,2,01}$	1.6083	0.1573	< 0.0001
			$1 \to 2$	$\beta_{2,2,2,12}$	-0.2099	0.1457	0.1496
		Lower left tooth (75)	$0 \to 1$	$\beta_{2,2,3,01}$	1.8307	0.1579	< 0.0001
			$1 \to 2$	$\beta_{2,2,3,12}$	-0.2834	0.1454	0.0512
		Lower right tooth (85)	$0 \to 1$	$\beta_{2,2,4,01}$	1.8725	0.1580	< 0.0001
			$1 \to 2$	$\beta_{2,2,4,12}$	-0.3777	0.1458	0.0096

Web Table 2: The detailed comparisons associated with the significant non-symmetries in caries transition intensity found in Table 4.

Gender	Transition	Teeth Compared		Wald Test Statistic (p-value)
Male	$0 \to 1$	Upper right first	Lower right first	-3.181 (0.0007)
		Upper left first	Lower left first	-3.200 (0.0007)
		Upper right second	Lower right second	0.236 (0.4068)
		Upper left second	Lower left second	1.323 (0.0928)
	$0 \to 1$	Upper right first	Upper right second	-13.625 (< 0.0001)
		Upper left first	Upper left second	-14.212 (< 0.0001)
		Lower right first	Lower right second	-10.382 (< 0.0001)
		Lower left first	Lower left second	-10.261 (< 0.0001)
	$1 \to 2$	Upper right first	Upper right second	2.563 (0.0052)
		Upper left first	Upper left second	3.443 (0.0003)
		Lower right first	Lower right second	3.864 (0.0001)
		Lower left first	Lower left second	3.934 (< 0.0001)
Female	$0 \to 1$	Upper right first	Lower right first	-0.988 (0.1592)
		Upper left first	Lower left first	0.494 (0.3015)
		Upper right second	Lower right second	-3.489 (0.0002)
		Upper left second	Lower left second	-2.423 (0.0077)
	$0 \to 1$	Upper right first	Upper right second	-14.055 (< 0.0001)
		Upper left first	Upper left second	-13.681 (< 0.0001)
		Lower right first	Lower right second	-16.200 (< 0.0001)
		Lower left first	Lower left second	-16.168 (< 0.0001)
	$1 \to 2$	Upper right first	Upper right second	2.424 (0.0077)
		Upper left first	Upper left second	2.000 (0.0227)
		Lower right first	Lower right second	4.966 (< 0.0001)
		Lower left first	Lower left second	4.167 (< 0.0001)

Web Appendix D: Additional DDHP Data Analysis Results Assuming ρ Being Gender-Specific

Web Table 3: The regression parameter estimates for the saturated model based on the DDHP data

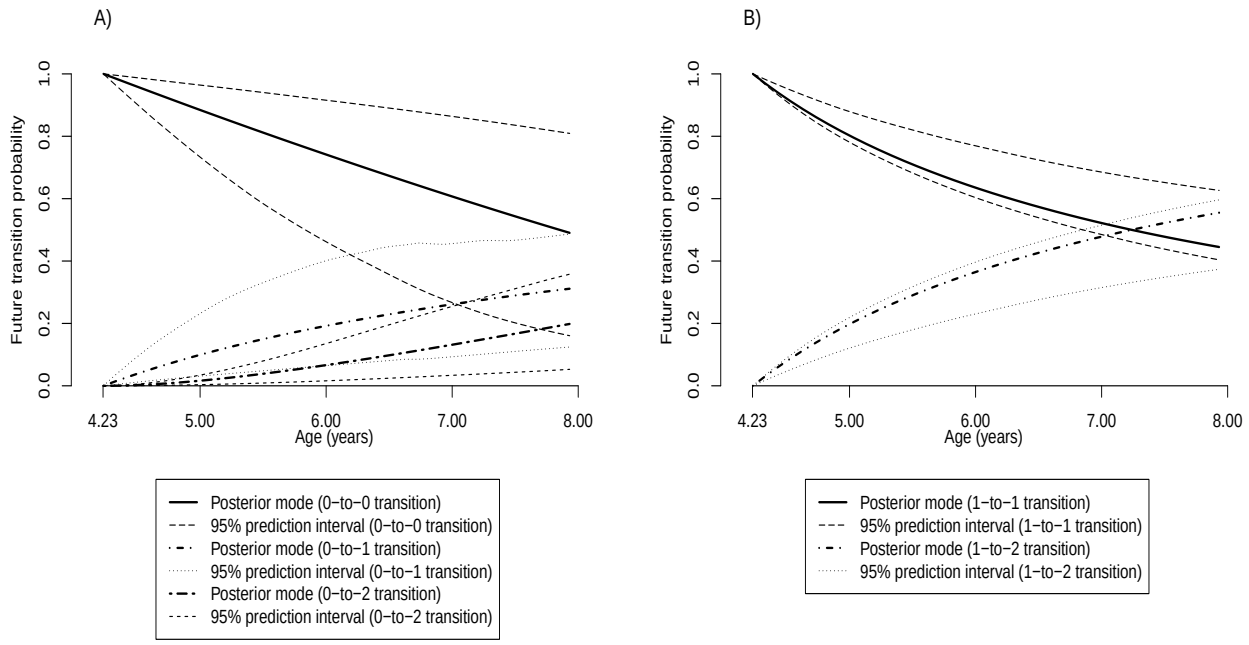
Gender	Molar Type	Quadrant	Transition	Parameter	Estimate	SE	p-value
Male	1st molar	Upper right tooth (54)	$0 \to 1$	$\beta_{1,1,1,01}$	The reference category		
			$1 \to 2$	$\beta_{1,1,1,12}$			
		Upper left tooth (64)	$0 \to 1$	$\beta_{1,1,2,01}$	-0.0216	0.1147	0.8506
			$1 \to 2$	$\beta_{1,1,2,12}$	0.1192	0.168	0.4781
		Lower left tooth (74)	$0 \to 1$	$\beta_{1,1,3,01}$	0.3386	0.1118	0.0025
			$1 \to 2$	$\beta_{1,1,3,12}$	0.2177	0.159	0.1709
		Lower right tooth (84)	$0 \to 1$	$\beta_{1,1,4,01}$	0.3556	0.1125	0.0016
			$1 \to 2$	$\beta_{1,1,4,12}$	0.2131	0.158	0.1775
	2nd molar	Upper right tooth (55)	$0 \to 1$	$\beta_{1,2,1,01}$	1.4635	0.1075	< 0.0001
			$1 \to 2$	$\beta_{1,2,1,12}$	-0.3788	0.1504	0.0118
		Upper left tooth (65)	$0 \to 1$	$\beta_{1,2,2,01}$	1.5315	0.1081	< 0.0001
			$1 \to 2$	$\beta_{1,2,2,12}$	-0.3816	0.1497	0.0108
		Lower left tooth (75)	$0 \to 1$	$\beta_{1,2,3,01}$	1.4042	0.1078	< 0.0001
			$1 \to 2$	$\beta_{1,2,3,12}$	-0.3242	0.1516	0.0326
		Lower right tooth (85)	$0 \to 1$	$\beta_{1,2,4,01}$	1.4407	0.1076	< 0.0001
			$1 \to 2$	$\beta_{1,2,4,12}$	-0.3054	0.1495	0.0411
Female	1st molar	Upper right tooth (54)	$0 \to 1$	$\beta_{2,1,1,01}$	0.1258	0.1616	0.4361
			$1 \to 2$	$\beta_{2,1,1,12}$	0.0293	0.1623	0.8567
		Upper left tooth (64)	$0 \to 1$	$\beta_{2,1,2,01}$	0.2306	0.1607	0.1512
			$1 \to 2$	$\beta_{2,1,2,12}$	0.0680	0.1581	0.6672
		Lower left tooth (74)	$0 \to 1$	$\beta_{2,1,3,01}$	0.1788	0.1611	0.2670
			$1 \to 2$	$\beta_{2,1,3,12}$	0.2740	0.1583	0.0835
		Lower right tooth (84)	$0 \to 1$	$\beta_{2,1,4,01}$	0.2308	0.1605	0.1504
			$1 \to 2$	$\beta_{2,1,4,12}$	0.2839	0.158	0.0723
	2nd molar	Upper right tooth (55)	$0 \to 1$	$\beta_{2,2,1,01}$	1.5512	0.1568	< 0.0001
			$1 \to 2$	$\beta_{2,2,1,12}$	-0.2991	0.1466	0.0413
		Upper left tooth (65)	$0 \to 1$	$\beta_{2,2,2,01}$	1.6082	0.1571	< 0.0001
			$1 \to 2$	$\beta_{2,2,2,12}$	-0.1906	0.1456	0.1904
		Lower left tooth (75)	$0 \to 1$	$\beta_{2,2,3,01}$	1.8309	0.1575	< 0.0001
			$1 \to 2$	$\beta_{2,2,3,12}$	-0.2635	0.1453	0.0697
		Lower right tooth (85)	$0 \to 1$	$\beta_{2,2,4,01}$	1.8726	0.1575	< 0.0001
			$1 \to 2$	$\beta_{2,2,4,12}$	-0.3576	0.1457	0.0141

Web Table 4: The Wald test statistics (p-value) for the three types of symmetry in caries transition intensity stratified by gender and transition type.

Gender	Test for symmetry	Transition	
		0 to 1	1 to 2
Male	Upper vs Lower	21.71(0.0002)	2.74(0.6025)
	Right vs Left	0.72(0.9490)	0.53(0.9709)
	First molar vs Second molar	538.41(< 0.0001)	47.08(< 0.0001)
Female	Upper vs Lower	19.05(0.0008)	5.73(0.2202)
	Right vs Left	1.85(0.7625)	1.66(0.7976)
	First molar vs Second molar	779.47(< 0.0001)	51.20(0.0004)

Web Table 5: The detailed comparisons associated with the significant non-symmetries in caries transition intensity found in Web Table 4.

Gender	Transition	Teeth Compared		Wald Test Statistic (p-value)
Male	$0 \to 1$	Upper right first	Lower right first	-3.160 (0.0008)
		Upper left first	Lower left first	-3.193 (0.0007)
		Upper right second	Lower right second	0.238 (0.4060)
		Upper left second	Lower left second	1.327 (0.0923)
	$0 \to 1$	Upper right first	Upper right second	-13.611 (< 0.0001)
		Upper left first	Upper left second	-14.208 (< 0.0001)
		Lower right first	Lower right second	-10.381 (< 0.0001)
		Lower left first	Lower left second	-10.261 (< 0.0001)
	$1 \to 2$	Upper right first	Upper right second	2.519 (0.0059)
		Upper left first	Upper left second	3.388 (0.0004)
		Lower right first	Lower right second	3.815 (0.0001)
		Lower left first	Lower left second	3.891 (< 0.0001)
Female	$0 \to 1$	Upper right first	Lower right first	-0.986 (0.1597)
		Upper left first	Lower left first	0.494 (0.3016)
		Upper right second	Lower right second	-3.495 (0.0002)
		Upper left second	Lower left second	-2.427 (0.0076)
	$0 \to 1$	Upper right first	Upper right second	-14.066 (< 0.0001)
		Upper left first	Upper left second	-13.693 (< 0.0001)
		Lower right first	Lower right second	-16.235 (< 0.0001)
		Lower left first	Lower left second	-16.201 (< 0.0001)
	$1 \to 2$	Upper right first	Upper right second	2.428 (0.0076)
		Upper left first	Upper left second	2.003 (0.0226)
		Lower right first	Lower right second	4.961 (< 0.0001)
		Lower left first	Lower left second	4.165 (< 0.0001)



Web Figure 3: The tooth-level future transition probabilities to every possible state out of the caries state at the last visit for the upper right first molar (A) and the upper right second molar (B).