Biostatistics (2013), **0**, 0, *pp.* 1–9
doi:10.1093/biostatistics/revision˙SMb

Analysis of counts with two latent classes, with application to risk assessment based on physician-visit records of cancer survivors

Supplementary Materials

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1. Section A. Application of EM Algorithm

This section presents the EM algorithm to compute the MLE in Section 3.1, adapted via the "full data" as $\big\{(N_i, \eta_i, T_i, Z_i) : i = 1, \ldots, n\big\}$ and the log-likelihood function based on the full data

$$l(\alpha, \beta, \theta; \mathbf{N}, \boldsymbol{\eta}|\mathbf{T}, \mathbf{Z}) = l_1(\alpha; \boldsymbol{\eta}|\mathbf{Z}) + l_2(\beta; \mathbf{N}, \boldsymbol{\eta}|\mathbf{T}, \mathbf{Z}) + l_3(\theta; \mathbf{N}, \boldsymbol{\eta}|\mathbf{T}, \mathbf{Z}), \tag{1.1}$$

where

$$l_1(\alpha; \boldsymbol{\eta}|\mathbf{Z}) = \sum_{i=1}^{n} \Big[\eta_i \log p(Z_i; \alpha) + (1 - \eta_i) \log\left[1 - p(Z_i; \alpha)\right]\Big], \tag{1.2}$$

$$l_2(\beta; \mathbf{N}, \boldsymbol{\eta}|\mathbf{T}, \mathbf{Z}) = \sum_{i=1}^{n} \eta_i \log P(N_i|\eta_i = 1, T_i, Z_i; \beta), \tag{1.3}$$

and

$$l_3(\theta; \mathbf{N}, \boldsymbol{\eta}|\mathbf{T}, \mathbf{Z}) = \sum_{i=1}^{n} (1 - \eta_i) \log P(N_i|\eta_i = 0, T_i, Z_i; \theta). \tag{1.4}$$

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The EM algorithm iteratively alternates between an E-step and an M-step until convergence. The M-step maximizes separately (1.2), (1.3), and (1.4) to update the estimates of (α, β, θ) using the most recent estimates of the η_i's. The computational advantage of this application is obvious, since the full-data log-likelihood is the summation of (1.2), (1.3), and (1.4), each of which depends on only one of the three parameter vectors.

Let the initial values be $\alpha^{(0)}$, $\beta^{(0)}$, and $\theta^{(0)}$. At the lth iteration of the algorithm with $l \geqslant 1$ and the $(l-1)$th estimates $\alpha^{(l-1)}$, $\beta^{(l-1)}$, and $\theta^{(l-1)}$, the algorithm updates the estimates as follows:

E-Step. For $i = 1, \ldots, n$, calculate $\eta_i^{(l)} = E\{\eta_i | T_i, N_i, Z_i; \alpha^{(l-1)}, \beta^{(l-1)}, \theta^{(l-1)}\}$ by

$$E\{\eta | T, N, Z; \alpha, \beta, \theta\} = \frac{P(N|\eta = 1, T, Z; \beta) p(Z; \alpha)}{P(N|\eta = 1, T, Z; \beta) p(Z; \alpha) + P(N|\eta = 0, T, Z; \theta)[1 - p(Z; \alpha)]}.$$

M-Step. Obtain $\alpha^{(l)}$, $\beta^{(l)}$, and $\theta^{(l)}$ by separately maximizing $l_1(\alpha; \boldsymbol{\eta}^{(l)} | \mathbf{Z})$, $l_2(\beta; \mathbf{N}, \boldsymbol{\eta}^{(l)} | \mathbf{T}, \mathbf{Z})$, and $l_3(\theta; \mathbf{N}, \boldsymbol{\eta}^{(l)} | \mathbf{T}, \mathbf{Z})$ in (1.1) with respect to α, β, and θ, respectively.

Under mild regularity conditions, the **M-Step** is equivalent to solving each of the estimating equations:

$$\frac{\partial l_1(\alpha; \boldsymbol{\eta}^{(l)} | \mathbf{Z})}{\partial \alpha} = \sum_{i=1}^{n} [\eta_i^{(l)} - p(Z_i; \alpha)] \frac{\partial p(Z_i; \alpha)/\partial \alpha}{p(Z_i; \alpha)[1 - p(Z_i; \alpha)]} = 0,$$

$$\frac{\partial l_2(\beta; \mathbf{N}, \boldsymbol{\eta}^{(l)} | \mathbf{T}, \mathbf{Z})}{\partial \beta} = \sum_{i=1}^{n} \eta_i^{(l)} [N_i - \Lambda_1(T_i, Z_i; \beta)] \frac{\partial \Lambda_1(T_i, Z_i; \beta)/\partial \beta}{\Lambda_1(T_i, Z_i; \beta)} = 0,$$

$$\frac{\partial l_3(\theta; \mathbf{N}, \boldsymbol{\eta}^{(l)} | \mathbf{T}, \mathbf{Z})}{\partial \theta} = \sum_{i=1}^{n} (1 - \eta_i^{(l)}) [N_i - \Lambda_0(T_i, Z_i; \theta)] \frac{\partial \Lambda_0(T_i, Z_i; \theta)/\partial \theta}{\Lambda_0(T_i, Z_i; \theta)} = 0.$$

2. Section B. Asymptotics of Pseudo-Likelihood Estimator for the Latent Class Model

This section outlines a derivation of the consistency and the asymptotic normality for the pseudo-MLE with the latent class model presented in (3.3) of the main paper.

Denote by $FI(\alpha,\beta,\theta)$ the Fisher information matrix of the likelihood function $L(\alpha,\beta,\theta;\mathbf{N}|\mathbf{T},\mathbf{Z})$ in (3.4) of the paper. Suppose that $\tilde{\theta}$ is a consistent estimator from a set of supplementary data of size m and $\sqrt{m}(\tilde{\theta}-\theta) \xrightarrow{d} N\big(0, AV_{\tilde{\theta}}(\theta)\big)$ as $m \to \infty$. For example, the MLE of θ based on the supplementary data for the *not-at-risk* group satisfies the assumptions.

Assuming that the primary and supplementary data are independent, the conventional regularity conditions ensure the limiting joint distribution:

$$\begin{pmatrix} \frac{1}{\sqrt{n}} \frac{\partial logL(\alpha,\beta,\theta;\mathbf{N}|\mathbf{T},\mathbf{Z})}{\partial(\alpha,\beta,\theta)} \\ \sqrt{m}(\tilde{\theta}-\theta) \end{pmatrix} \xrightarrow{d} N\left(0, \begin{pmatrix} FI(\alpha,\beta,\theta) & 0 \\ 0 & AV_{\tilde{\theta}}(\theta) \end{pmatrix}\right). \tag{2.5}$$

Partition $FI(\alpha,\beta,\theta)$ as follows:

$$\begin{bmatrix} I_{11} & I_{12} \\ I_{21} & I_{22} \end{bmatrix} = -E \begin{bmatrix} \dfrac{\partial^2 \log P(N|T,Z;\alpha,\beta,\theta)}{\partial(\alpha,\beta)^2} & \dfrac{\partial^2 \log P(N|T,Z;\alpha,\beta,\theta)}{\partial(\alpha,\beta)\partial\theta} \\ \dfrac{\partial^2 \log P(N|T,Z;\alpha,\beta,\theta)}{\partial\theta\partial(\alpha,\beta)} & \dfrac{\partial^2 \log P(N|T,Z;\alpha,\beta,\theta)}{\partial\theta^2} \end{bmatrix}. \tag{2.6}$$

Recall that the pseudo-MLE $(\tilde{\alpha},\tilde{\beta})$ maximizes $L(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})$ and is the solution to $\partial logL(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta) = 0$ almost surely. Thus, the first-order Taylor expansion of the partial derivation of the log-likelihood function yields

$$\frac{\partial logL(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})}{\partial(\alpha,\beta)} + (\tilde{\alpha}-\alpha,\tilde{\beta}-\beta)\frac{\partial^2 logL(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})}{\partial(\alpha,\beta)^2} \approx 0.$$

Given the continuity of $\partial logL(\alpha,\beta,\theta;\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta)$ and $\partial^2 logL(\alpha,\beta,\theta;\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta)^2$ with respect to θ, as $n \to \infty$ and $m \to \infty$, we can show that $-n^{-1}\partial^2 logL(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta)^2$ converges to I_{11} a.s. and $n^{-1/2}\partial logL(\alpha,\beta,\tilde{\theta};\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta)$ converges to $N(0, I_{11}^*)$ in distribution. Here $I_{11}^* = I_{11} + kI_{12}AV_{\tilde{\theta}}(\theta)I_{21}$, if $n/m \to k$. Following the standard arguments for the consistency and asymptotic normality of an MLE, we can then establish the consistency of the pseudo-MLE $(\tilde{\alpha},\tilde{\beta})$ and its asymptotic normality with the variance given in (3.5) of the paper.

3. Section C. Asymptotic Variance Estimation for the Pseudo-MLE

Following the partition of (2.6), denote the blocks of $\widehat{FI}(\alpha,\beta,\theta) = -\frac{1}{n}\partial^2 logL(\alpha,\beta,\theta;\mathbf{N}|\mathbf{T},\mathbf{Z})/\partial(\alpha,\beta)^2$ by $\hat{I}_{11}(\alpha,\beta,\theta)$, $\hat{I}_{12}(\alpha,\beta,\theta)$, $\hat{I}_{21}(\alpha,\beta,\theta)$, and $\hat{I}_{22}(\alpha,\beta,\theta)$. The following presents a consistent estimator for $AV_{\tilde{\alpha},\tilde{\beta}}(\alpha,\beta,\theta)$ in (3.5) of the paper:

$$\hat{I}_{11}^{-1}(\alpha,\beta,\theta) + \frac{n}{m}\hat{I}_{11}^{-1}(\alpha,\beta,\theta)\hat{I}_{12}(\alpha,\beta,\theta)\widehat{AV}_{\tilde{\theta}}\hat{I}_{21}(\alpha,\beta,\theta)\hat{I}_{11}^{-1}(\alpha,\beta,\theta) \tag{3.7}$$

with (α,β,θ) substituted by $(\tilde{\alpha},\tilde{\beta},\tilde{\theta})$ and $\widehat{AV}_{\tilde{\theta}}$ a consistent estimator of $AV_{\tilde{\theta}}(\theta)$.

Partition the variance matrix of the score function based on the primary data as follows:

$$Var\begin{bmatrix}\dfrac{\partial \log P(N|T,Z;\alpha,\beta,\theta)}{\partial(\alpha,\beta)}\\ \dfrac{\partial \log P(N|T,Z;\alpha,\beta,\theta)}{\partial\theta}\end{bmatrix} = \begin{bmatrix}\Pi_{11} & \Pi_{12}\\ \Pi_{21} & \Pi_{22}\end{bmatrix}.$$

Denote the block in the sample moment estimator for the variance matrix corresponding to Π_{11} by $\hat{\Pi}_{11}(\alpha,\beta,\theta)$. It yields a robust variance estimator for $AV_{\tilde{\alpha},\tilde{\beta}}(\alpha,\beta,\theta)$ replacing $\hat{I}_{11}^{-1}(\alpha,\beta,\theta)$ in (3.7) by

$$\hat{I}_{11}^{-1}(\alpha,\beta,\theta)\widehat{\Pi}_{11}(\alpha,\beta,\theta)\hat{I}_{11}^{-1}(\alpha,\beta,\theta). \tag{3.8}$$

In fact, (3.8) is the Huber sandwich variance estimator for the MLE of (α,β) with a known θ.

4. Section D. Additional Simulation Results

Table 1 presents a summary of the simulation outcomes in Cases (i) and (ii) of the *Robustness Study.* The simulation results in the further robustness study are summarized in Table 2.

(Table 1 is about here.)

(Table 2 is about here.)

5. Section E. Additional Analyses of CAYACS Data

We conducted the quasi-Poisson regression analysis separately for each set of physician records from the survivor cohort and the general population. To allow us to compare the analysis outcomes, together with the ln-transformed time length, we included in the regression analyses as explanatory variables the mutual factors in the data sets: *sex*, *age at study entry*, and *SES*. Table 3 presents the estimates of the regression model parameters along with their standard error estimates.

(Table 3 is about here.)

The likelihood function for (α, β, θ) based on the data of the survivor cohort combined with the data of the population sample is

$$L(\alpha, \beta, \theta; \mathbf{N}|\mathbf{T}, \mathbf{Z}) \times L_{supp}(\theta) = \prod_{i=1}^{n} P(N_i|T_i, Z_i; \alpha, \beta, \theta) \times \prod_{j=1}^{m} P(N_j|\eta_j \equiv 0, T_j, Z_j; \theta). \quad (5.9)$$

In addition to the MLE with only the data from the survivor cohort and the pseudo-MLE, we evaluated the MLE with the CAYACS data derived from (5.9) along with the corresponding sandwich standard error estimates. For comparison, Table 4 presents the estimates together with the MLE for the primary data and the pseudo-MLE.

(Table 4 is about here.)

Based on the three sets of parameter estimates and the corresponding standard error estimates, Figs. 1 and 2 show the estimated risk probabilities and the means of the visit counts over time, respectively.

(Fig. 1 is about here.)

(Fig. 2 is about here.)

Table 1. *Simulation Outcomes: Robustness Study (repetition number = 250)*

parameter	α_0	α_1	α_2	β_0	β_1	β_2	β_3	θ_0	θ_1	θ_2	θ_3
true value	1	-1	-0.8	1.8	-0.6	-0.5	1	0.5	-0.3	-0.25	1
	Case (i). Primary Data ($n = 500$): mixed Poisson ($\eta = 1$) & mixed Poisson ($\eta = 0$); $\gamma = 1$										
	MLE of (α, β, θ)										
$sm^{\dagger}$	-0.864	-0.114	-0.129	2.510	-0.707	-0.528	0.950	0.614	-0.692	-0.537	1.012
$sse^{\ddagger}$	0.385	0.416	0.648	0.326	0.214	0.376	0.220	0.346	0.213	0.379	0.236
$sm^{\dagger}_{se}$	0.216	0.218	0.347	0.041	0.018	0.025	0.029	0.087	0.040	0.055	0.061
$sm^{\dagger}_{sw.se}$	0.328	0.411	0.612	0.307	0.207	0.308	0.217	0.339	0.226	0.336	0.232
								Supp. Data ($m = 5000$): mixed Poisson			
	pseudo-MLE of (α, β)							GEE estimate of θ			
sm	-0.704	-0.544	-0.450	2.453	-0.557	-0.425	0.952	0.498	-0.299	-0.252	1.002
sse	0.282	0.299	0.449	0.274	0.165	0.287	0.195	0.062	0.033	0.052	0.044
sm_{pse}	0.220	0.234	0.369	0.041	0.020	0.026	0.029	0.067	0.032	0.050	0.047
$sm_{sw.pse}$	0.266	0.288	0.459	0.259	0.156	0.254	0.191	0.067	0.032	0.050	0.047
	Case (ii). Primary Data ($n = 500$): mixed Poisson ($\eta = 1$) & Poisson ($\eta = 0$); $\gamma = 1$										
	MLE of (α, β, θ)										
sm	-0.877	-0.787	-0.645	2.499	-0.496	-0.389	0.963	0.703	-0.430	-0.343	0.996
sse	0.301	0.353	0.526	0.333	0.189	0.296	0.244	0.199	0.114	0.177	0.139
sm_{se}	0.236	0.262	0.409	0.046	0.024	0.029	0.032	0.081	0.035	0.053	0.057
$sm_{sw.se}$	0.301	0.346	0.546	0.297	0.180	0.285	0.219	0.200	0.110	0.174	0.142
								Supp. Data ($m = 5000$): Poisson			
	pseudo-MLE of (α, β)							GEE estimate of θ			
sm	-0.723	-0.880	-0.704	2.430	-0.464	-0.372	0.973	0.499	-0.301	-0.249	1.000
sse	0.256	0.303	0.445	0.302	0.170	0.256	0.220	0.030	0.014	0.022	0.020
sm_{pse}	0.229	0.256	0.398	0.043	0.023	0.027	0.030	0.029	0.014	0.022	0.021
$sm_{sw.pse}$	0.267	0.297	0.472	0.272	0.163	0.264	0.201	0.029	0.014	0.022	0.021

† The sample means of the parameter estimates (sm), the conventional standard error estimates (sm_{se}), and the sandwich standard error estimates ($sm_{sw.pse}$).

‡ The sample standard errors of the parameter estimates.

Table 2. *Simulation Outcomes: Additional Robustness Study*

(Primary Data $n = 500$; Repetition Number = 250)

parameter	α_0	α_1	α_2	β_0	β_1	β_2	β_3	θ_0	θ_1	θ_2	θ_3
true value	1	-1	-0.8	1.8	-0.6	-0.5	1	0.5	-0.3	-0.25	1
	Case (iii.A1): Two Components in Stratum ($\eta = 0$) with Portion Ratio = 9:1										
	MLE of (α, β, θ)										
$sm^{\dagger}$	1.039	-0.975	-0.783	1.796	-0.605	-0.498	1.000	0.472	-0.303	-0.242	1.003
$sse^{\ddagger}$	0.257	0.297	0.438	0.077	0.053	0.062	0.055	0.195	0.099	0.140	0.140
$sm^{\dagger}_{se}$	0.245	0.296	0.421	0.083	0.055	0.068	0.059	0.200	0.096	0.143	0.135
$sm^{\dagger}_{sw.se}$	0.252	0.311	0.440	0.082	0.057	0.069	0.058	0.206	0.101	0.151	0.139
								Supplementary Data ($m = 5000$)			
	pseudo-MLE of (α, β)							GEE estimate of θ			
sm	1.030	-1.002	-0.795	1.799	-0.601	-0.495	0.998	0.514	-0.306	-0.248	1.000
sse	0.245	0.250	0.406	0.077	0.046	0.060	0.055	0.031	0.014	0.023	0.024
sm_{pse}	0.233	0.251	0.383	0.083	0.051	0.066	0.059	0.031	0.015	0.023	0.022
$sm_{sw.pse}$	0.234	0.251	0.384	0.081	0.049	0.064	0.058	0.031	0.015	0.023	0.022
	Case (iii.A2): Two Components in Stratum ($\eta = 0$) with Portion Ratio = 5:5										
	MLE of (α, β, θ)										
sm	1.217	-0.744	-0.552	1.775	-0.628	-0.524	1.000	0.335	-0.338	-0.318	1.034
sse	0.285	0.353	0.467	0.091	0.055	0.077	0.059	0.316	0.162	0.264	0.218
sm_{se}	0.256	0.288	0.426	0.075	0.046	0.059	0.053	0.240	0.110	0.164	0.163
$sm_{sw.se}$	0.299	0.362	0.526	0.083	0.059	0.077	0.058	0.309	0.175	0.268	0.208
								Supplementary Data ($m = 5000$)			
	pseudo-MLE of (α, β)							GEE estimate of θ			
sm	1.147	-1.020	-0.827	1.792	-0.585	-0.490	0.993	0.621	-0.339	-0.269	0.997
sse	0.244	0.272	0.362	0.089	0.045	0.065	0.060	0.034	0.018	0.028	0.024
sm_{pse}	0.245	0.261	0.401	0.081	0.050	0.065	0.058	0.037	0.018	0.028	0.026
$sm_{sw.pse}$	0.245	0.257	0.398	0.081	0.046	0.064	0.058	0.037	0.018	0.028	0.026
	Case (iii.A3): Two Components in Stratum ($\eta = 0$) with Portion Ratio = 2:8										
	MLE of (α, β, θ)										
sm	1.408	-0.006	0.142	1.759	-0.705	-0.586	1.002	-0.034	-0.919	-0.941	1.309
sse	0.516	0.573	0.842	0.098	0.068	0.093	0.062	1.161	0.659	0.968	0.778
sm_{se}	0.289	0.304	0.474	0.065	0.032	0.048	0.046	0.384	0.199	0.252	0.268
$sm_{sw.se}$	0.484	0.621	0.975	0.101	0.073	0.113	0.064	1.084	0.622	0.970	0.674
								Supplementary Data ($m = 5000$)			
	pseudo-MLE of (α, β)							GEE estimate of θ			
sm	1.170	-0.990	-0.773	1.792	-0.591	-0.497	0.992	0.795	-0.385	-0.292	1.000
sse	0.271	0.277	0.430	0.088	0.051	0.071	0.060	0.036	0.017	0.029	0.024
sm_{pse}	0.267	0.295	0.447	0.083	0.053	0.067	0.059	0.037	0.018	0.027	0.026
$sm_{sw.pse}$	0.265	0.288	0.443	0.081	0.048	0.067	0.058	0.037	0.018	0.027	0.026

† The sample means of the parameter estimates (sm), the conventional standard error estimates (sm_{se}), and the sandwich standard error estimates ($sm_{sw.pse}$).

‡ The sample standard errors of the parameter estimates.

Table 3. *Quasi Poisson Regression for the Population Sample and the Survivor Cohort*

	General Population			Survivor Cohort		
Factors	*estimate*	*s.e.*	*p-value*	*estimate*	*s.e.*	*p-value*
intercept	0.751	0.038	$< .001$	2.159	0.095	$< .001$
male (vs female)	-0.362	0.011	$< .001$	-0.360	0.038	$< .001$
age at study entry	0.306	0.019	$< .001$	0.148	0.058	0.011
SES high (vs low)	-0.047	0.011	$< .001$	-0.009	0.038	0.816
ln(time length)	1.263	0.013	$< .001$	0.882	0.035	$< .001$
dispersion parameter	$\hat{\phi} = 23.40$			$\hat{\phi} = 31.90$		

Table 4. *Analysis Outcomes of the CAYACS Data with Latent Class Model*†

		MLE with Primary Data		MLE with Combined Data		Pseudo-MLE with Combined Data	
Factor		*estimate*	*se.sw*	*estimate*	*se.sw*	*estimate*	*pse.sw*
In the Risk Model							
intercept		-0.322	(0.204)	**-0.681**	(0.188)	**-0.683**	(0.188)
male (vs female)		-0.355	(0.207)	**-0.320**	(0.129)	**-0.315**	(0.130)
age at study entry		-0.041	(0.324)	-0.098	(0.218)	-0.111	(0.219)
SES high (vs low)		-0.092	(0.232)	0.023	(0.131)	0.028	(0.132)
relapse/second cancer (vs not)		**1.200**	(0.215)	**1.255**	(0.177)	**1.253**	(0.177)
diagnosis period 1990s (vs 1980s)		**-0.964**	(0.167)	**-0.551**	(0.129)	**-0.545**	(0.129)
treatment (vs other)	chemo only	0.107	(0.158)	0.147	(0.151)	0.145	(0.151)
	rad only	**0.663**	(0.229)	**0.520**	(0.224)	**0.515**	(0.224)
	both	**0.362**	(0.163)	**0.392**	(0.162)	**0.392**	(0.162)
In the Frequency Model for the At-Risk Group							
intercept		**3.656**	(0.187)	**3.390**	(0.111)	**3.386**	(0.111)
male (vs female)		**-0.206**	(0.070)	**-0.179**	(0.047)	**-0.180**	(0.047)
age at study entry		0.095	(0.099)	0.122	(0.075)	0.125	(0.076)
SES high (vs low)		-0.005	(0.072)	-0.022	(0.046)	-0.023	(0.046)
ln(time length)		**0.476**	(0.066)	**0.591**	(0.041)	**0.592**	(0.041)
In the Frequency Model for the Not-At-Risk Group						GEE estimates Based on Supp. Data	
intercept		**1.560**	(0.137)	**0.782**	(0.033)	**0.751**	(0.038)
male (vs female)		**-0.353**	(0.070)	**-0.364**	(0.011)	**-0.362**	(0.011)
age at study entry		0.162	(0.103)	**0.291**	(0.020)	**0.306**	(0.019)
SES high (vs low)		0.028	(0.077)	**-0.045**	(0.012)	**-0.047**	(0.011)
ln(time length)		**0.897**	(0.053)	**1.252**	(0.012)	**1.263**	(0.013)

†Significant effect with p-value $\leqslant 0.05$ in **boldface**.

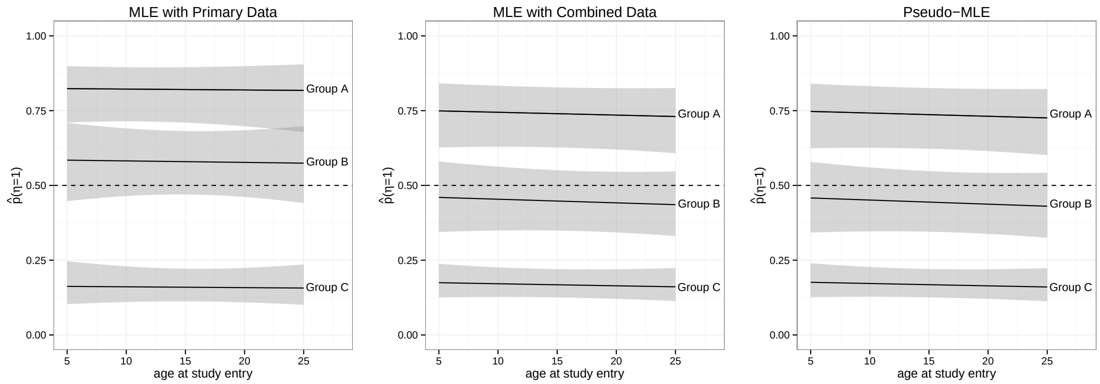

Fig. 1. Estimated risk probabilities with approximate 95% confidence intervals for three groups: Group A. Female, diagnosed in 80s, with relapse/second cancer, and treated with radiation therapy; Group B. Female, diagnosed in 80s, no relapse/second cancer, and treated with radiation therapy; Group C. Male, diagnosed in 90s, no relapse/second cancer, and treated without chemo/radiation therapy.

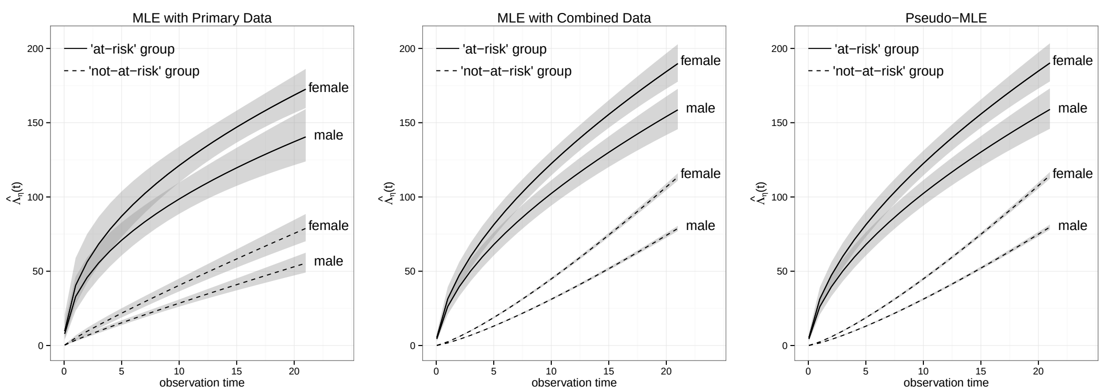

Fig. 2. Estimated mean functions of cumulative physician-visit counts with approximate 95% confidence intervals, for survivors with low SES and average age at entry.

[*Received July XX, 2013; revised September XX, 2013; accepted for publication XXXXXX XX, 201X*]