

## 2. Simple procedures

Use of SAS  
December 2010

# Contents

- transformation and selection
- descriptive procedures
- sorting data

## Example O'Neill et.al. (1983):

Lung function for 25 patients with cystic fibrosis.

**Table 12.11** Data for 25 patients with cystic fibrosis (O'Neill *et al.*, 1983)

Sub	Age	Sex	Height	Weight	BMP	FEV <sub>1</sub>	RV	FRC	TLC	PEmax
1	7	0	109	13.1	68	32	258	183	137	95
2	7	1	112	12.9	65	19	449	245	134	85
3	8	0	124	14.1	64	22	441	268	147	100
4	8	1	125	16.2	67	41	234	146	124	85
5	8	0	127	21.5	93	52	202	131	104	95
6	9	0	130	17.5	68	44	308	155	118	80
7	11	1	139	30.7	89	28	305	179	119	65
8	12	1	150	28.4	69	18	369	198	103	110
9	12	0	146	25.1	67	24	312	194	128	70
10	13	1	155	31.5	68	23	413	225	136	95
11	13	0	156	39.9	89	39	206	142	95	110
12	14	1	153	42.1	90	26	253	191	121	90
13	14	0	160	45.6	93	45	174	139	108	100
14	15	1	158	51.2	93	45	158	124	90	80
15	16	1	160	35.9	66	31	302	133	101	134
16	17	1	153	34.8	70	29	204	118	120	134
17	17	0	174	44.7	70	49	187	104	103	165
18	17	1	176	60.1	92	29	188	129	130	120
19	17	0	171	42.6	69	38	172	130	103	130
20	19	1	156	37.2	72	21	216	119	81	85
21	19	0	174	54.6	86	37	184	118	101	85
22	20	0	178	64.0	86	34	225	148	135	160
23	23	0	180	73.8	97	57	171	108	98	165
24	23	0	175	51.1	71	33	224	131	113	95
25	23	0	179	71.5	95	52	225	127	101	195

Data has been read into the sas-dataset:

p:\sas\data\other\pemax.sas7bdat

## Definition of new variables

We want to study body mass index, bmi.

```
libname mysas 'p:\sas\data\other';
```

```
data temp;      /*temporary data set*/  
  set mysas.pemax;  
  bmi=weight/(height/100)**2;  
run;
```

```
proc print data=temp;  
run;
```

Obs	age	sex	height	weight	fev1	pemax	bmi
1	7	1	109	13.1	32	95	11.0260
2	7	2	112	12.9	19	85	10.2838
3	8	1	124	14.1	22	100	9.1701
.	.	.	.	.	.	.	.

# Transformations

- **Arithmetics**

- The usual operators: `+` `-` `*` `/`
- Raising to a power: `**`, e.g.. `x**2`
- Square root: `sqrt(x)`
- Logarithms: `log(x)`, `log10(x)`, `log2(x)`

- **Relations:**

`=` `<` `>` `<=` `>=` `<>` (unequal)

`eq` `lt` `gt` `le` `ge` `ne` (alternative notation)

- **Logical operators:**

`and` `or` `not`

## Other types of variable definitions

```
data mysas.pemax;  
    set mysas.pemax; /*original file changed*/
```

```
if sex=1 then csex='m';  
if sex=2 then csex='f';
```

```
if 0<bmi<12 then fat=1;  
if 12<=bmi<18 then fat=2;  
if 18<bmi then fat=3;  
run;
```

```
proc print data=mysas.pemax;  
    var csex age bmi fat;  
run;
```

Obs	csex	age	bmi	fat
1	f	7	11.0260	1
2	m	7	10.2838	1
.	.	.	.	.
.	.	.	.	.
14	m	15	20.5095	3

If I do not want to change 'mysas.pemax', I can make a new data set:

```
data temp;
  set mysas.pemax;

  if sex=1 then csex='m';
  if sex=2 then csex='f';

  if 0<bmi<12 then fat=1;
  if 12<=bmi<18 then fat=2;
  if 18<bmi then fat=3;
run;

proc print data=temp;
  var csex age bmi fat;
run;
```

Obs	csex	age	bmi	fat
1	f	7	11.0260	1
2	m	7	10.2838	1
.	.	.	.	.
.	.	.	.	.
14	m	15	20.5095	3

## Measures of location, centre

- Average

$$\bar{x} = \frac{1}{n}(x_1 + \cdots + x_n)$$

- can be interpreted as the centre of gravity
- is heavily influenced by outlying observations

- Median

- the observation in 'the middle'
- is not influenced by outlying observations (**robust**)



## Measures of variation

- Variance, standard deviation

$$s^2 = \frac{1}{n-1} \sum (x_i - \bar{x})^2$$

**standard deviation** =  $\sqrt{\text{variance}}$

- Quantiles
  - median: 50% quantile
  - quartiles: 25%, 50% and 75% quantiles

# Calculation of summary statistics in SAS

```
proc means data=temp;  
run;
```

The MEANS Procedure

Variable	N	Mean	Std Dev	Minimum	Maximum
age	25	14.4800000	5.0589854	7.0000000	23.0000000
sex	25	1.4400000	0.5066228	1.0000000	2.0000000
fev1	25	34.7200000	11.1971723	18.0000000	57.0000000
pemax	25	109.1200000	33.4369058	65.0000000	195.0000000
bmi	25	15.3422331	3.8633242	9.1701353	22.7777778

These are **default**,  
others may be chosen as **options**

# Options in PROC MEANS

`/*Some of the keywords available with PROC MEANS:`

`N - number of observations`

`MEAN - mean value`

`MIN - minimum value`

`MAX - maximum value`

`SUM - total of values`

`NMISS - number of missing values`

`MAXDEC=n - set maximum number of decimal places */`

`statistic-keyword(s)` specifies which statistics to compute  
and the order to display them in the output.

The available keywords in the PROC statement are

Descriptive statistic keywords

`CLM RANGE CSS SKEWNESS|SKEW CV STDDEV|STD KURTOSIS|KURT STDERR`

`LCLM SUM MAX SUMWGT MEAN UCLM MIN USS N VAR NMISS`

Quantile statistic keywords

`MEDIAN|P50 Q3|P75 P1 P90 P5 P95 P10 P99 Q1|P25 QRANGE`

## If we want to see the medians:

```
proc means data=temp median;  
  var age bmi fev1;  
run;
```

The MEANS Procedure

Variable	Median
-----	
age	14.0000000
bmi	14.8660771
fev1	33.0000000
-----	

Oops: Now, we got **only** the median!

```
proc means data=temp N mean median;  
  var age bmi fev1;  
run;
```

The MEANS Procedure

Variable	N	Mean	Median
-----			
age	25	14.4800000	14.0000000
bmi	25	15.3422331	14.8660771
fev1	25	34.7200000	33.0000000
-----			

# Alternative procedure: UNIVARIATE

```
proc univariate data=mysas.pemax;  
    var bmi;  
run;
```

a lot of output...

The UNIVARIATE Procedure

Variable: bmi

## Moments

N	25	Sum Weights	25
Mean	15.3422331	Sum Observations	383.555827
Std Deviation	3.86332415	Variance	14.9252735
Skewness	0.27214922	Kurtosis	-0.7599282
Uncorrected SS	6242.80947	Corrected SS	358.206564
Coeff Variation	25.1809768	Std Error Mean	0.77266483

## Basic Statistical Measures

Location		Variability	
Mean	15.34223	Std Deviation	3.86332
Median	14.86608	Variance	14.92527
Mode	.	Range	13.60764
		Interquartile Range	5.36231

Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----
Student's t	t 19.85626	Pr >  t  <.0001
Sign	M 12.5	Pr >=  M  <.0001
Signed Rank	S 162.5	Pr >=  S  <.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	22.77778
99%	22.77778
95%	22.31516
90%	20.50953
75% Q3	17.98454
50% Median	14.86608
25% Q1	12.62222
10%	10.35503
5%	10.28380
1%	9.17014
0% Min	9.17014

Extreme Observations

-----Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
9.17014	3	19.4021	18
10.28380	2	20.1995	22
10.35503	6	20.5095	14
10.36800	4	22.3152	25
11.02601	1	22.7778	23

# Categorical variables: PROC FREQ

Can be used to illustrate distributions of categorical variables, e.g.

```
proc freq data=temp;
  tables csex sex fat;
run;
```

The FREQ Procedure

csex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
f	11	44.00	11	44.00
m	14	56.00	25	100.00

sex	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	14	56.00	14	56.00
2	11	44.00	25	100.00

fat	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	6	24.00	6	24.00
2	13	52.00	19	76.00
3	6	24.00	25	100.00



## Filtering data - selecting subsets

- In DATA-step
  - regarding observations: WHERE, IF, DELETE
  - regarding variables: DROP, KEEP
- In procedures
  - Regarding observations: WHERE
  - Regarding variables: VAR-statement  
(depending on procedure)

# How to use WHERE

If we only want to look at the girls:

```
data temp1;                                /* temporary data set */
  set mysas.pemax;
  where csex='f';
run;
```

```
proc print data=temp1;
  var csex age bmi;
run;
```

Obs	csex	age	bmi
1	f	7	10.2838
2	f	8	10.3680
3	f	11	15.8894
4	f	12	12.6222
.....			

## Alternative ways of writing,

using **IF** or **DELETE**

Look out, if data contains missing values.

```
data temp2;  
  set mysas.pemax;  
  if csex='f';  
run;
```

-----

```
data temp3;  
  set mysas.pemax;  
  if csex ne 'm';  
run;
```

-----

```
data temp4;  
  set mysas.pemax;  
  if sex='m' then delete;  
run;
```

temp2 includes only girls,

temp3, temp4 includes girls *and* children with information on 'csex'.

Filterings may be combined:

```
data temp5;  
  set mysas.pemax;  
  where csex='f' and age>12;  
run;
```

```
proc print data=temp;  
  var csex age bmi;  
run;
```

Obs	csex	age	bmi
1	f	13	13.1113
2	f	14	17.9845
3	f	15	20.5095
4	f	16	14.0234
5	f	17	14.8661
6	f	17	19.4021
7	f	19	15.2860

Note: Observations with age missing are included with:

```
data pemax6;  
  set mysas.pemax;  
  where csex='female' and age<12;  
run;
```

## How to use DROP and KEEP

Now that we have `bmi`,  
we may not need `height` and `weight`:

The most efficient is to simply delete them:

```
data temp7;  
  set mysas.pemax;  
  drop height weight;  
run;
```

You can also specify which variables you want to keep:

```
data temp8;  
  set mysas.pemax;  
  keep bmi csex;  
run;
```

## Using WHERE in procedures

If we for a specific procedure only want to look at the girls  
(but continue to work with all data):

```
proc print data=mysas.pemax;  
  where csex='f';  
  var csex age bmi;  
run;
```

Obs	csex	age	bmi
1	female	7	10.2838
2	female	8	10.3680
3	female	11	15.8894
4	female	12	12.6222
.....			

## Sorting of data

- Often used because other procedures require sorted data
- Example

```
proc sort data=account;  
    by town descending debt;  
run;
```

- data are sorted by `town` (small values first).
- for each value of `town` data are sorted by `debt` (high values first - because of descending statement).

## BY statement

- Used in many procedures (MEANS, REG, GLM, ...)
- Runs analyses within groups
- Requires that data are sorted
- Remember to get rid of missings, or they will form a separate group
- Example

```
proc sort data=new.fitness;  
    by group;  
run;  
proc means data=new.fitness;  
    var maxpulse;  
    by group;  
run;
```



# Output

----- Experimental group=0 -----

The MEANS Procedure

Analysis Variable : maxpulse Maximum heart rate

N	Mean	Std Dev	Minimum	Maximum
10	177.5000000	6.1689185	168.0000000	186.0000000

----- Experimental group=1 -----

Analysis Variable : maxpulse Maximum heart rate

N	Mean	Std Dev	Minimum	Maximum
10	172.7000000	9.1899704	164.0000000	192.0000000

----- Experimental group=2 -----

Analysis Variable : maxpulse Maximum heart rate

N	Mean	Std Dev	Minimum	Maximum
11	171.3636364	10.9660634	155.0000000	188.0000000

# The Juul data set

Anders Juul et al., Dep. GR, Rigshosp.

Serum IGF-I (Insulin-like Growth Factor) reference data set

Age	N	Source
0–5	44	Circumcision, hernia operation
5–20	833	4 schools in the Copenhagen area
20+	153	Hospital staff

AGE	age
MENARCHE	1. menstrual period occurred (1/2, 2 for yes)
SEXNR	1 for boys, 2 for girls
SIGF1	Serum IGF-I
TANNER	Puberty stage a.m. Tanner (1–5)
TESTVOL	Testicular volume

## Exercise: Simple procedures

In your p-drive, you can find the file '`\juul2.sas7bdat`' containing the Juul data with variables

- Age (years)
- Height (cm)
- Menarche (No/Yes: 1/2)
- Sexnr (M/F: 1/2)
- Serum IGF1, growth hormone ( $\mu\text{g/ml}$ )
- Tanner stage (1–5)
- Testis volume (ml)
- Weight (kg)

1. Read the data it into SAS using a libname statement.
2. Calculate means and standard deviations
3. Use PROC FREQ to determine the distribution of the categorical variables
4. Make a new variable giving the BMI for each person
5. Determine the BMI distribution in each of the Tanner stages (e.g. using a BY-statement).