```
/* Input Canada and Cuba raw data */
DATA Canada_2010;
INPUT Age$ Pop:comma9. Death:comma7.;
DATALINES;
0-19 7,720,330 3,513
20-39 8,294,465 6,105
40-59 9,672,975 28,504
60-79 4,757,805 82,887
80+ 1,167,315 107,057
;
DATA Cuba_2010;
INPUT Age$ Pop:comma9. Death:comma6.;
DATALINES;
0-19 2,832,863 1,337
20-39 3,339,537 2,830
40-59 3,178,253 12,641
60-79 1,557,773 34,977
80+ 328,016 34,632
;
RUN;

/* Part 1 */
/* Indirect Standardization: Calculate overall SMR for Canada using Cuba as reference */
PROC STDRATE DATA=Canada_2010 REFDATA=Cuba_2010 METHOD=indirect STAT=rate(mult=100000) PLOTS=none;
POPULATION EVENT=Death TOTAL=Pop;
REFERENCE EVENT=Death TOTAL=Pop;
STRATA Age;
RUN;

/* Part 2 */
/* Direct Standardization: Calculate DAR (Crude Rate per 100,000 persons) */
/* Add new columns with country name*/
DATA Canada_2010b;
SET Canada_2010;
Country = 'Canada';
RUN;
DATA Cuba_2010b;
SET Cuba_2010;
Country = 'Cuba';
RUN;
/* Merge the Canada and Cuba datasets */
DATA TwoNations;
SET Canada_2010b Cuba_2010b;
RUN;

/* Input Reference Population */
/* This reference population is an average of the sum of population from an age range divided by total population */
/*
(pop value of 0-19 for Canada) + (pop value of 0-19 for Cuba)
    divided by (Total pop value of 0-19 for Canada+Cuba) for all 5 Age ranges
    obtained values were '0-19'=24.6, '20-39'=27.2, '40-59'=0.30, '60-79'=14.7, '80+'=3.5
*/
DATA ModifyRef;
INPUT Age$ Pop;
DATALINES;
0-19 25
20-39 27
40-59 30
60-79 15
80+ 3
;

PROC STDRATE DATA=TwoNations REFDATA=ModifyRef METHOD=direct STAT=rate(mult=100000)
PLOTS(only)=(dist rate);
POPULATION GROUP=Country EVENT=Death TOTAL=Pop;
REFERENCE TOTAL=Pop;
STRATA Age / stats;
RUN;
```

1. The expected overall mortality rate for the study population Canada is 0.8168 if the reference stratum specific rate from the Cuban population applies.
2. After applying Direct Standardization the overall Crude Death Rate (Canada: 721.4 and Cuba: 769.1) is more similar than the directly adjusted rates with an updated reference population that fits reasonably well with values of 656.1 and 807.5 per 100,000 respectively. The differences between these are much greater than the ones calculated in the tutorial (difference of ~150 compared to tutorial difference of ~90) although the directly adjusted rate now accounts for population age demographics so it is more reliable than the UNref reference population calculations. The larger difference between DAR values can possibly be contributed by the fact that when adjusted using a fitting reference population Cuba's data has more deaths than Canada's.

The STDRATE Procedure

Standardization Information	
Data Set	WORK.CANADA_2010
Reference Data Set	WORK.CUBA_2010
Method	Indirect Standardization
Statistic	Rate
Number of Strata	5
Rate Multiplier	100000

The STDRATE Procedure

Standardized Morbidity/Mortality Ratio							
Observed Events	Expected Events	SMR	Standard Error	95% Normal Confidence Limits		Z	Pr > |Z|
228066	279219	0.8168	0.00171	0.8134	0.8202	-107.11	<.0001

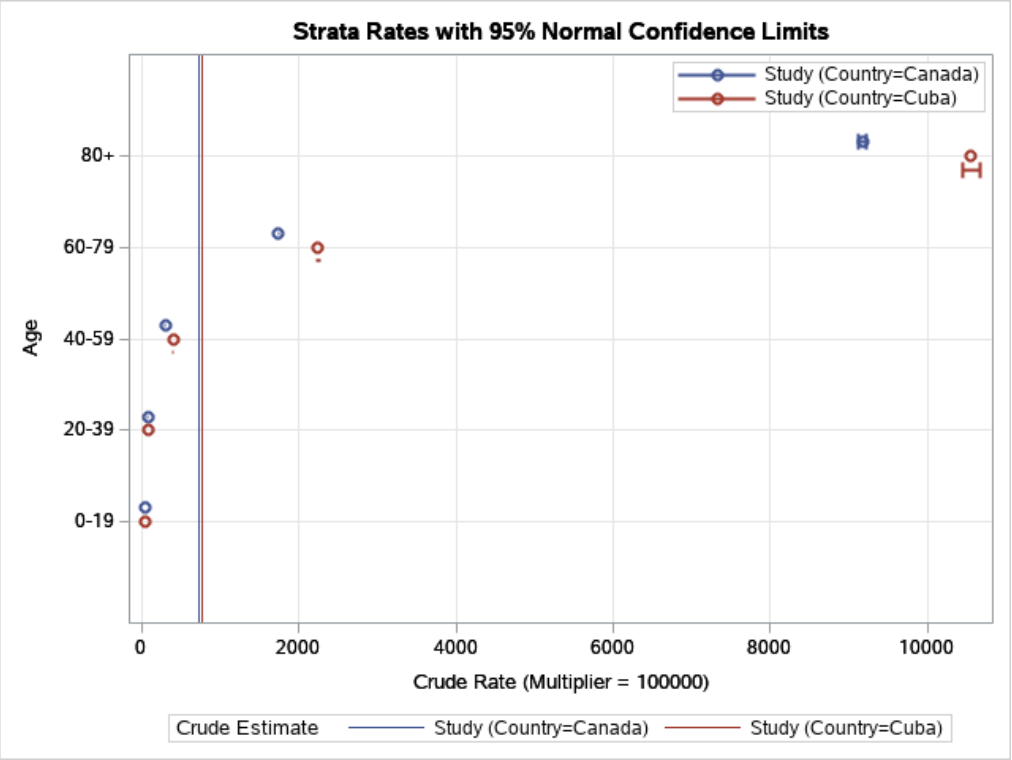
Indirectly Standardized Rate Estimates Rate Multiplier = 100000									
Study Population			Reference Crude Rate	Expected Events	SMR	Standardized Rate			
Observed Events	Population-Time	Crude Rate				Estimate	Standard Error	95% Normal Confidence Limits	
228066	31612890	721.4	769.1	279219	0.8168	628.2	1.3154	625.6	630.8

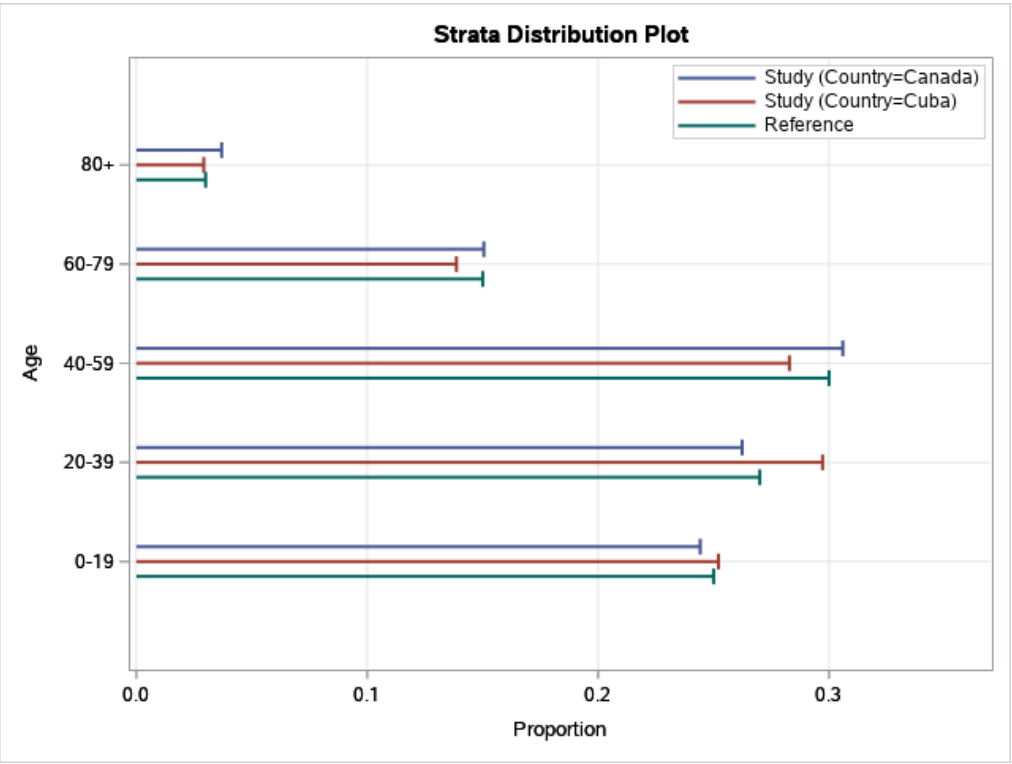
The STDRATE Procedure

Standardization Information	
Data Set	WORK.TWONATIONS
Group Variable	Country
Reference Data Set	WORK.MODIFYREF
Method	Direct Standardization
Statistic	Rate
Number of Strata	5
Rate Multiplier	100000

The STDRATE Procedure

Directly Standardized Strata Statistics Rate Multiplier = 100000											
			Study Population							Reference Population		
				Population-Time						Population-Time		
Country	Stratum Index	Age	Observed Events	Value	Proportion	Crude Rate	Standard Error	95% Normal Confidence Limits		Value	Proportion	Expected Events
Canada	1	0-19	3513	7720330	0.2442	45.5	0.7677	44.0	47.0	25.00000	0.2500	0.011376
Canada	2	20-39	6105	8294465	0.2624	73.6	0.9420	71.8	75.4	27.00000	0.2700	0.019873
Canada	3	40-59	28504	9672975	0.3060	294.7	1.7454	291.3	298.1	30.00000	0.3000	0.088403
Canada	4	60-79	82887	4757805	0.1505	1742.1	6.0511	1730.3	1754.0	15.00000	0.1500	0.261319
Canada	5	80+	107057	1167315	0.0369	9171.2	28.0298	9116.3	9226.2	3.00000	0.0300	0.275137
Cuba	1	0-19	1337	2832863	0.2521	47.2	1.2907	44.7	49.7	25.00000	0.2500	0.011799
Cuba	2	20-39	2830	3339537	0.2972	84.7	1.5930	81.6	87.9	27.00000	0.2700	0.022880
Cuba	3	40-59	12641	3178253	0.2829	397.7	3.5375	390.8	404.7	30.00000	0.3000	0.119320
Cuba	4	60-79	34977	1557773	0.1386	2245.3	12.0057	2221.8	2268.9	15.00000	0.1500	0.336798
Cuba	5	80+	34632	328016	0.0292	10558.0	56.7340	10446.8	10669.2	3.00000	0.0300	0.316741





Directly Standardized Rate Estimates
Rate Multiplier = 100000

Country	Study Population			Reference Population		Standardized Rate			
	Observed Events	Population-Time	Crude Rate	Expected Events	Population-Time	Estimate	Standard Error	95% Normal Confidence Limits	
Canada	228066	31612890	721.4	0.656107	100.00000	656.1	1.3808	653.4	658.8
Cuba	86417	11236442	769.1	0.807538	100.00000	807.5	2.7487	802.2	812.9