Nightingale Report

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Introduction

In celebration of the 200th anniversary of Florence Nightingale's birth, the first female member of the Royal Statistical Society best known worldwide for revolutionizing nursing and health care through campaigning for health reform, this research is built on Nightingale's 1863 mortality data from Canadian residential schools and other 'native schools' in the British Empire ("Sanitary statistics of native colonial schools and hospitals", https://archive.org/embed/sanitarystatisti00nigh). Nightingale drew two main conclusions from these data: 1) mortality was much higher for Indigenous children in Canadian residential schools than comparable institutions in other areas; and 2) girls in Canadian schools had substantially higher mortality than boys. Neither of these results are surprising given the endemic and systematic nature of the abuse, including sexual abuse, children in the residential school system suffered (see "Honouring the Truth, Reconciling for the Future: Summary of the Final Report of the Truth and Reconciliation Commission of Canada" https://nctr.ca/reports2.php). What is perhaps less widely recognized is that solid epidemiological evidence of the harm these schools were inflicting existed as early as 1863.

The objective of this research is to apply modern statistical techniques that was not accessible at the time of Nightingale's report to the data, as well as quantifying the uncertainty associated with the estimates while accounting for correlation in the data introduced by the sampling design.

Method

Data

An essential step prior to the start of analysis is to digitize the appropriate table from Nightingale's report and prepare for analysis. In this research, table A. Attendance and Mortality at Colonial Native Schools from Nightingale's report provided primary data for re-analysis. Attendance and mortality numbers in each school were organized into a data sheet by age groups, sex, and names of the country in which the schools reside in. Since the attendance was displayed in the form of an average whereas mortality was recorded as total number of deaths over the period of years included in the return, we multiplied the average number of native children attending each school by the total number of years in return to get a variable representing a rough total number of children attending each school over the years. This step was critical in scaling the predictor and outcome variable.

Model

The primary statistical concern for this re-analysis is that the data are clustered, with deaths reported for a small number of institutions in each country. A Generalized Linear Mixed Model, with a Poisson-distributed death count and an institution-level random effect, is the preferred approach for data of this sort in current epidemiological research.

Equipped with the tools and techniques of modern statistics and contemporary analyses of trends and variations in global mortality, we fit a Bayesian hierarchical model to data extracted above from Nightingale's report in order to quantify the excess mortality in residential schools. The model is as shown below:

$$Y_{ij} \sim Poisson(O_i \mu_{ij})$$
$$log(\mu_i) = X_{ij}\beta + U_i$$
$$U_i \sim N(0, \sigma^2)$$

In this model, Y_{ij} is an indicator variable for school j in country i. O_i is the offset term, representing total number of children at school j over return years on log scale. μ_{ij} is the rate of deaths among Indigenous children in residential schools at school j in country i. X_{ij} is a vector of covariates, including an interaction term between sex, country, and age, and the intercept. β is the regression coefficient. U_i is the random effect for school, following a normal distribution with mean 0 and standard deviation σ^2. An exponential prior was given for σ with a median of 1, meaning a school that is one standard deviation above average would have the same probability of deaths among school children as other schools.

Results

Despite the small sample size in the dataset, we have taken the appropriate steps to prove the statistical significance of the large magnitude of excess mortality shown in Nightingale's descriptive statistics.

Figure 1 and Figure 2 below represent the probability of deaths among residential school children by age group, sex, and country, as documented in Nightingale's report. It is evident in the graph that across different age groups and sex, the mortality rate in Canadian residential schools is consistently higher than the other countries, although the confidence interval is wide, indicating a large amount of uncertainty in this claim. More specifically, girls have a much higher mortality than boys in the Canadian residential schools system. In addition, although average mortality seems to be consistent among different sex and age groups with the exception of Canada, it is overall much higher in comparison to children of other races who were not present in residential schools in the same time period.

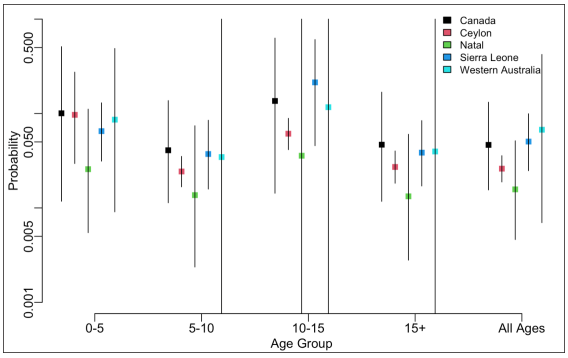


Figure 1: Probability of Deaths Among Residential School Children - Male

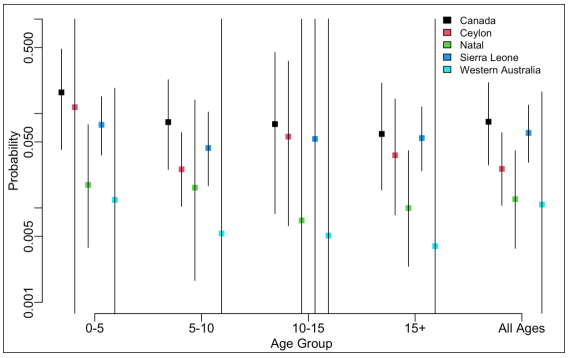
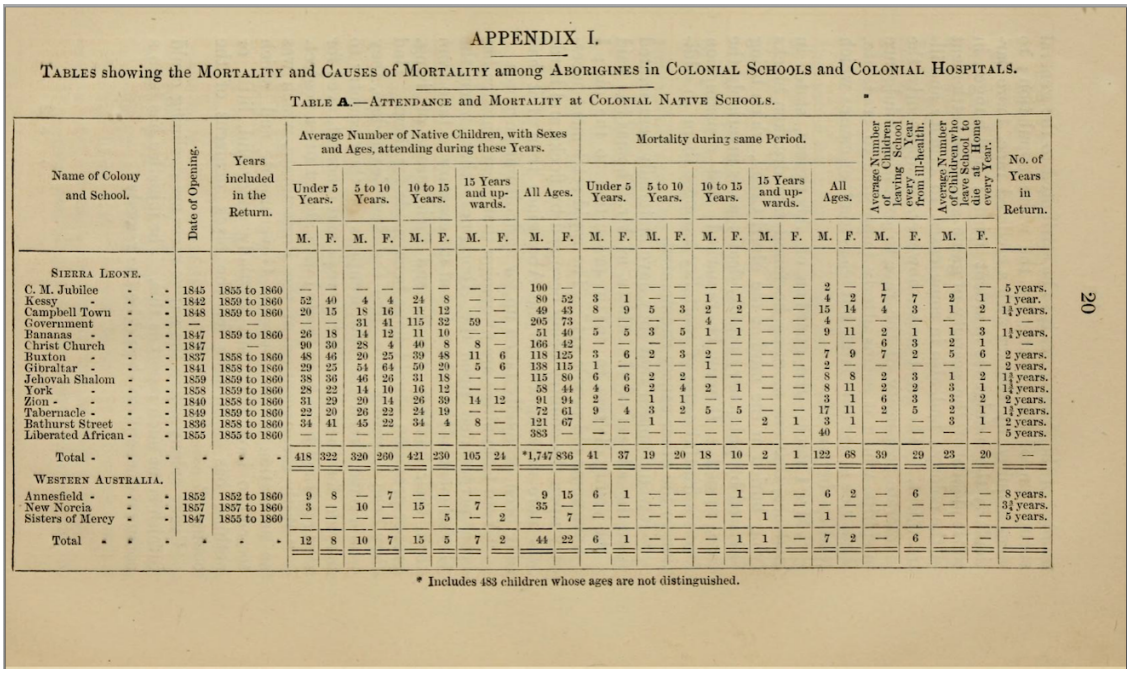


Figure 2: Probability of Deaths Among Residential School Children - Female

Conclusion

By applying modern statistical methods, we have demonstrated the ability of Nightingale's 1863 data to verify and quantify the detrimental effects of these schools. Mortality was indeed much higher for Indigenous children in Canadian residential schools than comparable institutions in Sierra Leone, Western Australia, Ceylon, and Natal. Girls in Canadian schools also had substantially higher mortality than boys. This research further confirmed the significance in harm suffered by the individuals in Canada's residential school system in the mid 19th century and racial inequalities.

Appendix I - Raw Data



APPENDIX I.

TABLES showing the MORTALITY and CAUSES of MORTALITY among ABORIGINES in COLONIAL SCHOOLS and COLONIAL HOSPITALS.

TABLE A.—ATTENDANCE and MORTALITY at COLONIAL NATIVE SCHOOLS.

Name of Colony and School.	Date of Opening.	Years included in the Return.	Average Number of Native Children, with Sexes and Ages, attending during these Years.										Mortality during same Period.										Average Number of Children leaving School every Year from ill-health.		Average Number of Children who have been known to die at Home every Year.		No. of Years in Return.
			Under 5 Years.		5 to 10 Years.		10 to 15 Years.		15 Years and upwards.		All Ages.		Under 5 Years.		5 to 10 Years.		10 to 15 Years.		15 Years and upwards.		All Ages.						
			M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
SIERRA LEONE.																											
C. M. Jubilee - -	1845	1855 to 1860	—	—	—	—	—	—	—	—	100	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	5 years.
Kessy - -	1842	1859 to 1860	52	40	4	4	24	8	—	—	80	52	3	1	—	—	1	1	—	—	4	2	7	7	2	1	1 year.
Campbell Town -	1848	1859 to 1860	20	15	18	16	11	12	—	—	49	43	8	9	5	3	2	2	—	—	15	14	4	3	1	2	1½ years.
Government - -	—	—	—	—	31	41	115	32	59	—	205	73	—	—	—	—	4	—	—	—	4	—	—	—	—	—	—
Bananas - -	1847	1859 to 1860	26	18	14	12	11	10	—	—	51	40	5	5	3	5	1	1	—	—	9	11	2	1	1	3	1½ years.
Christ Church -	1847	—	90	30	28	4	40	8	8	—	166	42	—	—	—	—	—	—	—	—	—	—	6	3	2	1	—
Buxton - -	1857	1858 to 1860	48	46	20	25	39	48	11	6	118	125	3	6	2	3	2	—	—	—	7	9	7	2	5	6	2 years.
Gibraltar - -	1841	1858 to 1860	29	25	54	64	50	20	5	6	138	115	1	—	—	—	1	—	—	—	2	—	—	—	—	—	2 years.
Jehovah Shalom -	1859	1859 to 1860	38	36	46	26	31	18	—	—	115	80	6	6	2	2	—	—	—	—	8	8	2	3	1	2	1½ years.
York - -	1858	1859 to 1860	28	22	14	10	16	12	—	—	58	44	4	6	2	4	2	1	—	—	8	11	2	2	3	1	1½ years.
Zion - -	1840	1858 to 1860	31	29	20	14	26	39	14	12	91	94	2	—	1	1	—	—	—	—	3	1	6	3	3	2	2 years.
Tabernacle - -	1849	1859 to 1860	22	20	26	22	24	19	—	—	72	61	9	4	3	2	5	5	—	—	17	11	2	5	2	1	1½ years.
Bathurst Street -	1836	1858 to 1860	34	41	45	22	34	4	8	—	121	67	—	—	1	—	—	—	2	1	3	1	—	—	3	1	2 years.
Liberated African -	1855	1855 to 1860	—	—	—	—	—	—	—	—	383	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	5 years.
Total - - - - - -			418	322	320	260	421	230	105	24	*1,747	836	41	37	19	20	18	10	2	1	122	68	39	29	23	20	—
WESTERN AUSTRALIA.																											
Annesfield - - -	1852	1852 to 1860	9	8	—	7	—	—	—	—	9	15	6	1	—	—	—	1	—	—	6	2	—	6	—	—	8 years.
New Norcia - -	1857	1857 to 1860	3	—	10	—	15	—	7	—	35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3½ years.
Sisters of Mercy -	1847	1855 to 1860	—	—	—	—	—	5	—	2	—	7	—	—	—	—	—	—	1	—	1	—	—	—	—	—	5 years.
Total - - - - - -			12	8	10	7	15	5	7	2	44	22	6	1	—	—	—	1	1	—	7	2	—	6	—	—	—

* Includes 483 children whose ages are not distinguished.

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Figure 3: Original Table from Florence Nightingale's Report - Sanitary Statistics of Native Colonial Schools and Hospitals

Appendix II - Data Summary Table

Table 1: Data Availability Summary

			Numer of Schools with Available Data by Age Group				
Country	Total No. Schools	Total Person Years	0-5 Years	5-10 Years	10-15 Years	15+ Years	All Ages
Canada	13	42820	2	2	6	2	7
Ceylon	101	691740	2	30	44	30	63
Natal	11	76820	3	4	2	0	5
Sierra Leone	14	82825	9	8	7	1	12
Western Australia	3	7165	1	0	0	0	1

Appendix III - Model Parameters: Standard Deviation and 95% Credible Interval

	sd	0.025quant	0.975quant
(Intercept)	0.7585543	-3.5426827	-0.5601540
sexM	1.1459662	-3.0907595	1.4024030
countryCeylon	10.0421085	-20.1199025	19.2962633
countryNatal	1.0831000	-4.1572441	0.0959871
countrySierra Leone	0.8408032	-2.4900441	0.8170743
countryWestern Australia	1.6555643	-5.8614566	0.6457548
age10-15	0.7033669	-2.0056645	0.7585015
age15+	1.1564198	-3.4056561	1.1272518
age5-10	0.7703576	-2.5932131	0.4319286
ageall ages	0.6463658	-2.2558397	0.2828289
sexM:countryCeylon	10.0309601	-19.2197468	20.1525774
sexM:countryNatal	1.4100966	-1.7414676	3.7979048
sexM:countrySierra Leone	1.1679484	-1.5907283	2.9957400
sexM:countryWestern Australia	1.5680809	-0.1435714	6.0158798
sexM:age10-15	1.3117908	-2.5427189	2.6083249
sexM:age15+	1.9536021	-2.2054835	5.4677651
sexM:age5-10	1.3490857	-2.1112153	3.1873627
sexM:ageall ages	1.2232159	-2.3466762	2.4582090
countryCeylon:age10-15	10.0329542	-20.5548172	18.8243746
countryNatal:age10-15	1.3703154	-2.4305805	2.9557100
countrySierra Leone:age10-15	0.7894812	-1.5677218	1.5329385
countryWestern Australia:age10-15	31.6227760	-62.0861723	62.0343582
countryCeylon:age15+	10.0867243	-19.7205185	19.8696910
countryNatal:age15+	31.6227760	-62.0861723	62.0343582
countrySierra Leone:age15+	22.3780766	-43.2476187	44.5867923
countryWestern Australia:age15+	31.6227760	-62.0861723	62.0343582
countryCeylon:age5-10	10.0450869	-19.8402265	19.5865202
countryNatal:age5-10	1.1336999	-1.7887493	2.6612488
countrySierra Leone:age5-10	0.8192431	-0.8580566	2.3599406
countryWestern Australia:age5-10	31.6227760	-62.0861723	62.0343582
countryCeylon:ageall ages	10.0299654	-20.3510923	19.0163550
countryNatal:ageall ages	0.9575098	-1.7000415	2.0591713
countrySierra Leone:ageall ages	0.6781097	-0.7150139	1.9512288
countryWestern Australia:ageall ages	1.3780333	-1.4266284	3.9899907
sexM:countryCeylon:age10-15	10.0413761	-19.3572828	20.0549176
sexM:countryNatal:age10-15	1.9927927	-3.9674873	3.8549759
sexM:countrySierra Leone:age10-15	1.3942517	-2.7152081	2.7670319
sexM:countryWestern Australia:age10-15	31.6227760	-62.0861723	62.0343582
sexM:countryCeylon:age15+	10.1470366	-20.9666127	18.8613305
sexM:countryNatal:age15+	31.6227760	-62.0861723	62.0343582
sexM:countrySierra Leone:age15+	22.3780766	-43.2476186	44.5867925
sexM:countryWestern Australia:age15+	31.6227760	-62.0861723	62.0343582
sexM:countryCeylon:age5-10	10.0543222	-20.0799218	19.3832403
sexM:countryNatal:age5-10	1.7762575	-3.8809231	3.0940411
sexM:countrySierra Leone:age5-10	1.4048129	-3.4699765	2.0538604
sexM:countryWestern Australia:age5-10	31.6227760	-62.0861723	62.0343582
sexM:countryCeylon:ageall ages	10.0324554	-19.3571534	20.0200235
sexM:countryNatal:ageall ages	1.5557603	-3.0310044	3.0809708
sexM:countrySierra Leone:ageall ages	1.2549624	-2.5315747	2.3991520
sexM:countryWestern Australia:ageall ages	1.8172723	-3.9724555	3.1714946