Summer B Webinars in Psychometrics and Statistics

Data Summary in SAS

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Outline
I. PROC MEANS
II. PROC UNIVARIATE
III. PROC FREQ
IV. PROC STANDARD

I. PROC MEANS

The MEANS procedure serves as a data summarization tool to compute descriptive statistics.

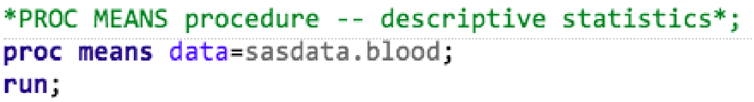
- Mean, standard deviation, confidential interval for mean
- Quantiles, including median
- Identify extreme values

Use dataset *Blood.txt* to see the procedure. Here is the information about the variables.

Variable	**Label**
Subject	Subject ID
Gender	Gender (F or M)
BloodType	Blood type (A, B, O, or AB)
AgeGroup	Age group (Young or Old)
WBC	White blood cells
RBC	Red blood cells
Chol	Cholesterol

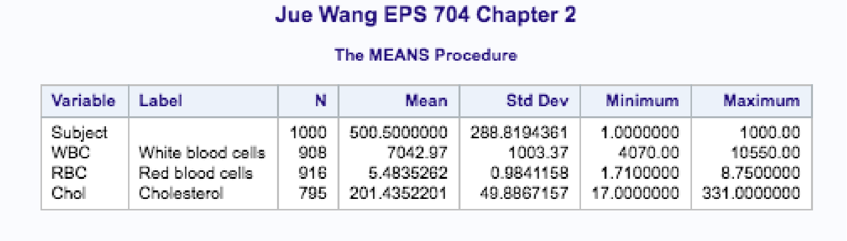
First, we import the dataset.

Second, we get descriptive statistics using the PROC MEANS.



```
*PROC MEANS procedure -- descriptive statistics*;
proc means data=sasdata.blood;
run;
```

SAS output table



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The MEANS Procedure

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
Subject		1000	500.5000000	288.8194361	1.0000000	1000.00
WBC	White blood cells	908	7042.97	1003.37	4070.00	10550.00
RBC	Red blood cells	916	5.4835262	0.9841158	1.7100000	8.7500000
Chol	Cholesterol	795	201.4352201	49.8867157	17.0000000	331.0000000

a. PROC MEANS options and VAR statement

By default, it provides the number of valid responses (N), mean, standard deviation, minimum, and maximum for all of the numeric variables.

- We can compute the statistics for specific variables using statement VAR.
- We can also specify the statistics that we want in particular.

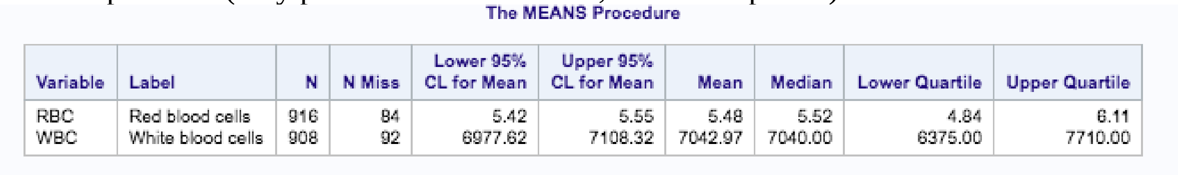
Here is a list of commonly used PROC MEANS options

PROC MEANS option	**Statistic produced**
N	Number of non-missing values
NMISS	Number of missing values
MEAN	Arithmetic mean
SUM	Sum of the values
MIN	Minimum value
MAX	Maximum value
MEDIAN	Median value
STD	Standard deviation
VAR	Variance
CLM	95% confidence interval for the mean
Q1	Value of the first quartile (25th percentile)
Q3	Value of the third quartile (75th percentile)
QRANGE	Interquartile range ($IQR = Q3 - Q1$)

Note: Besides these statistics, the option MAXDEC=*value* is often used to specify decimal places to be printed in the output table. For example,

```
*PROC MEANS procedure -- use VAR statement and request specific statistics*;
proc means data=sasdata.blood n nmiss clm mean median Q1 Q3 maxdec=2;
   var RBC WBC;
run;
```

SAS output table (only printed RBC and WBC; 2 decimal places)



The MEANS Procedure

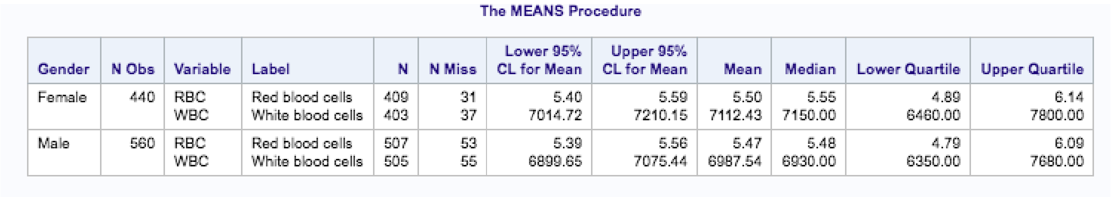
Variable	Label	N	N Miss	Lower 95% CL for Mean	Upper 95% CL for Mean	Mean	Median	Lower Quartile	Upper Quartile
RBC	Red blood cells	916	84	5.42	5.55	5.48	5.52	4.84	6.11
WBC	White blood cells	908	92	6977.62	7108.32	7042.97	7040.00	6375.00	7710.00

b. CLASS statement

This statement specifies a grouping variable for which summary statistics are produced separately for the subjects in different groups.

```
*PROC MEANS procedure -- use VAR statement and request specific statistics*;
proc means data=sasdata.blood n nmiss clm mean median Q1 Q3 maxdec=2;
   class gender;
   var RBC WBC;
run;
```

SAS output table



The MEANS Procedure

Gender	N Obs	Variable	Label	N	N Miss	Lower 95% CL for Mean	Upper 95% CL for Mean	Mean	Median	Lower Quartile	Upper Quartile
Female	440	RBC WBC	Red blood cells White blood cells	409 403	31 37	5.40 7014.72	5.59 7210.15	5.50 7112.43	5.55 7150.00	4.89 6460.00	6.14 7800.00
Male	560	RBC WBC	Red blood cells White blood cells	507 505	53 55	5.39 6899.65	5.56 7075.44	5.47 6987.54	5.48 6930.00	4.79 6350.00	6.09 7680.00

c. OUTPUT statement

The OUTPUT statement puts the computed summary statistics in another dataset. For example

```
*PROC MEANS procedure -- OUTPUT statement*;
proc means data=sasdata.blood n nmiss clm mean median Q1 Q3 maxdec=2;
   class gender;
   var RBC;
   output out=out_RBC mean=mean_RBC std=sd_RBC;
run;
```

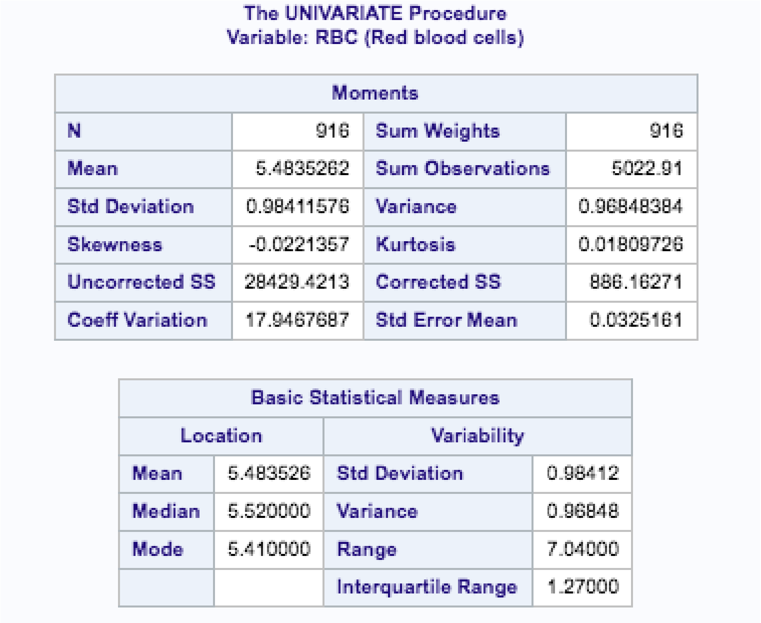
Now, check the OUTPUT DATA (not the RESULTS) to see the out_RBC dataset. This dataset is stored in the WORK library (temporary).

II. PROC UNIVARIATE

This procedure provides a variety of summary statistics for each variable. For example,

```
*PROC UNIVARIATE procedure*;
proc univariate data=sasdata.blood;
  var RBC WBC Chol;
run;
```

Partial SAS output tables



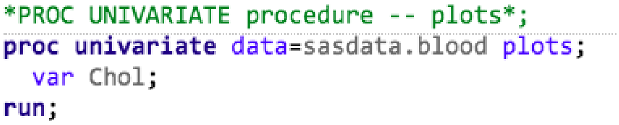
The UNIVARIATE Procedure
Variable: RBC (Red blood cells)

Moments			
N	916	Sum Weights	916
Mean	5.4835262	Sum Observations	5022.91
Std Deviation	0.98411576	Variance	0.96848384
Skewness	-0.0221357	Kurtosis	0.01809726
Uncorrected SS	28429.4213	Corrected SS	886.16271
Coeff Variation	17.9467687	Std Error Mean	0.0325161

Basic Statistical Measures			
Location		Variability	
Mean	5.483526	Std Deviation	0.98412
Median	5.520000	Variance	0.96848
Mode	5.410000	Range	7.04000
		Interquartile Range	1.27000

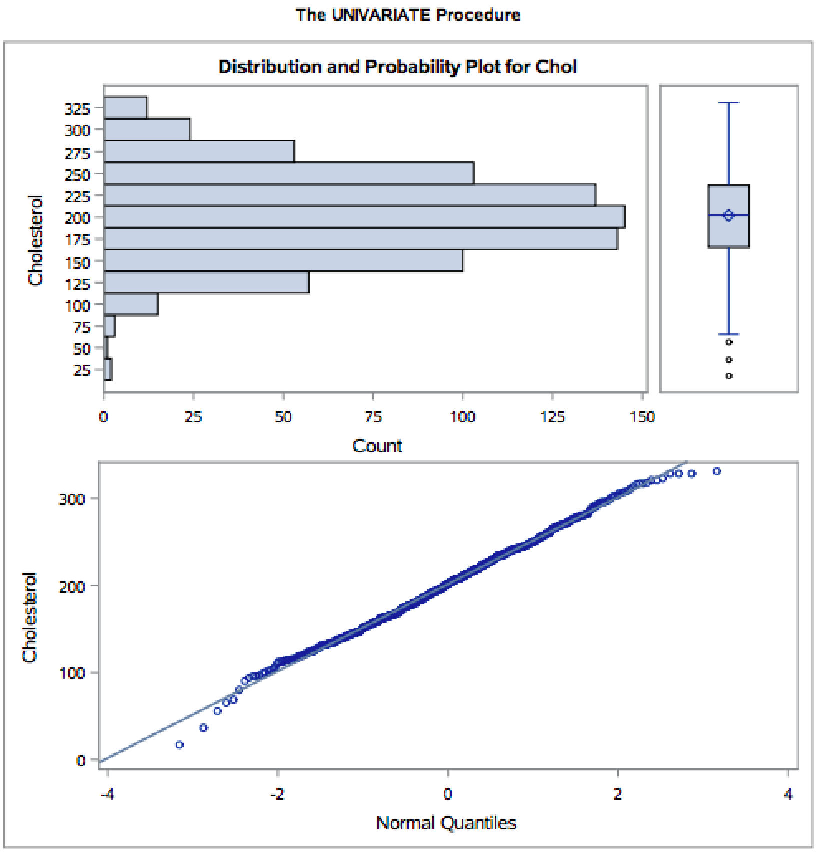
Note: The complete list of output tables is not shown here to save space. Please check them out in your SAS. The CLASS statement works the same way in the UNIVARIATE procedure.

A nice feature of this procedure is that we can generate some plots, such as histogram, boxplot, and normal probability plot. To do so, we simply add the PLOTS option to PROC UNIVARIATE.



```
*PROC UNIVARIATE procedure -- plots*;
proc univariate data=sasdata.blood plots;
  var Chol;
run;
```

SAS output figures

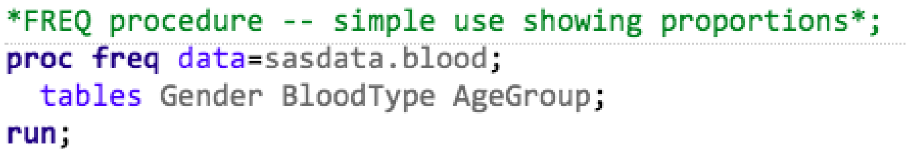


III. PROC FREQ

This procedure can be used to count frequency, percent, cumulative frequency, and cumulative percent in one-way, two-way, and three-way tables.

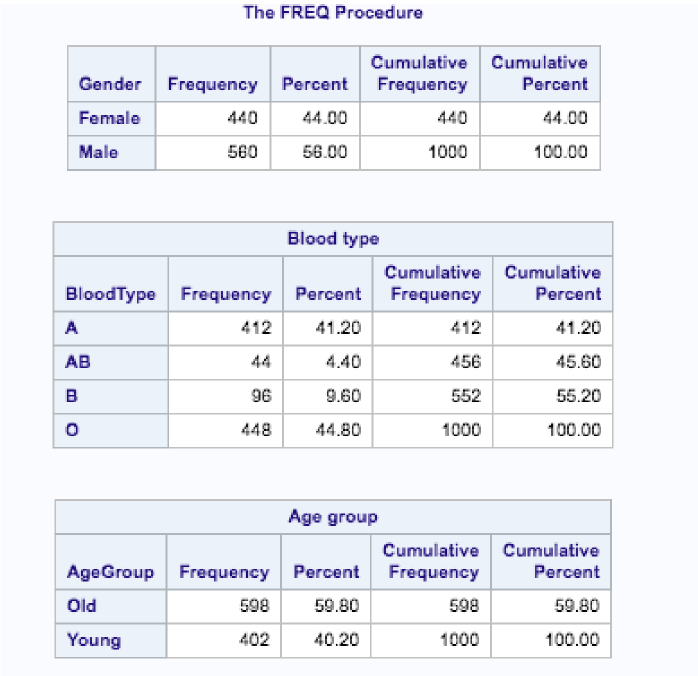
a. The TABLES statement: specify variables that will be summarized

- One-way table: provides frequency measures for each variable separately. For example



```
*FREQ procedure -- simple use showing proportions*;
proc freq data=sasdata.blood;
  tables Gender BloodType AgeGroup;
run;
```

SAS output tables



The FREQ Procedure

Gender	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Female	440	44.00	440	44.00
Male	560	56.00	1000	100.00

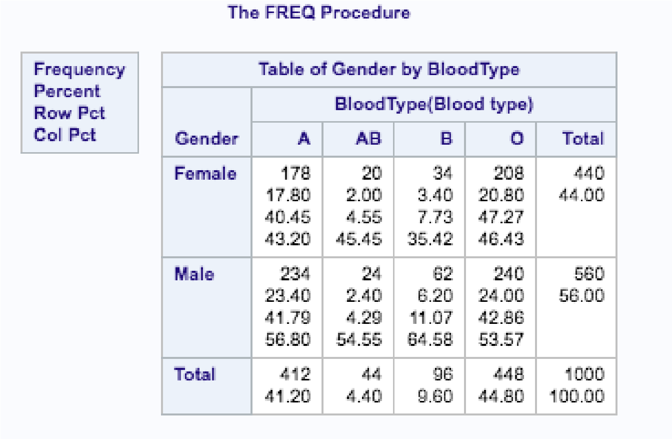
Blood type				
BloodType	Frequency	Percent	Cumulative Frequency	Cumulative Percent
A	412	41.20	412	41.20
AB	44	4.40	456	45.60
B	96	9.60	552	55.20
O	448	44.80	1000	100.00

Age group				
AgeGroup	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Old	598	59.80	598	59.80
Young	402	40.20	1000	100.00

- Create a two-way table using * between two variables, e.g., Gender by Blood Type.

```
*FREQ procedure -- 2-way table*;
proc freq data=sasdata.blood;
  tables Gender*BloodType;
run;
```

SAS output table



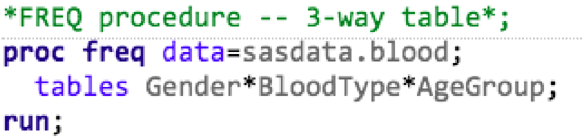
The FREQ Procedure

Frequency
Percent
Row Pct
Col Pct

Table of Gender by BloodType					
	BloodType(Blood type)				
Gender	A	AB	B	O	Total
Female	178 17.80 40.45 43.20	20 2.00 4.55 45.45	34 3.40 7.73 35.42	208 20.80 47.27 46.43	440 44.00
Male	234 23.40 41.79 56.80	24 2.40 4.29 54.55	62 6.20 11.07 64.58	240 24.00 42.86 53.57	560 56.00
Total	412 41.20	44 4.40	96 9.60	448 44.80	1000 100.00

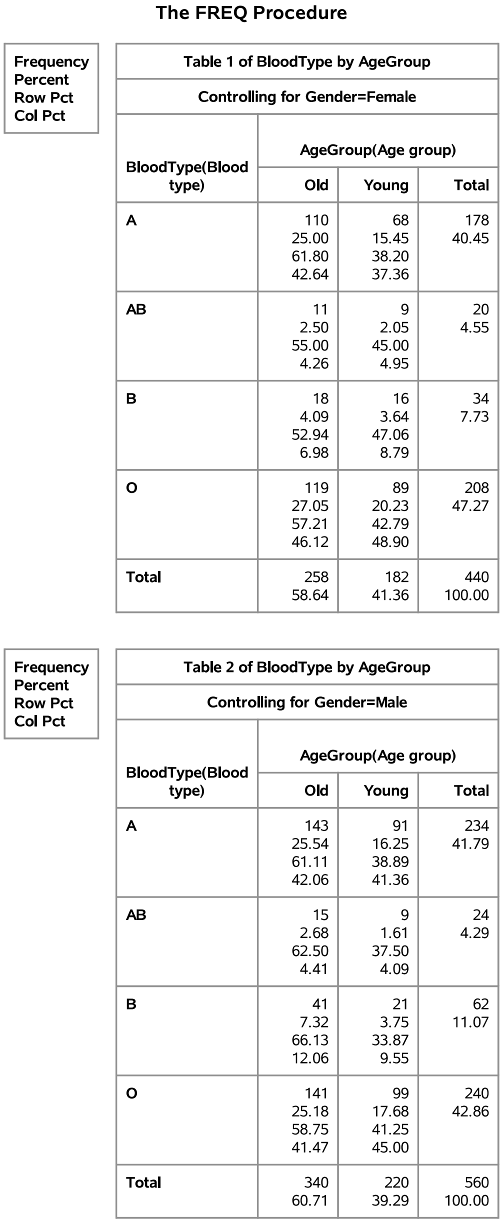
Note: SAS reads Row variable (Gender) * Column variable (BloodType). You can transpose the 2-way table by specifying BloodType*Gender.

- Extension I: Create a three-way table Gender by Blood Type by Age Group.



```
*FREQ procedure -- 3-way table*;
proc freq data=sasdata.blood;
  tables Gender*BloodType*AgeGroup;
run;
```

SAS output tables



The FREQ Procedure

Frequency
Percent
Row Pct
Col Pct

Table 1 of BloodType by AgeGroup

Controlling for Gender=Female

BloodType(Blood type)	AgeGroup(Age group)		
	Old	**Young**	**Total**
A	110 25.00 61.80 42.64	68 15.45 38.20 37.36	178 40.45
AB	11 2.50 55.00 4.26	9 2.05 45.00 4.95	20 4.55
B	18 4.09 52.94 6.98	16 3.64 47.06 8.79	34 7.73
O	119 27.05 57.21 46.12	89 20.23 42.79 48.90	208 47.27
Total	258 58.64	182 41.36	440 100.00

Frequency
Percent
Row Pct
Col Pct

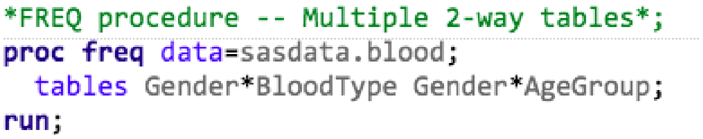
Table 2 of BloodType by AgeGroup

Controlling for Gender=Male

BloodType(Blood type)	AgeGroup(Age group)		
	Old	**Young**	**Total**
A	143 25.54 61.11 42.06	91 16.25 38.89 41.36	234 41.79
AB	15 2.68 62.50 4.41	9 1.61 37.50 4.09	24 4.29
B	41 7.32 66.13 12.06	21 3.75 33.87 9.55	62 11.07
O	141 25.18 58.75 41.47	99 17.68 41.25 45.00	240 42.86
Total	340 60.71	220 39.29	560 100.00

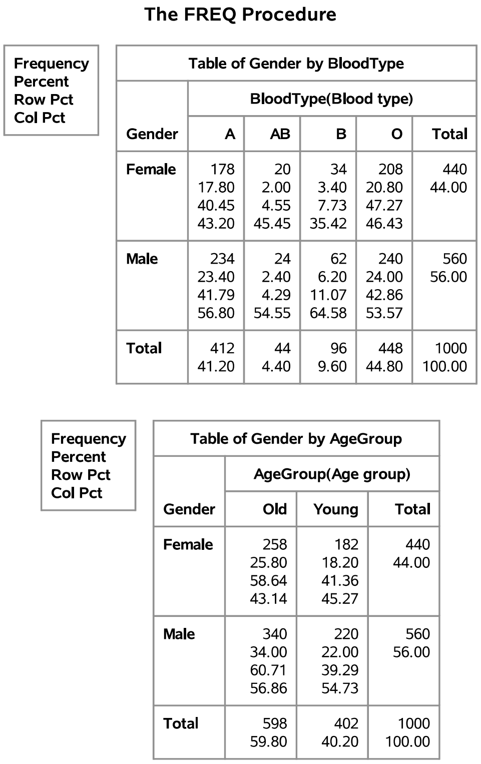
Note: 1st variable (separate tables)*2nd variable (rows)*3rd variable (columns).

- Extension II: Can create multiple tables



```
*FREQ procedure -- Multiple 2-way tables*;
proc freq data=sasdata.blood;
  tables Gender*BloodType Gender*AgeGroup;
run;
```

SAS output tables



The FREQ Procedure

Frequency
Percent
Row Pct
Col Pct

Table of Gender by BloodType					
	BloodType(Blood type)				
Gender	**A**	**AB**	**B**	**O**	**Total**
Female	178 17.80 40.45 43.20	20 2.00 4.55 45.45	34 3.40 7.73 35.42	208 20.80 47.27 46.43	440 44.00
Male	234 23.40 41.79 56.80	24 2.40 4.29 54.55	62 6.20 11.07 64.58	240 24.00 42.86 53.57	560 56.00
Total	412 41.20	44 4.40	96 9.60	448 44.80	1000 100.00

Frequency
Percent
Row Pct
Col Pct

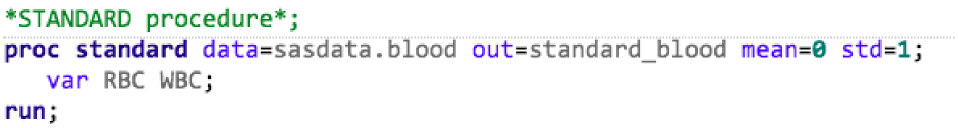
Table of Gender by AgeGroup			
	AgeGroup(Age group)		
Gender	**Old**	**Young**	**Total**
Female	258 25.80 58.64 43.14	182 18.20 41.36 45.27	440 44.00
Male	340 34.00 60.71 56.86	220 22.00 39.29 54.73	560 56.00
Total	598 59.80	402 40.20	1000 100.00

2.4 PROC STANDARD

This procedure is used to standardize the variables.

- No output will be created. Therefore, we use OUT=   to specify a dataset for saving the standardized variables.
- We can define a theoretical mean (other than zero) for centering and any meaning unit (instead of 1) as the new standard deviation. Therefore, in PROC STANDARD, we need to define the mean and standard deviation that we want for the standardized/new variable.

Example (Create standardized RBC and WBC values to Z scores)



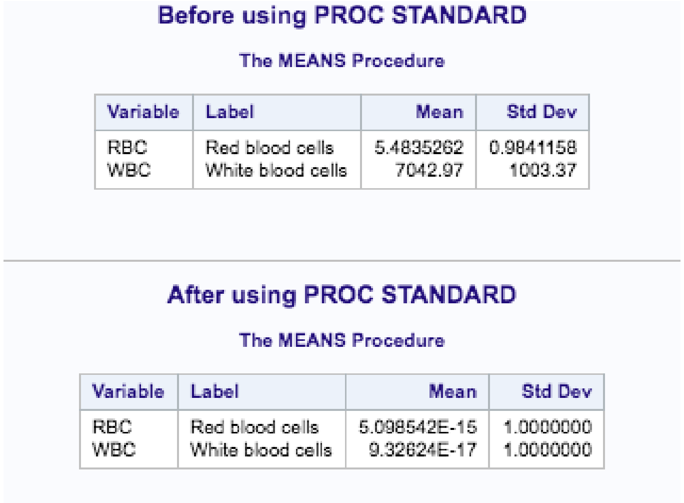
```
*STANDARD procedure*;
proc standard data=sasdata.blood out=standard_blood mean=0 std=1;
   var RBC WBC;
run;
```

Check the output dataset standard_blood in the OUTPUT DATA window. Also, let’s use PROC MEANS to check the mean and standard deviation of the new RBC and WBC variables.

Before standardization	After standardization

Before using PROC STANDARD;
title1 "Before using PROC STANDARD";
proc means data=sasdata.blood mean std;
   var RBC WBC;
run;
	After using PROC STANDARD;
	title1 "After using PROC STANDARD";
	proc means data=standard_blood mean std;
	   var RBC WBC;
	run;

SAS output tables



Before using PROC STANDARD

The MEANS Procedure

Variable	Label	Mean	Std Dev
RBC WBC	Red blood cells White blood cells	5.4835262 7042.97	0.9841158 1003.37

After using PROC STANDARD

The MEANS Procedure

Variable	Label	Mean	Std Dev
RBC WBC	Red blood cells White blood cells	5.098542E-15 9.32624E-17	1.0000000 1.0000000