PLSC 502 – Fall 2023
Descriptive Graphics

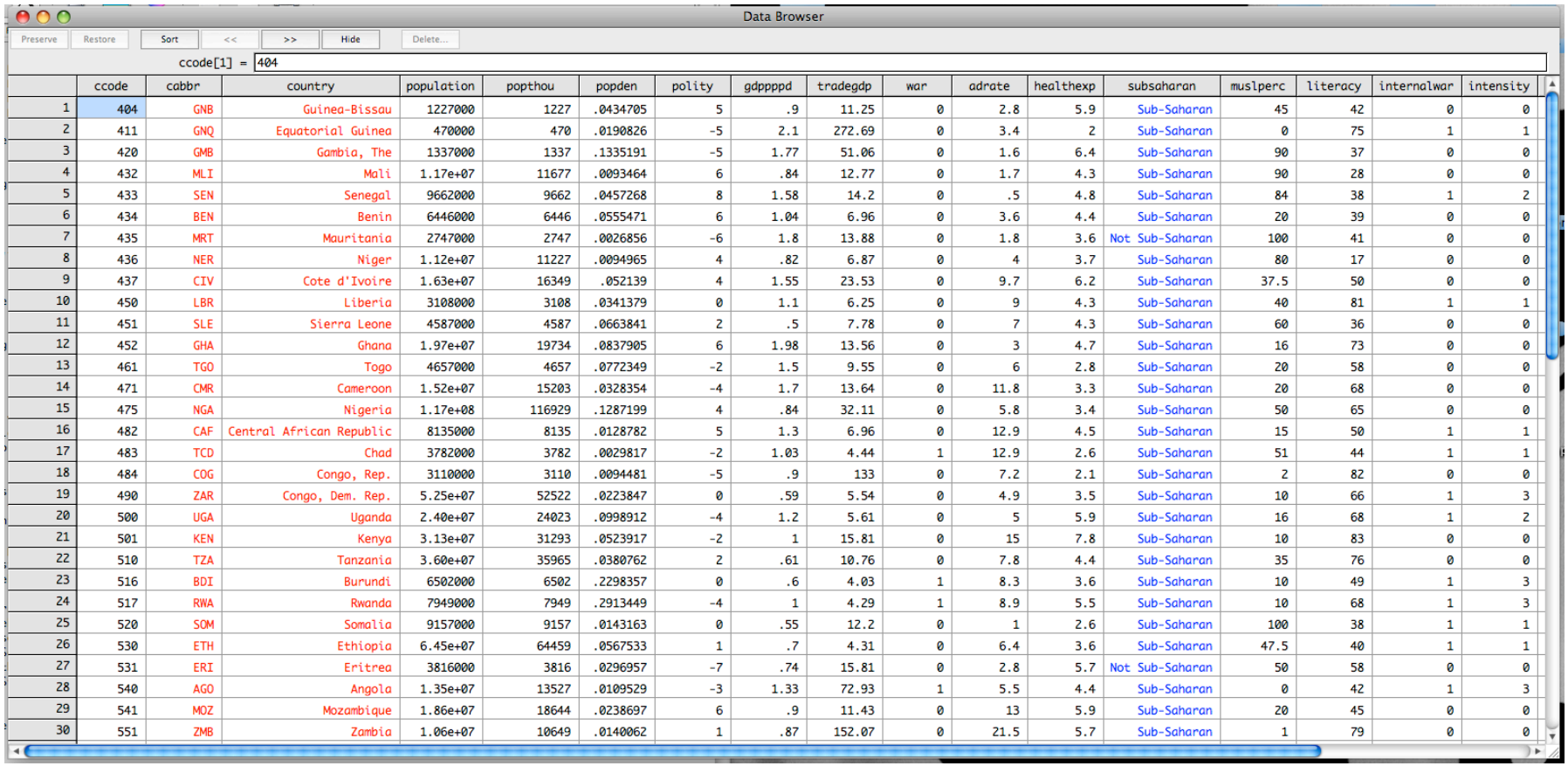
September 11, 2023

Why Plot?

We use plots to:

- Know your data.
- Catch mistakes.
- Learn something...

Example: Africa, 2001



	ccode	cabbr	country	population	popthou	popden	polity	gdppppd	tradegdp	war	adrate	healthexp	subsaharan	muslperc	literacy	internalwar	intensity
1	404	GNB	Guinea-Bissau	1227000	1227	.0434705	5	.9	11.25	0	2.8	5.9	Sub-Saharan	45	42	0	0
2	411	GNQ	Equatorial Guinea	470000	470	.0190826	-5	2.1	272.69	0	3.4	2	Sub-Saharan	0	75	1	1
3	420	GMB	Gambia, The	1337000	1337	.1335191	-5	1.77	51.06	0	1.6	6.4	Sub-Saharan	90	37	0	0
4	432	MLI	Mali	1.17e+07	11677	.0093464	6	.84	12.77	0	1.7	4.3	Sub-Saharan	90	28	0	0
5	433	SEN	Senegal	9662000	9662	.0457268	8	1.58	14.2	0	.5	4.8	Sub-Saharan	84	38	1	2
6	434	BEN	Benin	6446000	6446	.0555471	6	1.04	6.96	0	3.6	4.4	Sub-Saharan	20	39	0	0
7	435	MRT	Mauritania	2747000	2747	.0026856	-6	1.8	13.88	0	1.8	3.6	Not Sub-Saharan	100	41	0	0
8	436	NER	Niger	1.12e+07	11227	.0094965	4	.82	6.87	0	4	3.7	Sub-Saharan	80	17	0	0
9	437	CIV	Cote d'Ivoire	1.63e+07	16349	.052139	4	1.55	23.53	0	9.7	6.2	Sub-Saharan	37.5	50	0	0
10	450	LBR	Liberia	3108000	3108	.0341379	0	1.1	6.25	0	9	4.3	Sub-Saharan	40	81	1	1
11	451	SLE	Sierra Leone	4587000	4587	.0663841	2	.5	7.78	0	7	4.3	Sub-Saharan	60	36	0	0
12	452	GHA	Ghana	1.97e+07	19734	.0837905	6	1.98	13.56	0	3	4.7	Sub-Saharan	16	73	0	0
13	461	TGO	Togo	4657000	4657	.0772349	-2	1.5	9.55	0	6	2.8	Sub-Saharan	20	58	0	0
14	471	CMR	Cameroon	1.52e+07	15203	.0328354	-4	1.7	13.64	0	11.8	3.3	Sub-Saharan	20	68	0	0
15	475	NGA	Nigeria	1.17e+08	116929	.1287199	4	.84	32.11	0	5.8	3.4	Sub-Saharan	50	65	0	0
16	482	CAF	Central African Republic	8135000	8135	.0128782	5	1.3	6.96	0	12.9	4.5	Sub-Saharan	15	50	1	1
17	483	TCD	Chad	3782000	3782	.0029817	-2	1.03	4.44	1	12.9	2.6	Sub-Saharan	51	44	1	1
18	484	COG	Congo, Rep.	3110000	3110	.0094481	-5	.9	133	0	7.2	2.1	Sub-Saharan	2	82	0	0
19	490	ZAR	Congo, Dem. Rep.	5.25e+07	52522	.0223847	0	.59	5.54	0	4.9	3.5	Sub-Saharan	10	66	1	3
20	500	UGA	Uganda	2.40e+07	24023	.0998912	-4	1.2	5.61	0	5	5.9	Sub-Saharan	16	68	1	2
21	501	KEN	Kenya	3.13e+07	31293	.0523917	-2	1	15.81	0	15	7.8	Sub-Saharan	10	83	0	0
22	510	TZA	Tanzania	3.60e+07	35965	.0380762	2	.61	10.76	0	7.8	4.4	Sub-Saharan	35	76	0	0
23	516	BDI	Burundi	6502000	6502	.2298357	0	.6	4.03	1	8.3	3.6	Sub-Saharan	10	49	1	3
24	517	RWA	Rwanda	7949000	7949	.2913449	-4	1	4.29	1	8.9	5.5	Sub-Saharan	10	68	1	3
25	520	SOM	Somalia	9157000	9157	.0143163	0	.55	12.2	0	1	2.6	Sub-Saharan	100	38	1	1
26	530	ETH	Ethiopia	6.45e+07	64459	.0567533	1	.7	4.31	0	6.4	3.6	Sub-Saharan	47.5	40	1	1
27	531	ERI	Eritrea	3816000	3816	.0296957	-7	.74	15.81	0	2.8	5.7	Not Sub-Saharan	50	58	0	0
28	540	AGO	Angola	1.35e+07	13527	.0109529	-3	1.33	72.93	1	5.5	4.4	Sub-Saharan	0	42	1	3
29	541	MOZ	Mozambique	1.86e+07	18644	.0238697	6	.9	11.43	0	13	5.9	Sub-Saharan	20	45	0	0
30	551	ZMB	Zambia	1.06e+07	10649	.0140062	1	.87	152.07	0	21.5	5.7	Sub-Saharan	1	79	0	0

Example: Africa, 2001

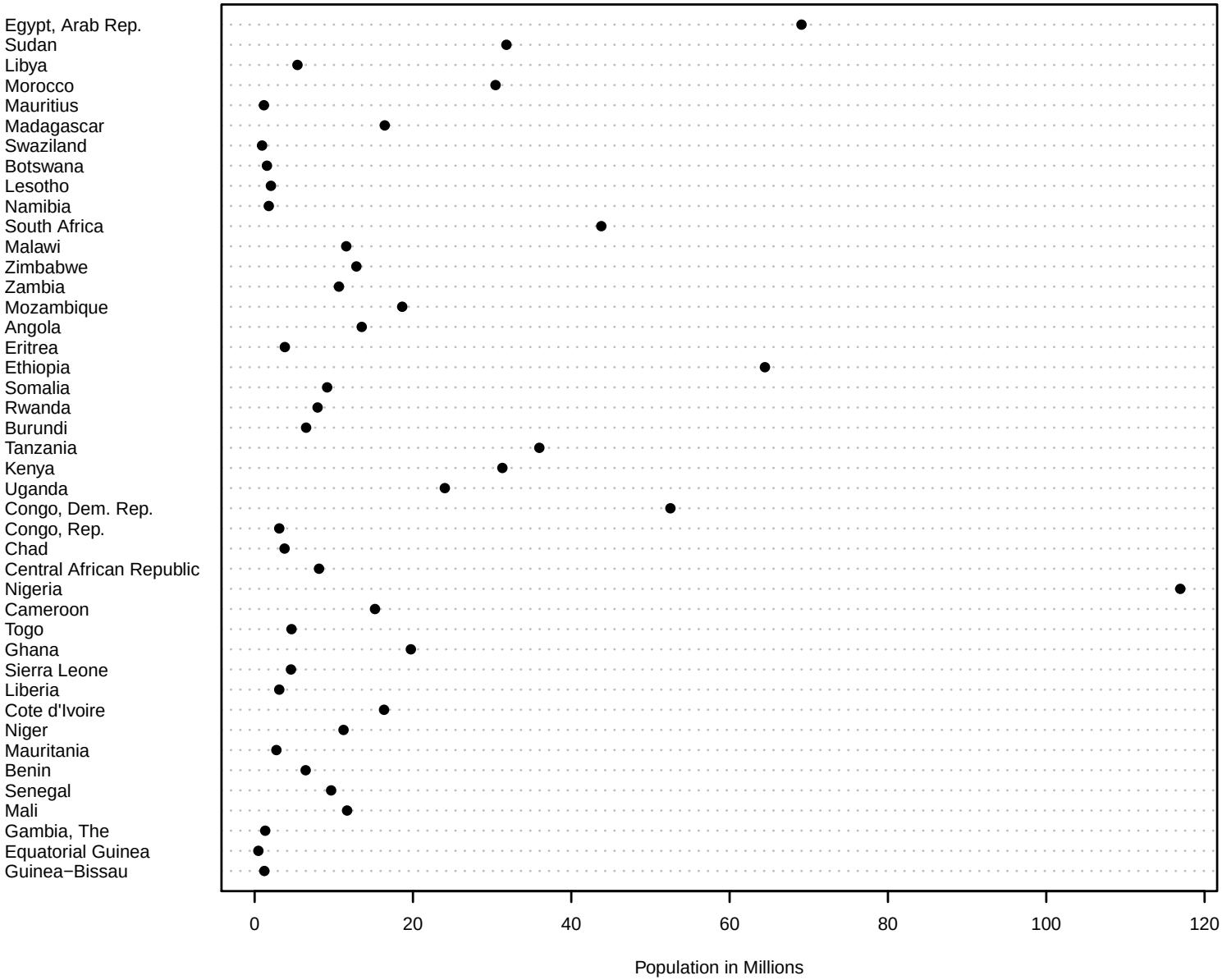
```
    ccode           cabbr                        country     population          popthou
Min.   :404.0   AGO    : 1   Angola                  : 1   Min.   :   470000   Min.   :   470
1st Qu.:451.5   BDI    : 1   Benin                   : 1   1st Qu.:  3446000   1st Qu.:  3446
Median :510.0   BEN    : 1   Botswana                : 1   Median :  9662000   Median :  9662
Mean   :509.5   BWA    : 1   Burundi                 : 1   Mean   : 17390256   Mean   : 17390
3rd Qu.:556.5   CAF    : 1   Cameroon                : 1   3rd Qu.: 19189000   3rd Qu.: 19189
Max.   :651.0   CIV    : 1   Central African Republic: 1   Max.   :116929000   Max.   :116929
                (Other):37   (Other)                 :37
    popden             polity           gdppppd          tradegdp            war
Min.   :0.002228   Min.   :-9.0000   Min.   : 0.500   Min.   :  4.030   Min.   :0.0000
1st Qu.:0.013442   1st Qu.:-4.5000   1st Qu.: 0.855   1st Qu.:  7.645   1st Qu.:0.0000
Median :0.035707   Median : 0.0000   Median : 1.200   Median : 13.560   Median :0.0000
Mean   :0.064279   Mean   : 0.5116   Mean   : 2.159   Mean   : 30.493   Mean   :0.1163
3rd Qu.:0.068302   3rd Qu.: 5.5000   3rd Qu.: 2.040   3rd Qu.: 30.010   3rd Qu.:0.0000
Max.   :0.574020   Max.   :10.0000   Max.   :10.800   Max.   :272.690   Max.   :1.0000

    adrate          healthexp              subsaharan    muslperc         literacy
Min.   : 0.100   Min.   :2.000   Not Sub-Saharan: 6   Min.   :  0.00   Min.   :17.00
1st Qu.: 2.700   1st Qu.:3.450   Sub-Saharan    :37   1st Qu.: 10.00   1st Qu.:43.00
Median : 6.000   Median :4.400                        Median : 20.00   Median :61.00
Mean   : 9.365   Mean   :4.598                        Mean   : 35.96   Mean   :60.07
3rd Qu.:12.900   3rd Qu.:5.800                        3rd Qu.: 55.50   3rd Qu.:78.50
Max.   :38.800   Max.   :8.600                        Max.   :100.00   Max.   :89.00

 internalwar       intensity
Min.   :0.0000   Min.   :0.0000
1st Qu.:0.0000   1st Qu.:0.0000
Median :0.0000   Median :0.0000
Mean   :0.3023   Mean   :0.5814
3rd Qu.:1.0000   3rd Qu.:1.0000
Max.   :1.0000   Max.   :3.0000
```

A Better (?) Summary

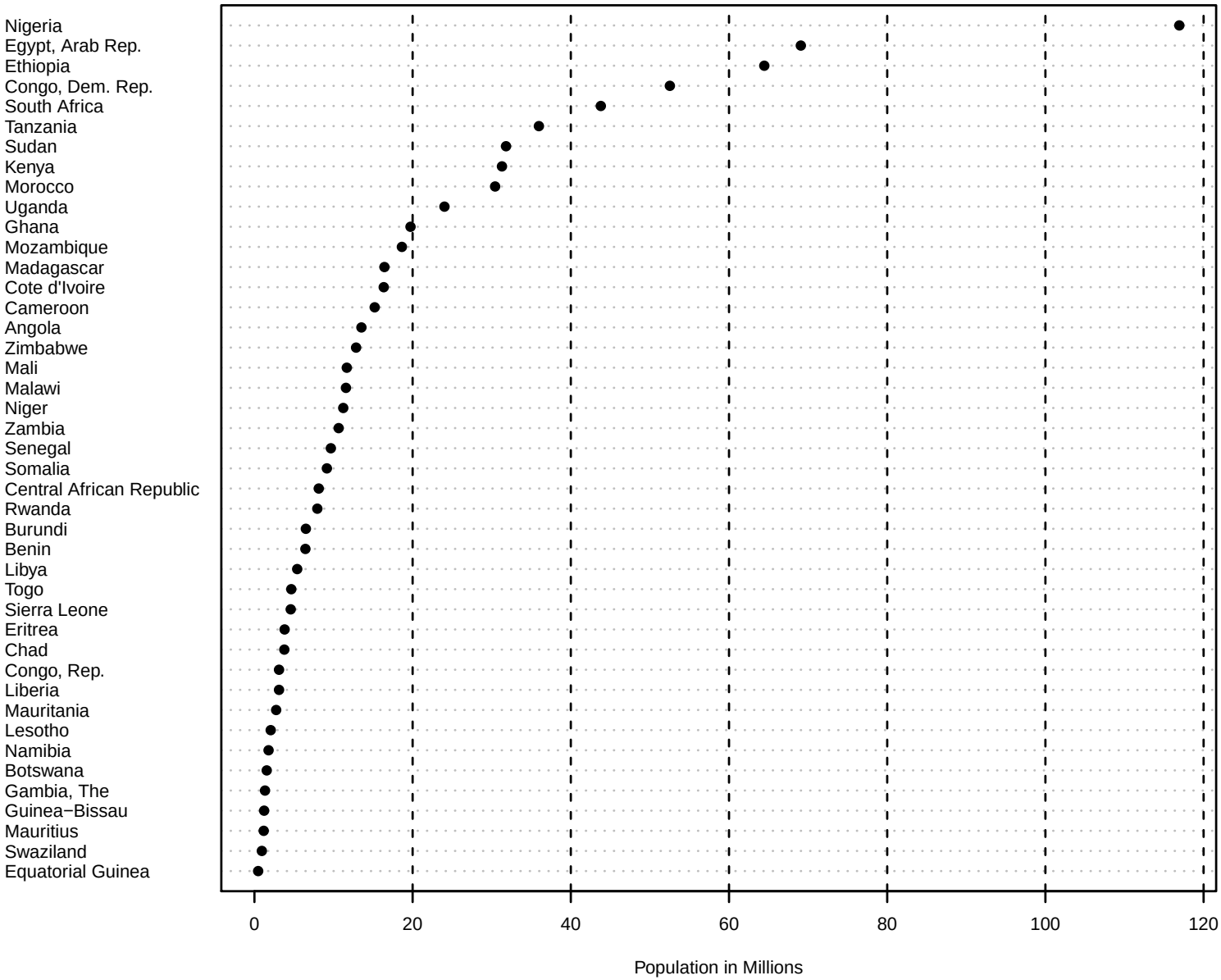
```
> describe(Africa,trim=0)
```

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
ccode	1	43	509.47	63.84	510.00	509.47	81.54	404.00	651.00	247.00	0.21	-0.97	9.74
cabbr*	2	43	22.00	12.56	22.00	22.00	16.31	1.00	43.00	42.00	0.00	-1.28	1.91
country*	3	43	22.00	12.56	22.00	22.00	16.31	1.00	43.00	42.00	0.00	-1.28	1.91
population	4	43	17390255.81	22864218.24	9662000.00	17390255.81	10044615.00	470000.00	116929000.00	116459000.00	2.42	6.64	3486760.59
popthou	5	43	17390.26	22864.22	9662.00	17390.26	10044.61	470.00	116929.00	116459.00	2.42	6.64	3486.76
popden	6	43	0.06	0.10	0.04	0.06	0.04	0.00	0.57	0.57	3.59	14.70	0.01
polity	7	43	0.51	5.41	0.00	0.51	7.41	-9.00	10.00	19.00	0.01	-1.38	0.82
gdppppd	8	43	2.16	2.42	1.20	2.16	0.74	0.50	10.80	10.30	2.19	3.99	0.37
tradegdp	9	43	30.49	49.00	13.56	30.49	9.79	4.03	272.69	268.66	3.35	12.26	7.47
war	10	43	0.12	0.32	0.00	0.12	0.00	0.00	1.00	1.00	2.31	3.42	0.05
adrate	11	43	9.37	9.96	6.00	9.37	6.38	0.10	38.80	38.70	1.44	1.23	1.52
healthexp	12	43	4.60	1.63	4.40	4.60	1.63	2.00	8.60	6.60	0.46	-0.52	0.25
subsaharan*	13	43	1.86	0.35	2.00	1.86	0.00	1.00	2.00	1.00	-2.01	2.08	0.05
muslperc	14	43	35.96	34.58	20.00	35.96	29.65	0.00	100.00	100.00	0.68	-1.04	5.27
literacy	15	43	60.07	18.94	61.00	60.07	26.69	17.00	89.00	72.00	-0.20	-1.18	2.89
internalwar	16	43	0.30	0.46	0.00	0.30	0.00	0.00	1.00	1.00	0.83	-1.34	0.07
intensity	17	43	0.58	1.03	0.00	0.58	0.00	0.00	3.00	3.00	1.52	0.79	0.16

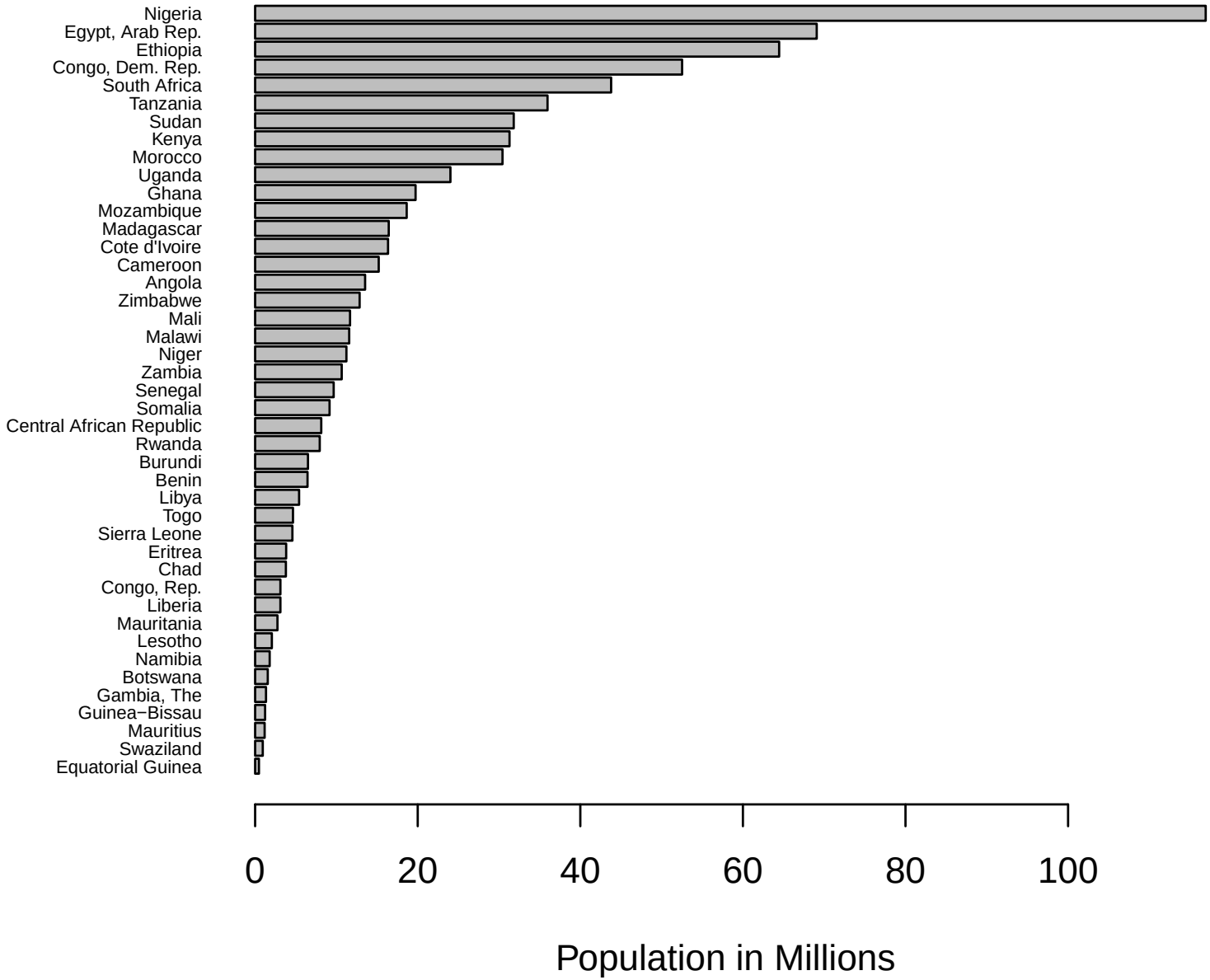
The Dotchart



The Dotchart, Sorted

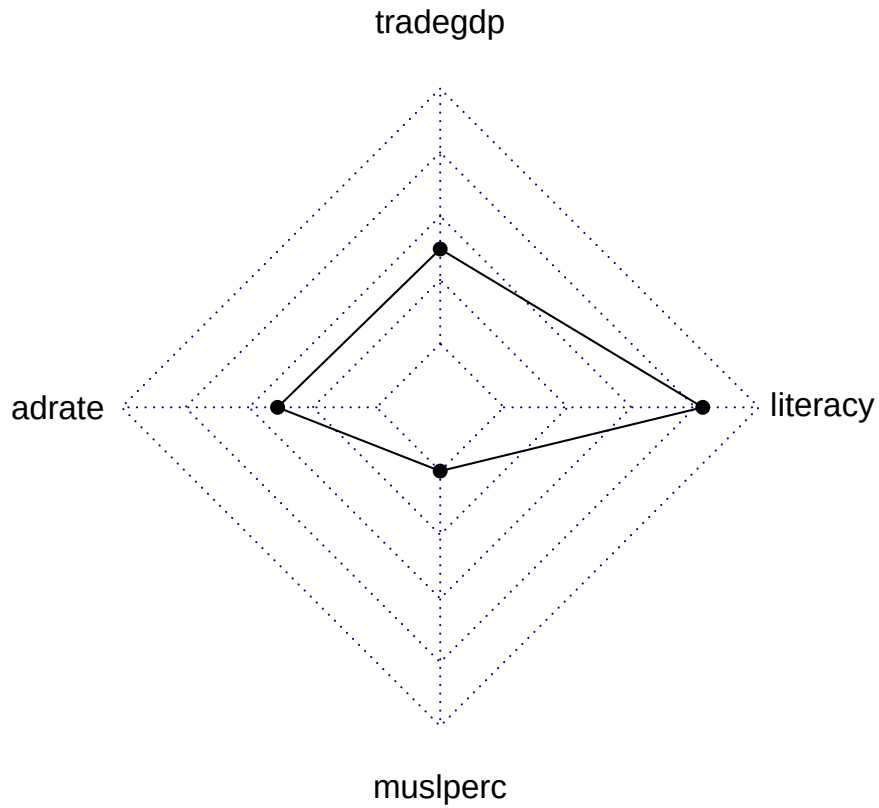


The Barchart, Sorted



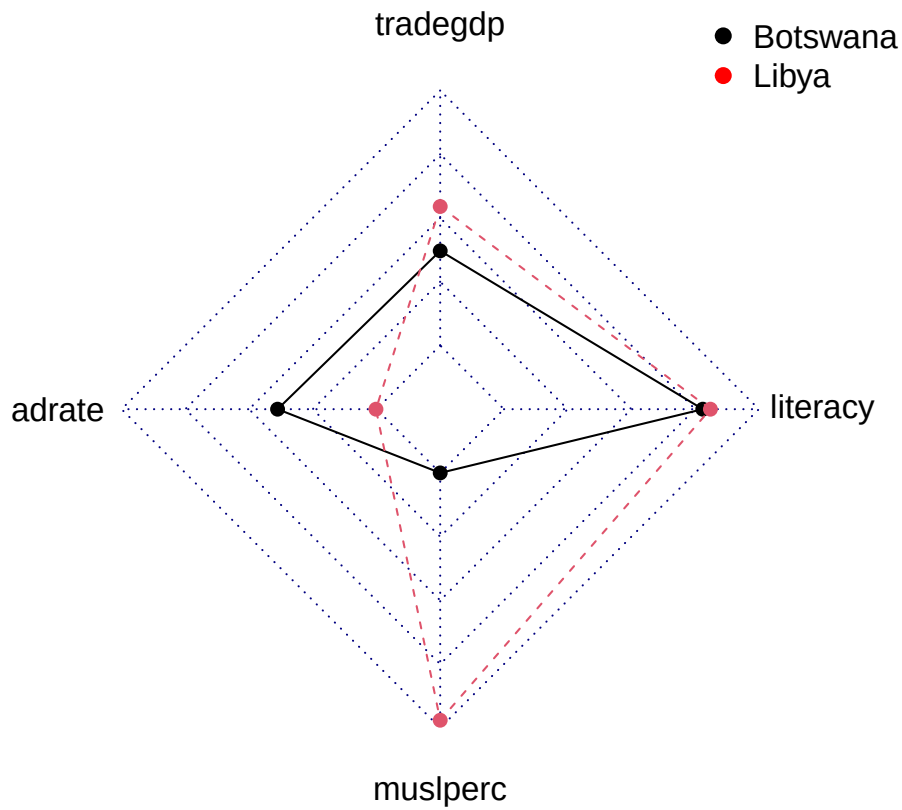
“Spiderplots” / Radar Plots / etc.

Radar Chart: Botswana

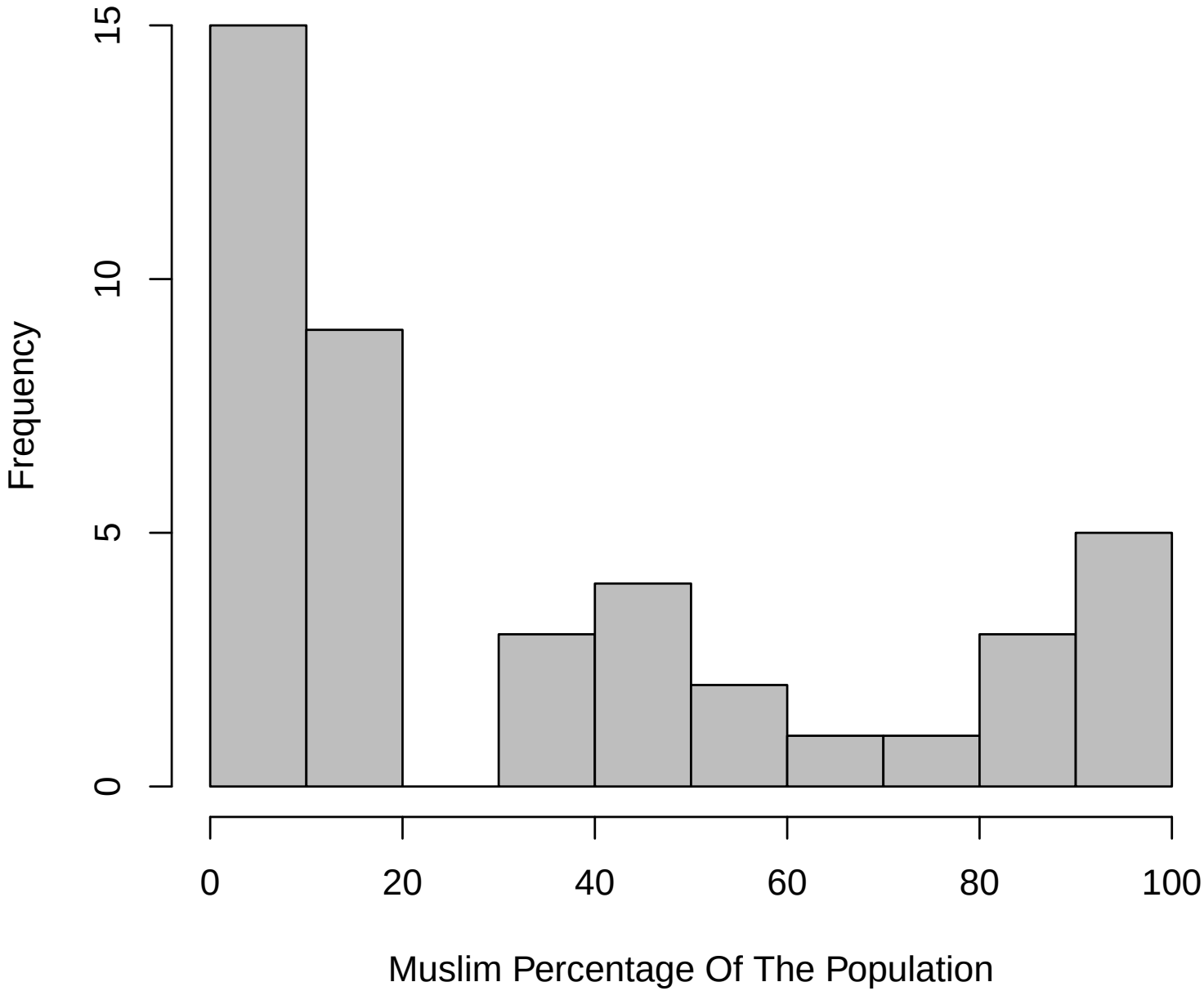


“Spiderplots” / Radar Plots / etc. (cont’d)

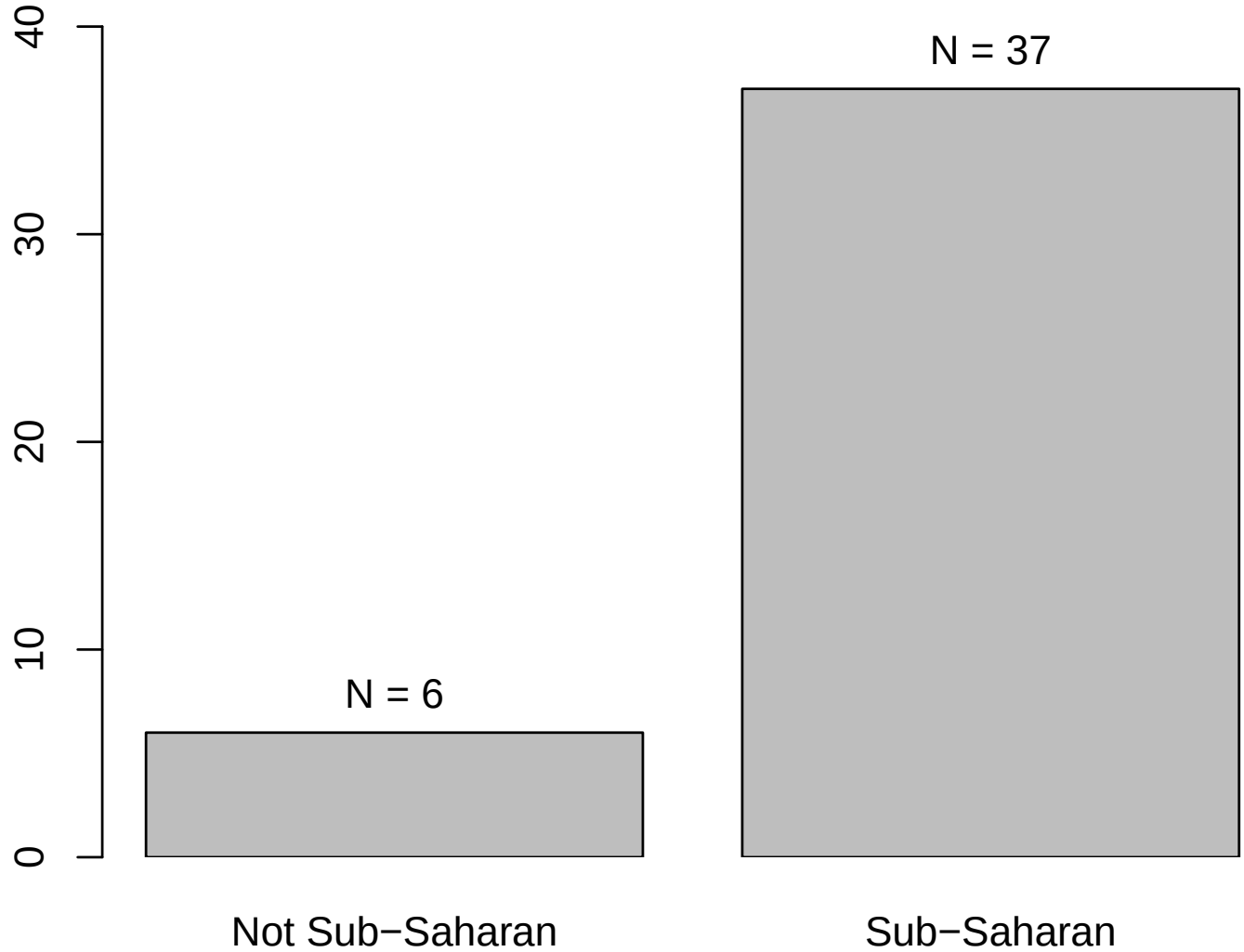
Radar Chart: Botswana and Libya



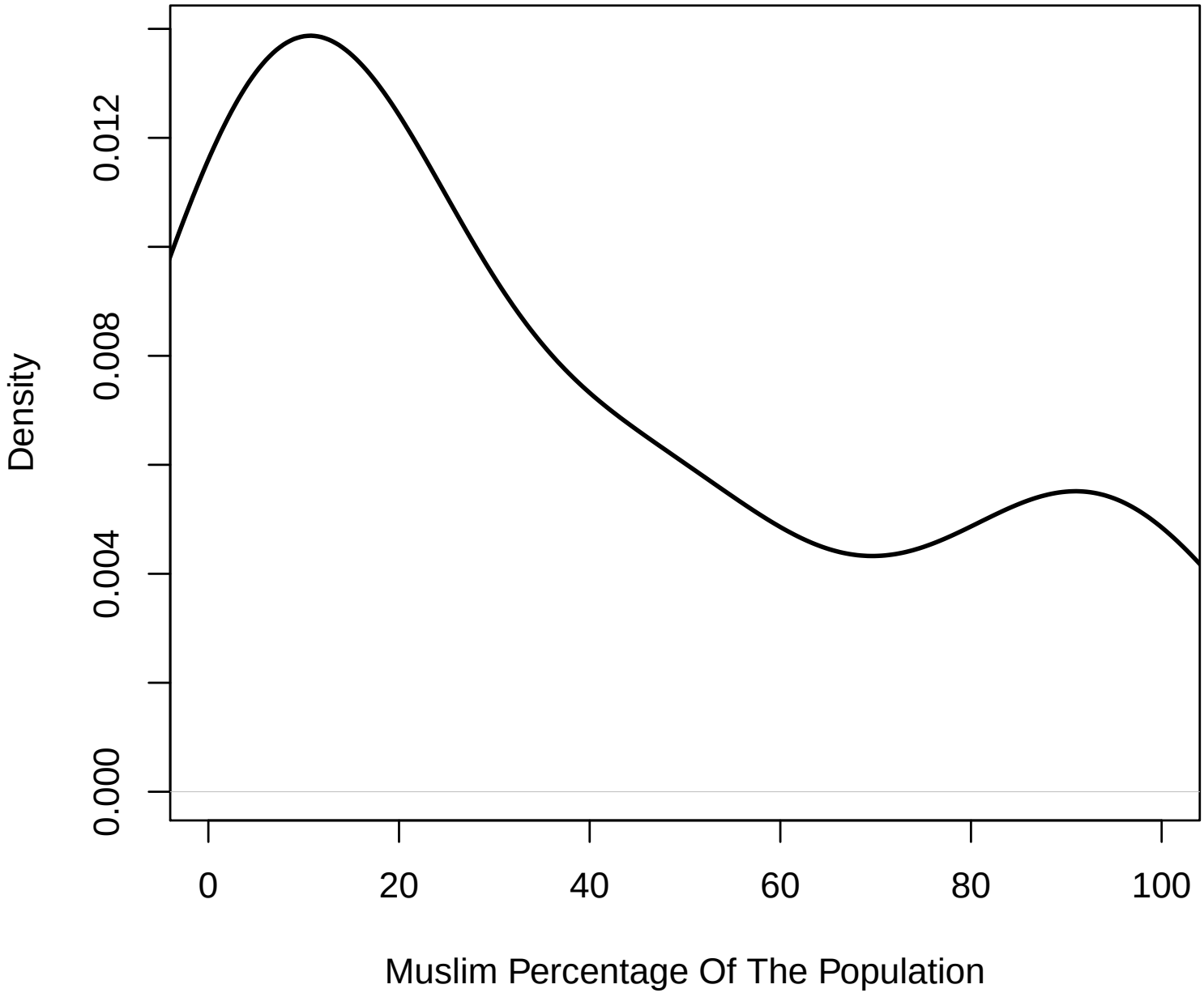
The Histogram



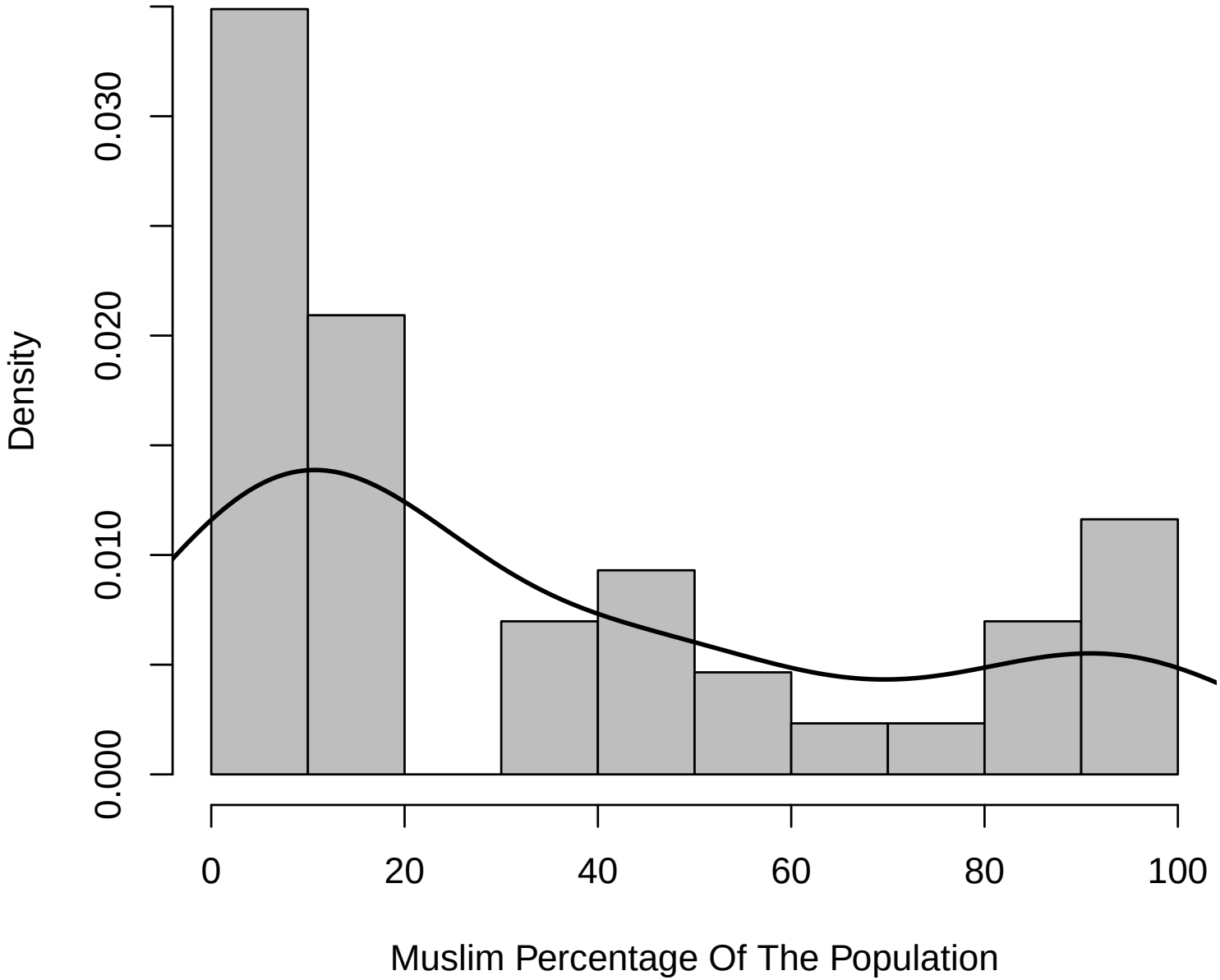
Another Histogram



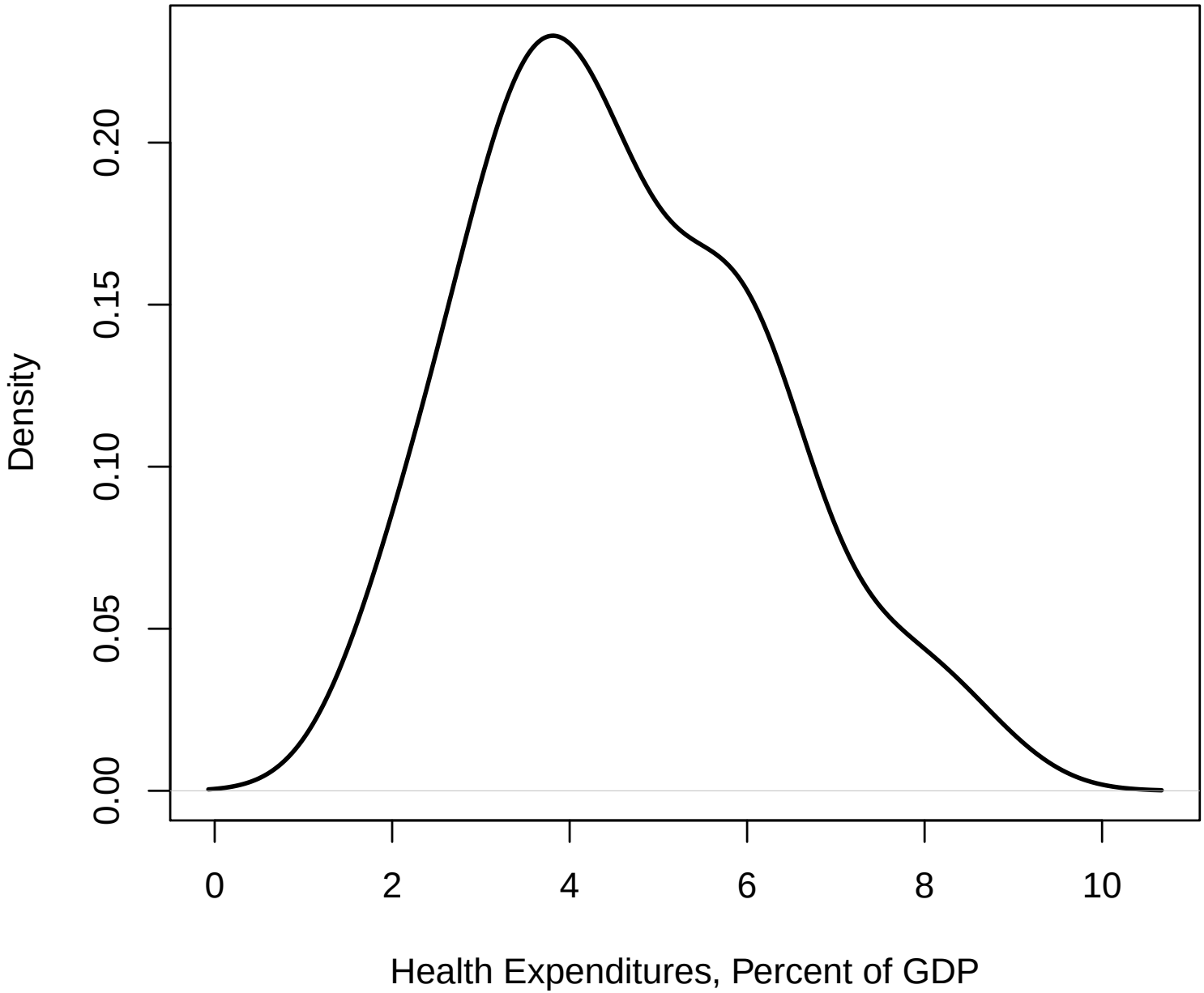
Kernel Density Plot



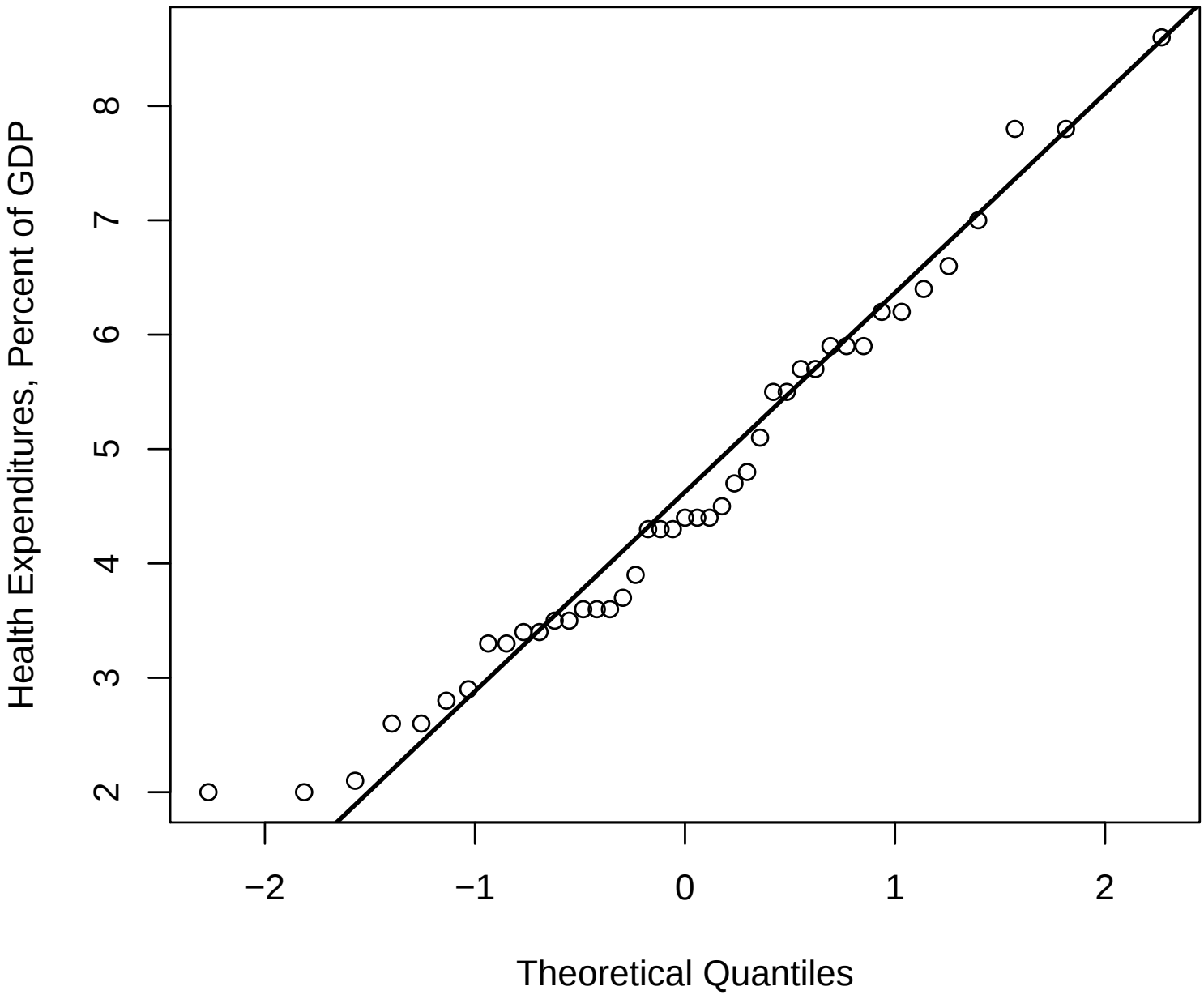
Combined Plot



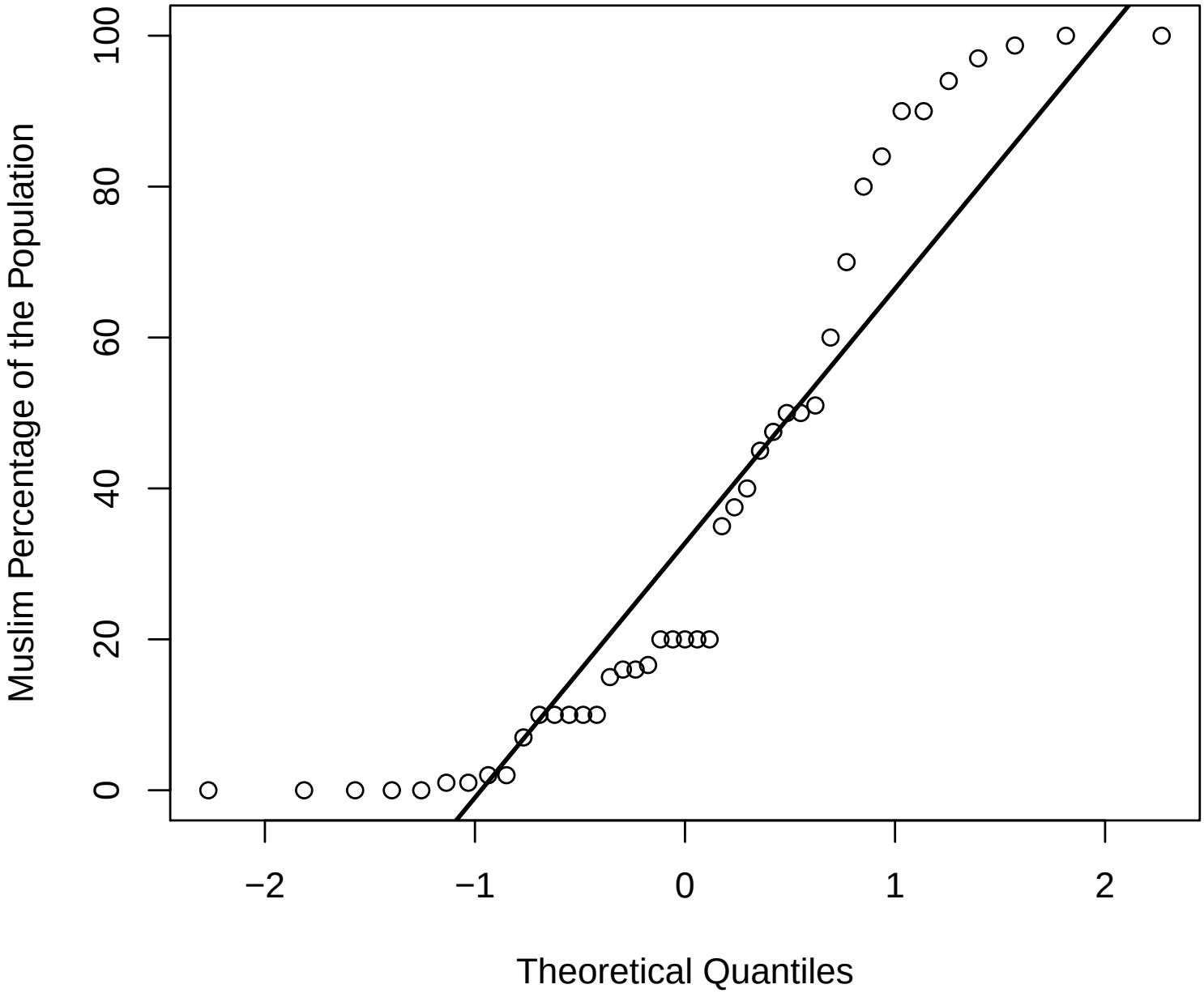
Density Plot: Health Expenditures



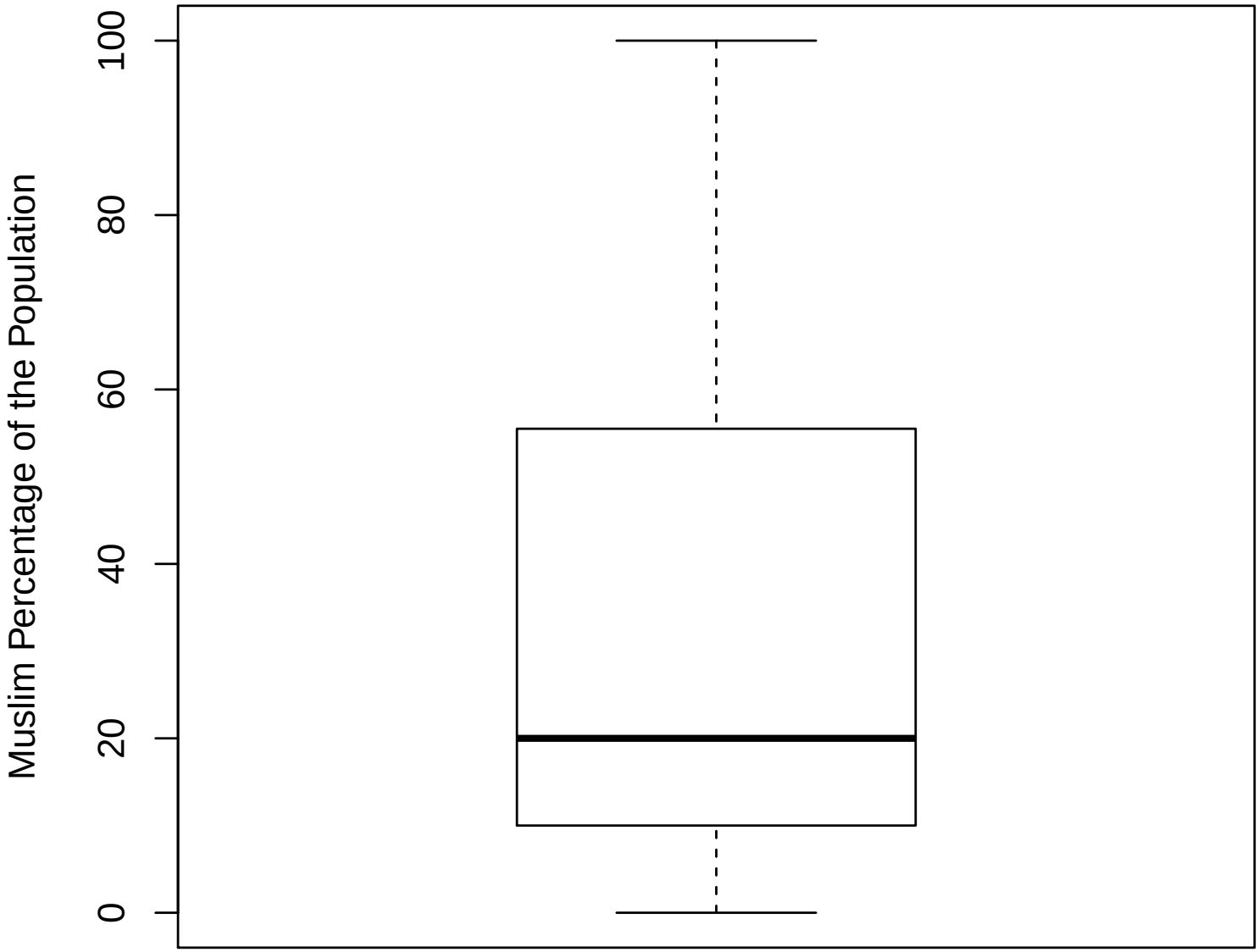
Q-Q Plot: Health Expenditures



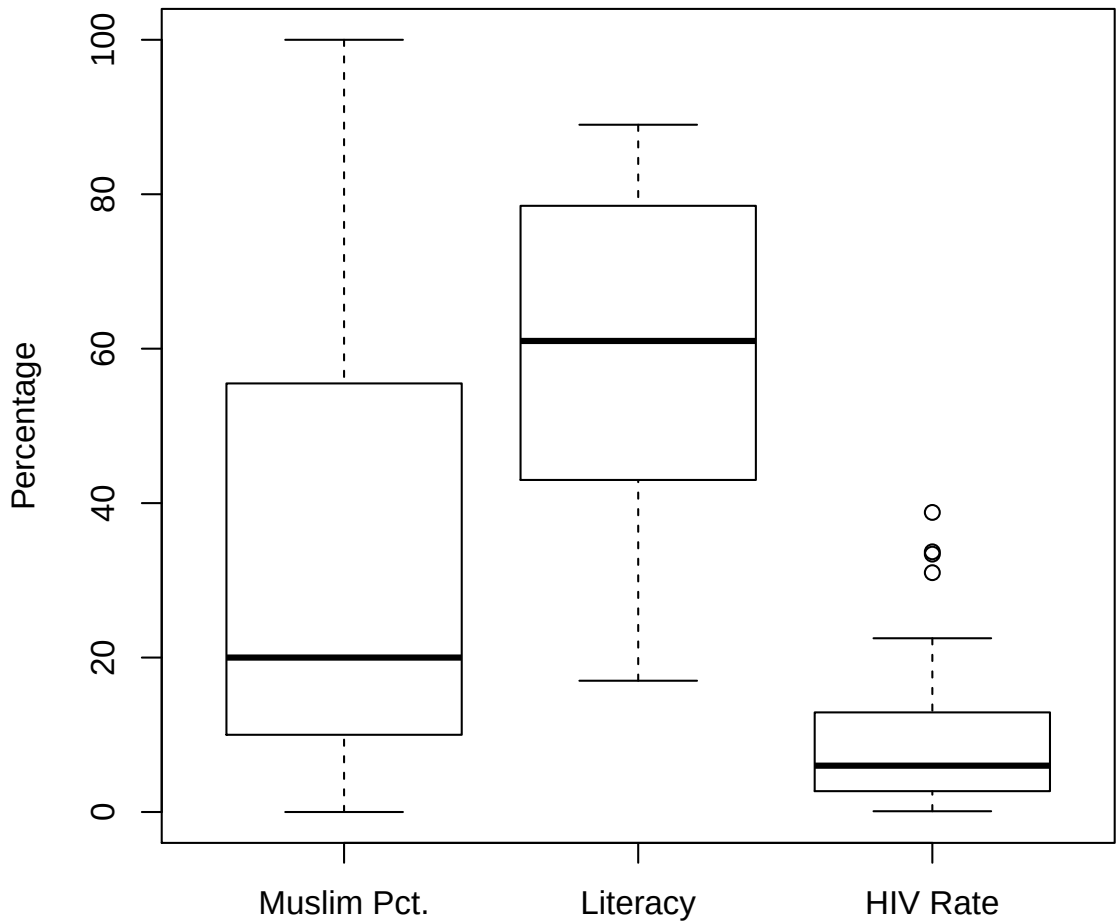
Q-Q Plot: Muslim Percentage



Boxplot: Muslim Percentage



Boxplot: Muslim Percentage, Literacy, and HIV Prevalence



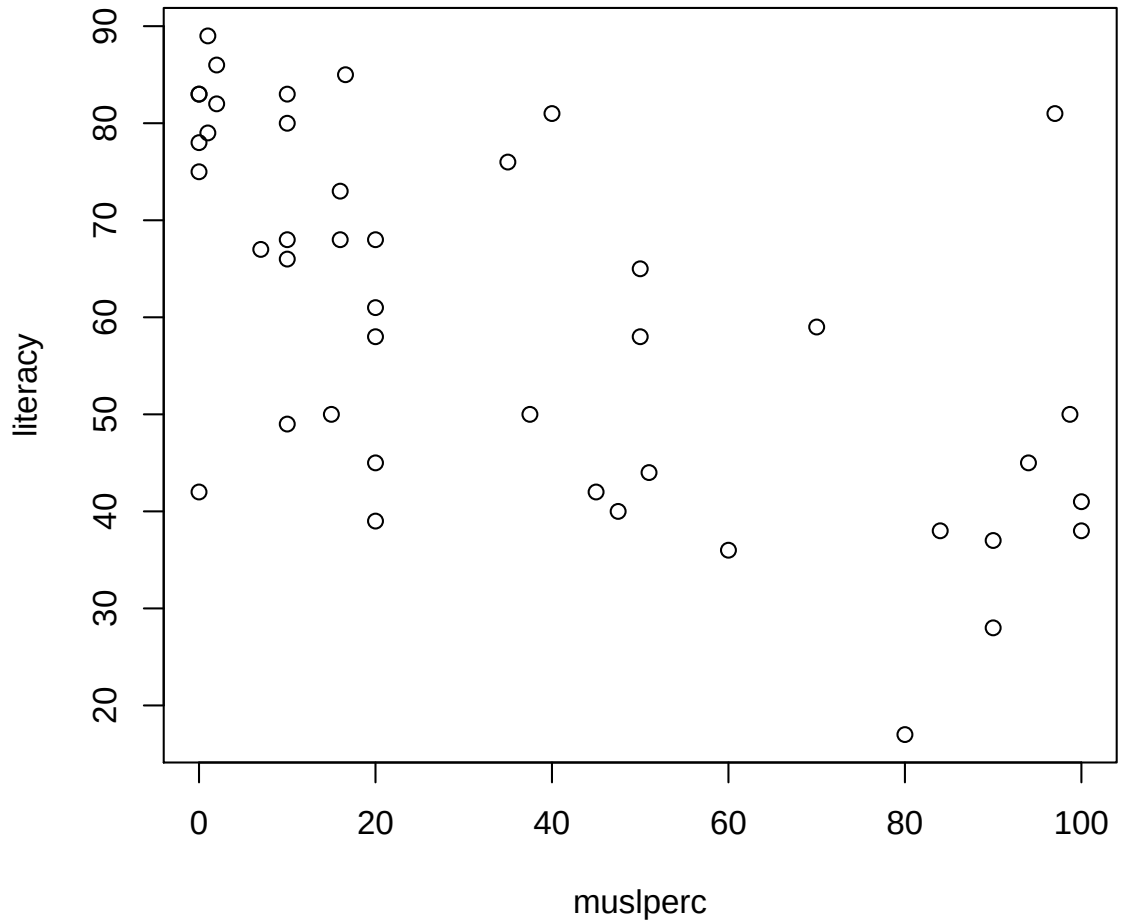
Other Univariate Graphics

- *Stripplots* (or *stripcharts*)
- *Pie charts*
- "Donut" plots
- "Stem and leaf" plots

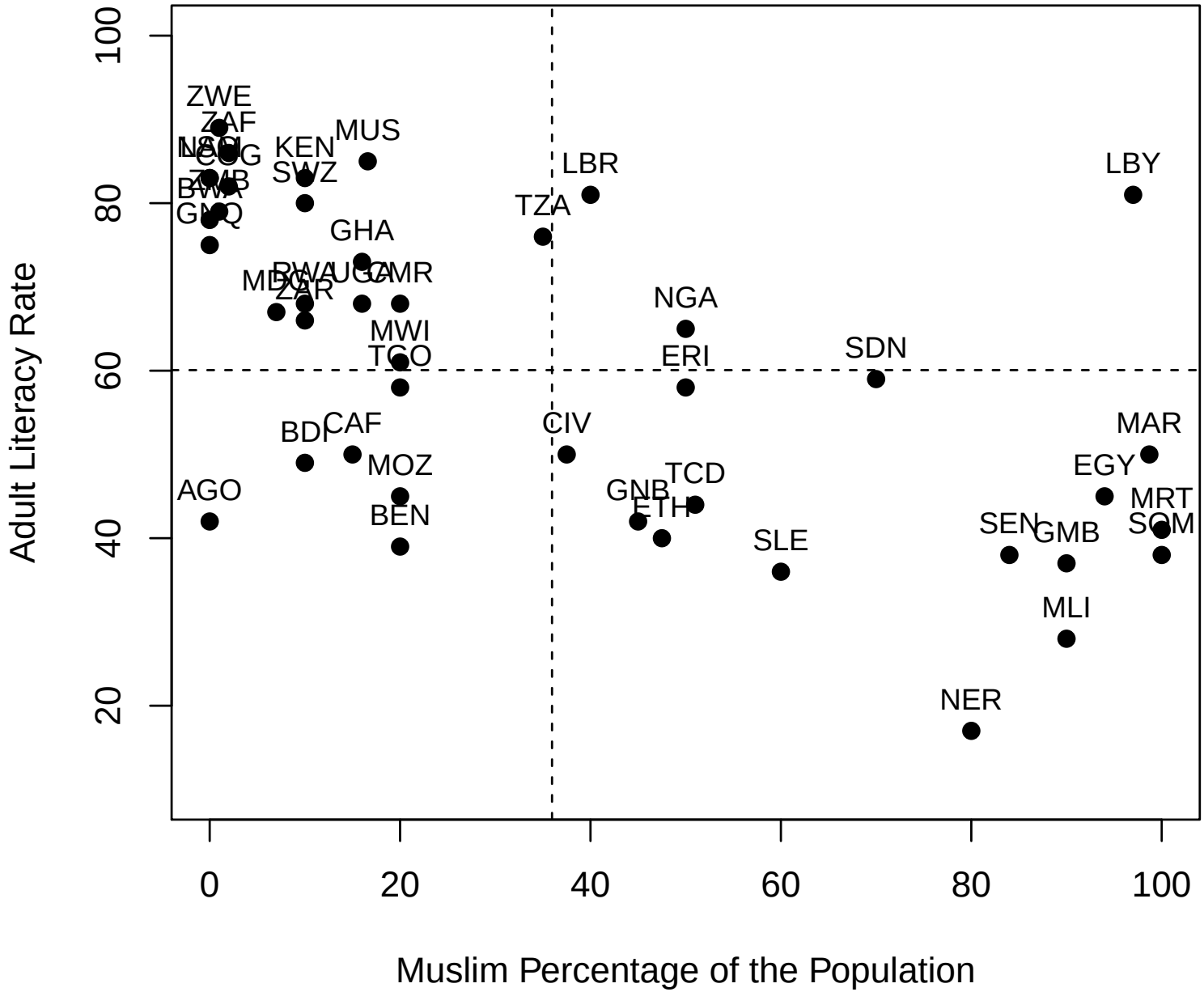
Bivariate and Multivariate Plots

Continuous Data: Scatterplots

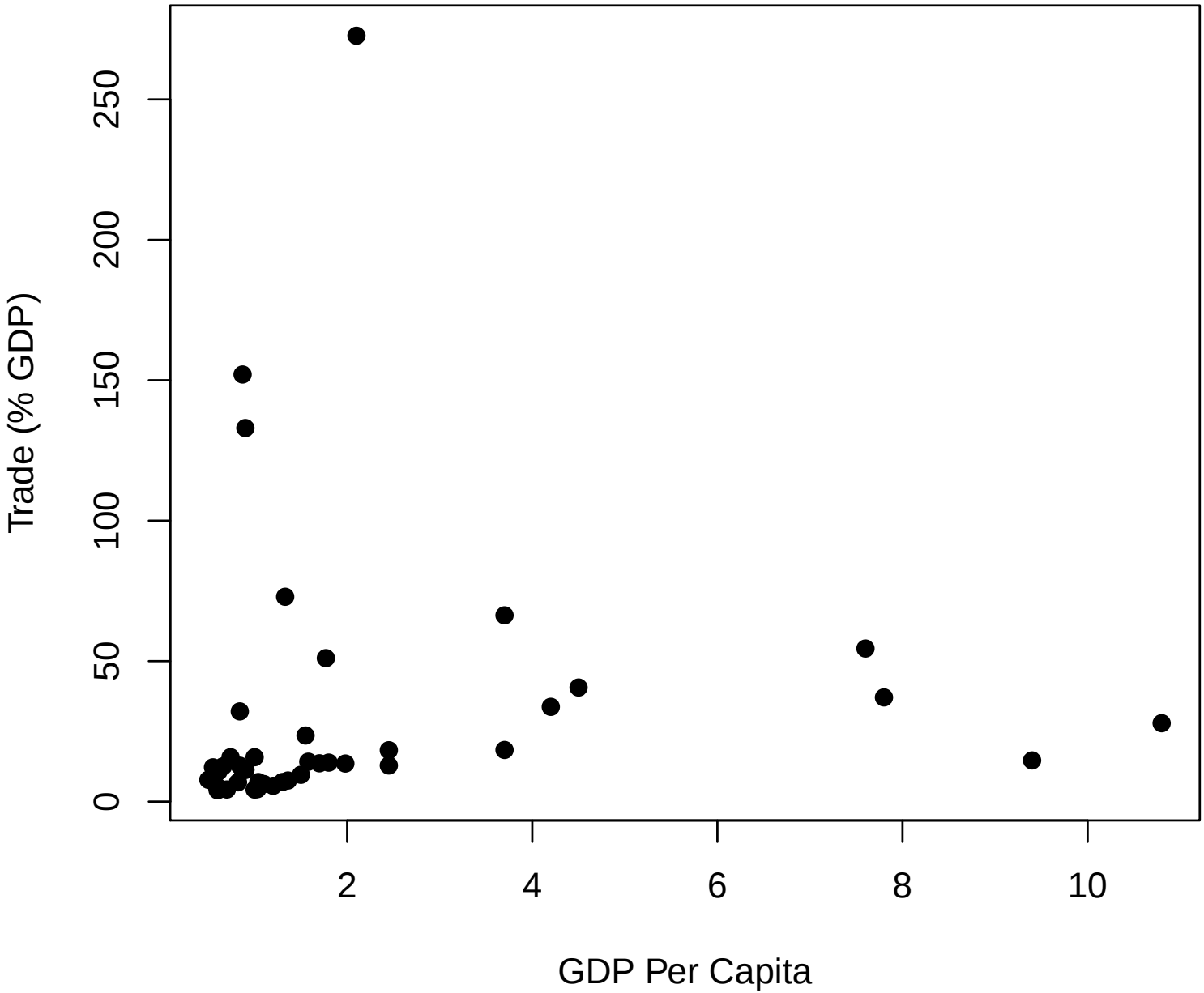
```
> with(Africa, plot(muslperc,literacy))
```



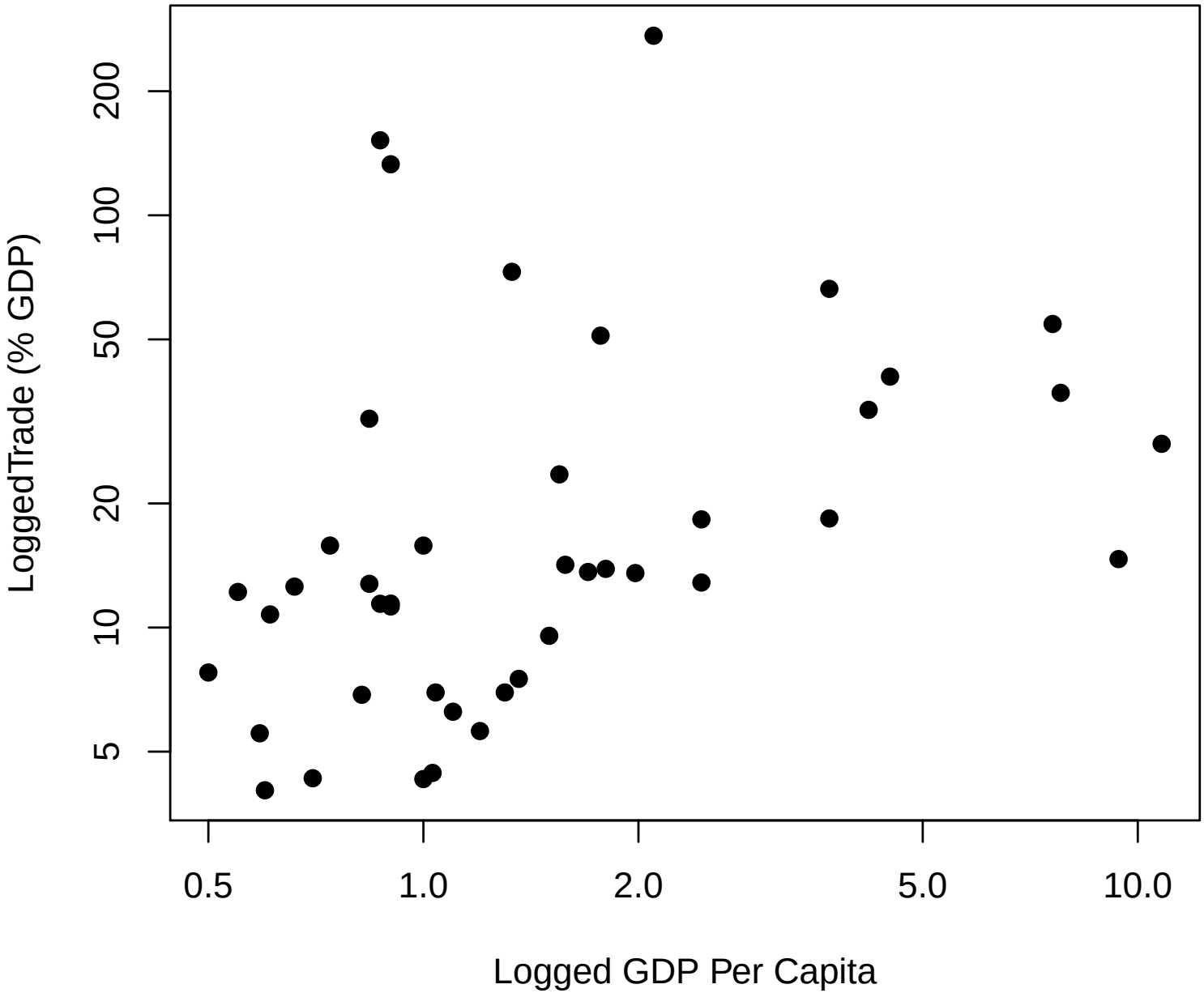
A Better Scatterplot



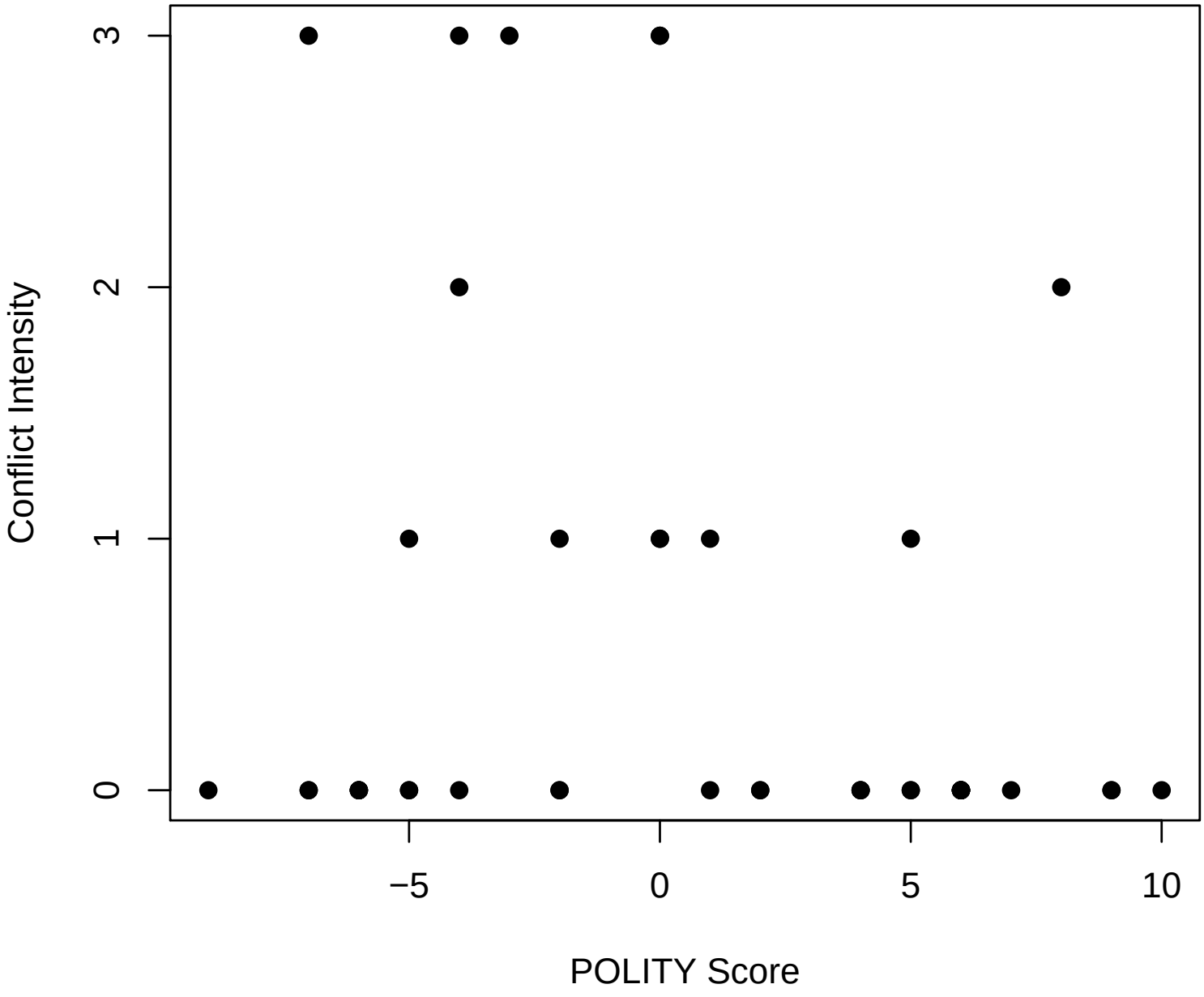
Skewed Data: Trade and GDP



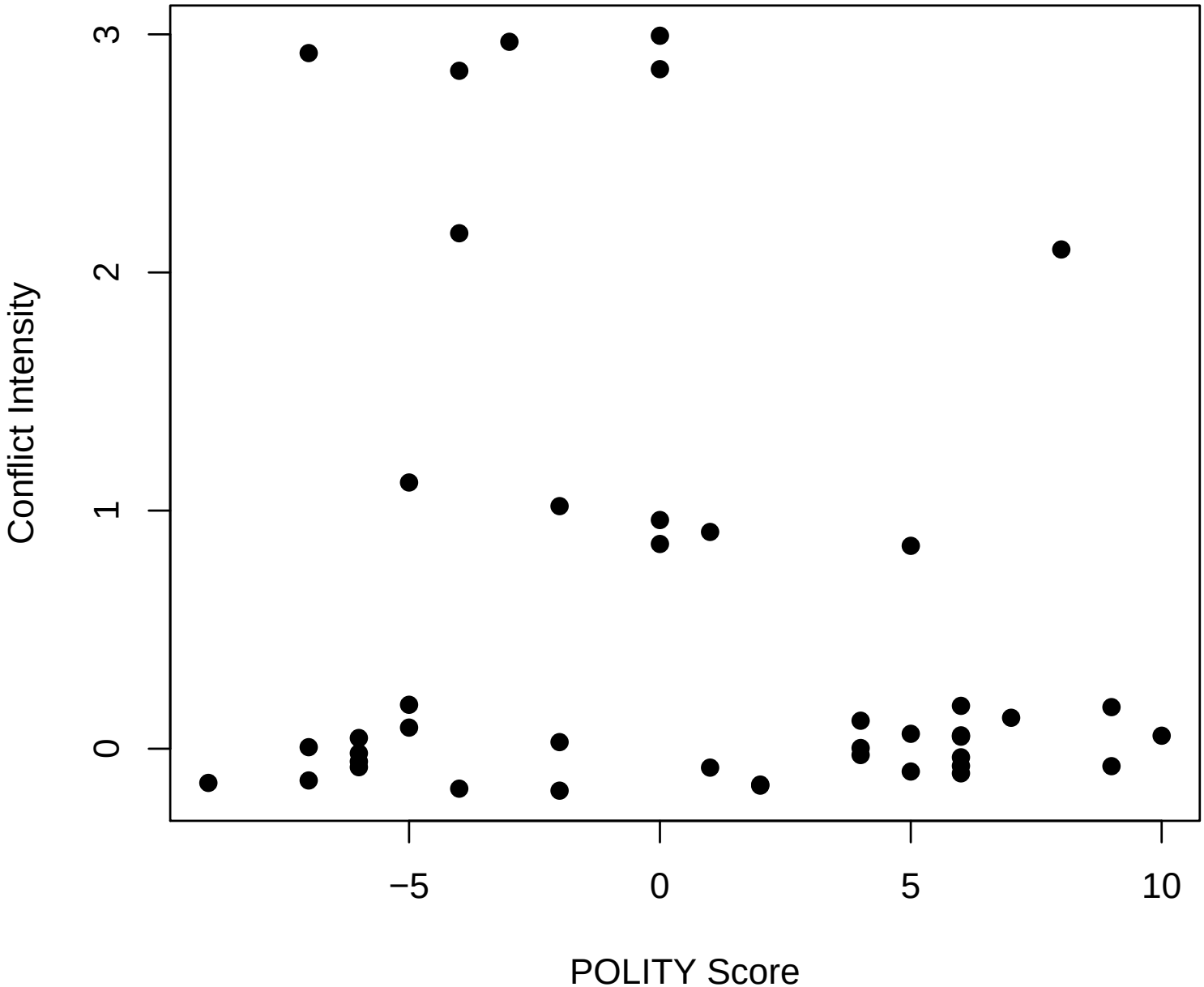
Log-Scale Axes



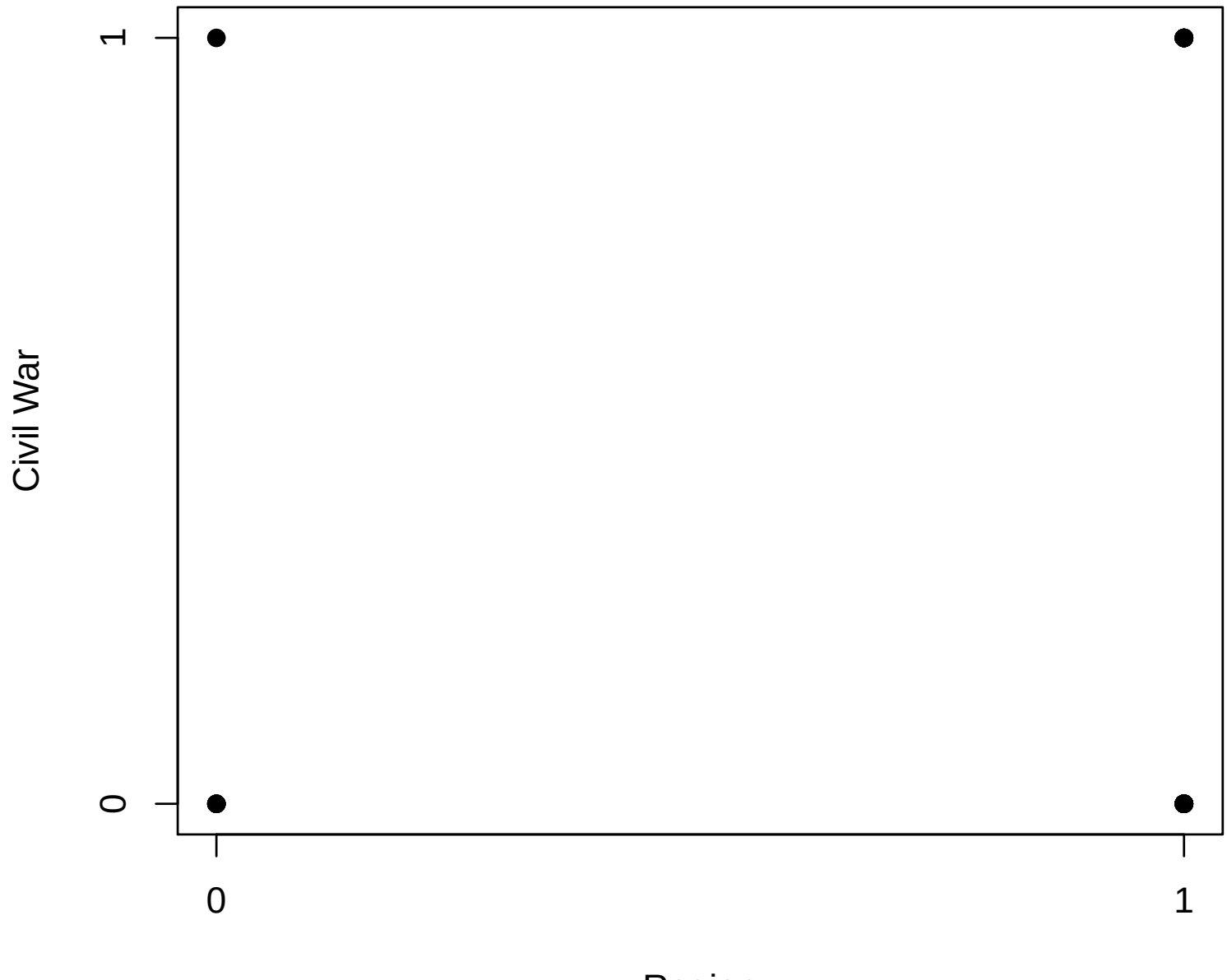
"Binned" Data: Conflict Intensity and Democracy



"Jittering" Binned Data



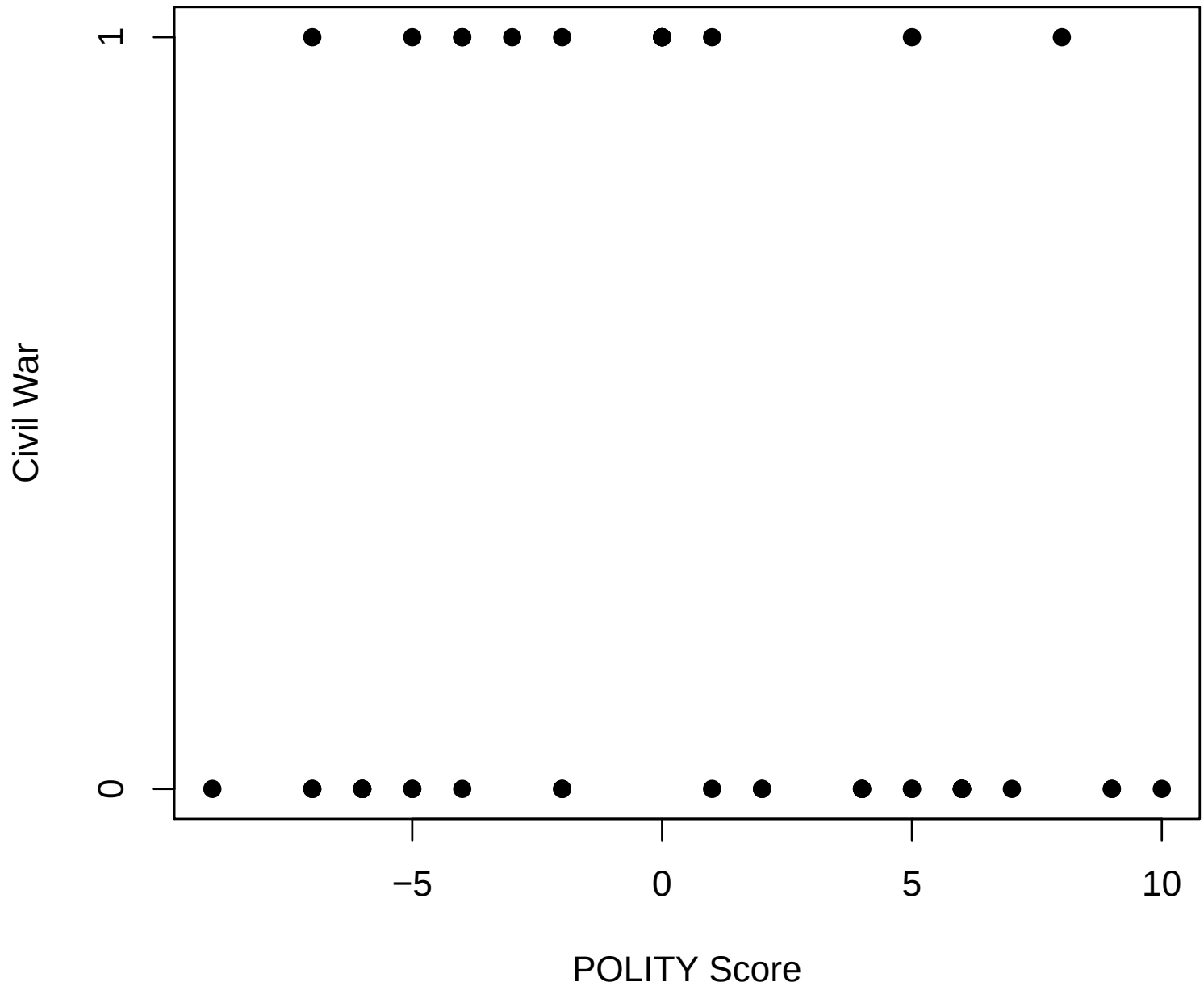
How Not To Draw A Scatterplot



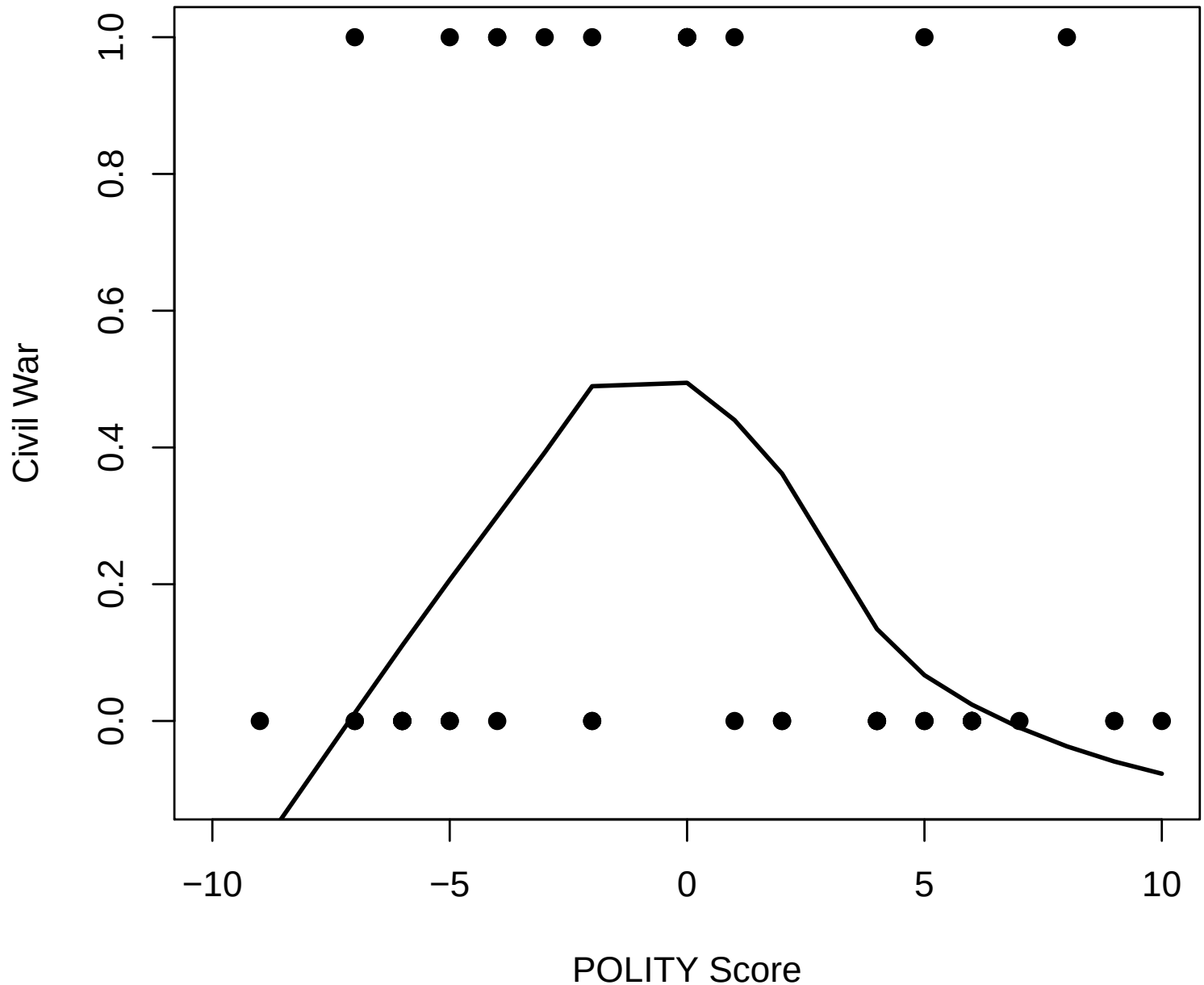
Binary Data = Tables

```
> with(Africa,
       xtabs(~subsaharan+internalwar))

                    internalwar
subsaharan            0  1
  Not Sub-Saharan     5  1
  Sub-Saharan        25 12
```

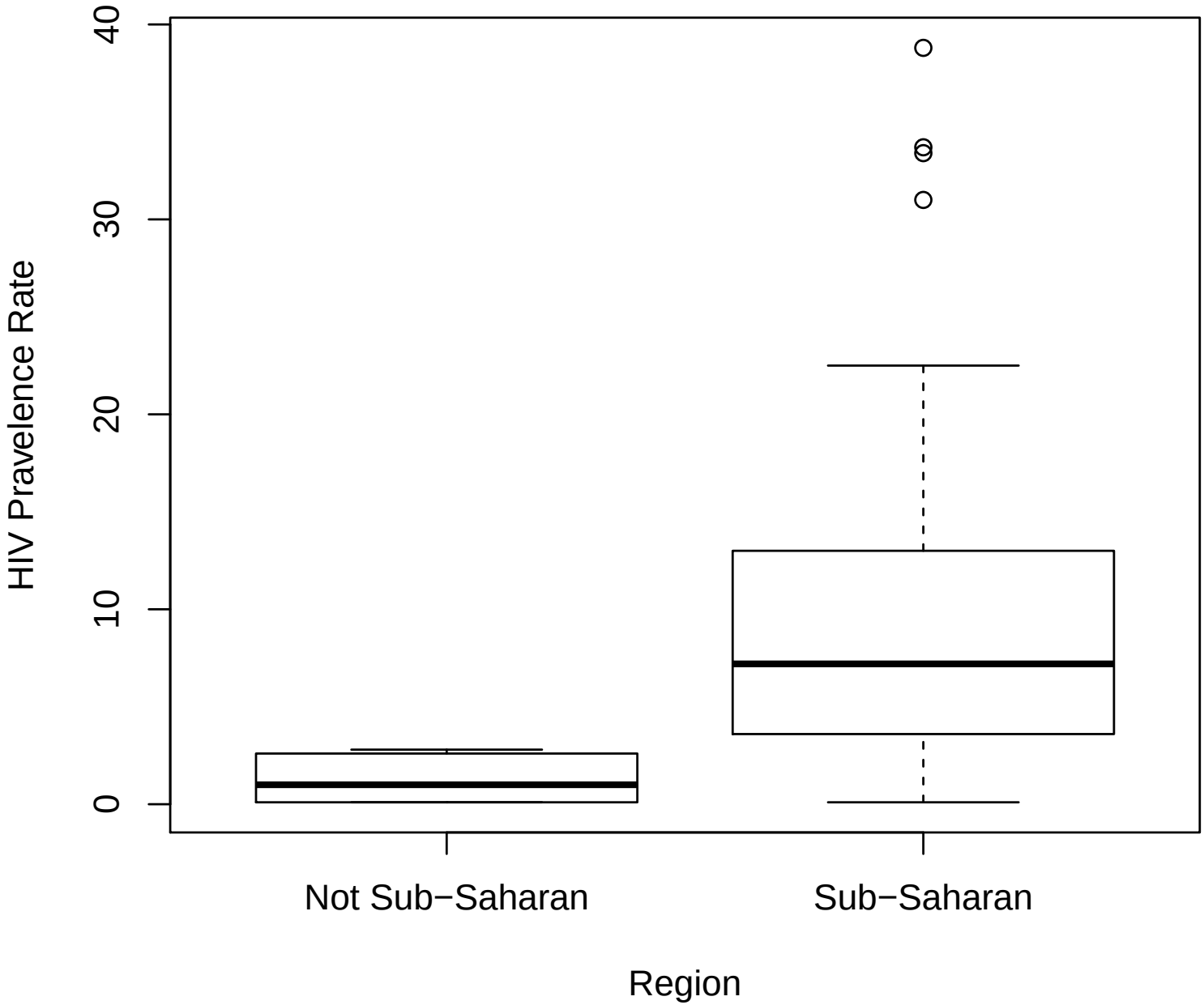
Mixed Binary-Continuous



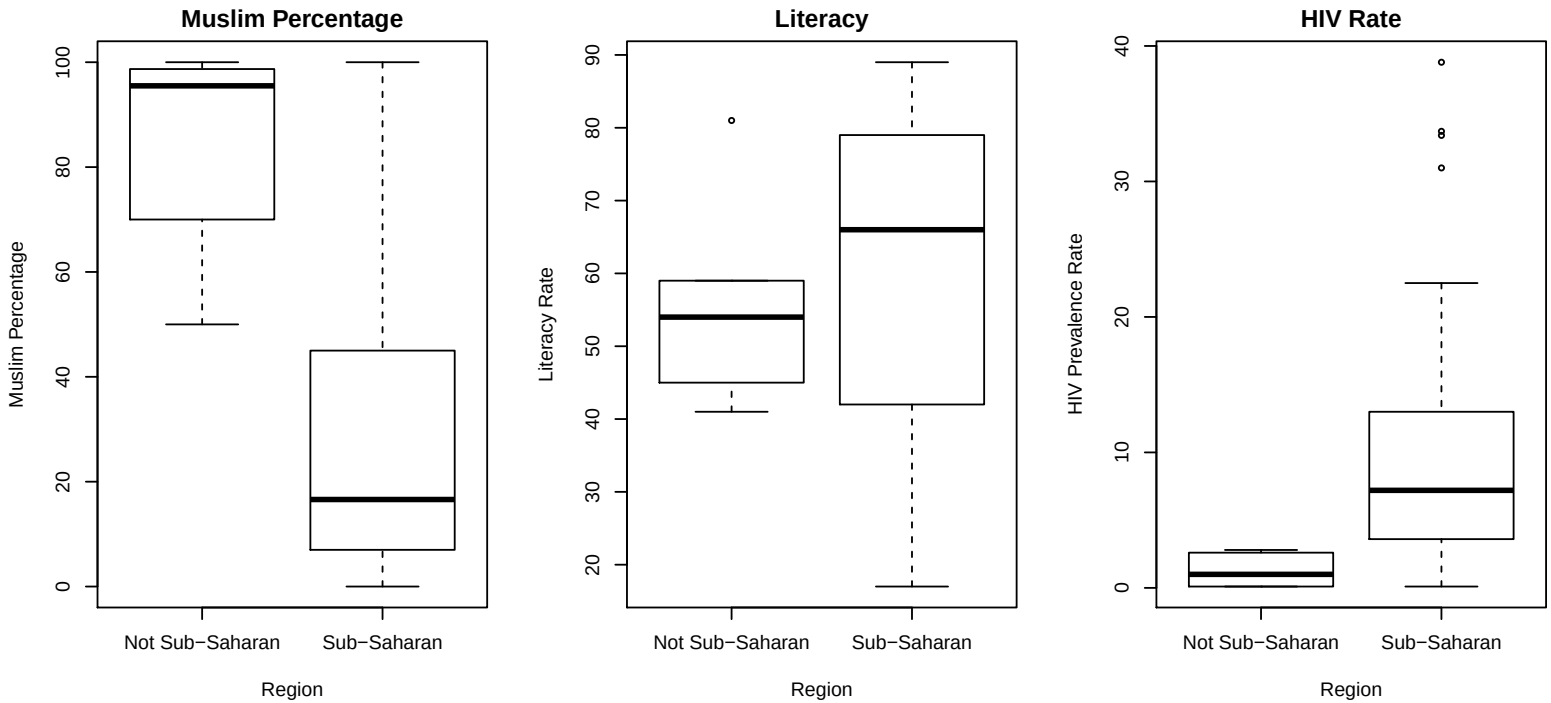
"Lowess" Smoothed Plot



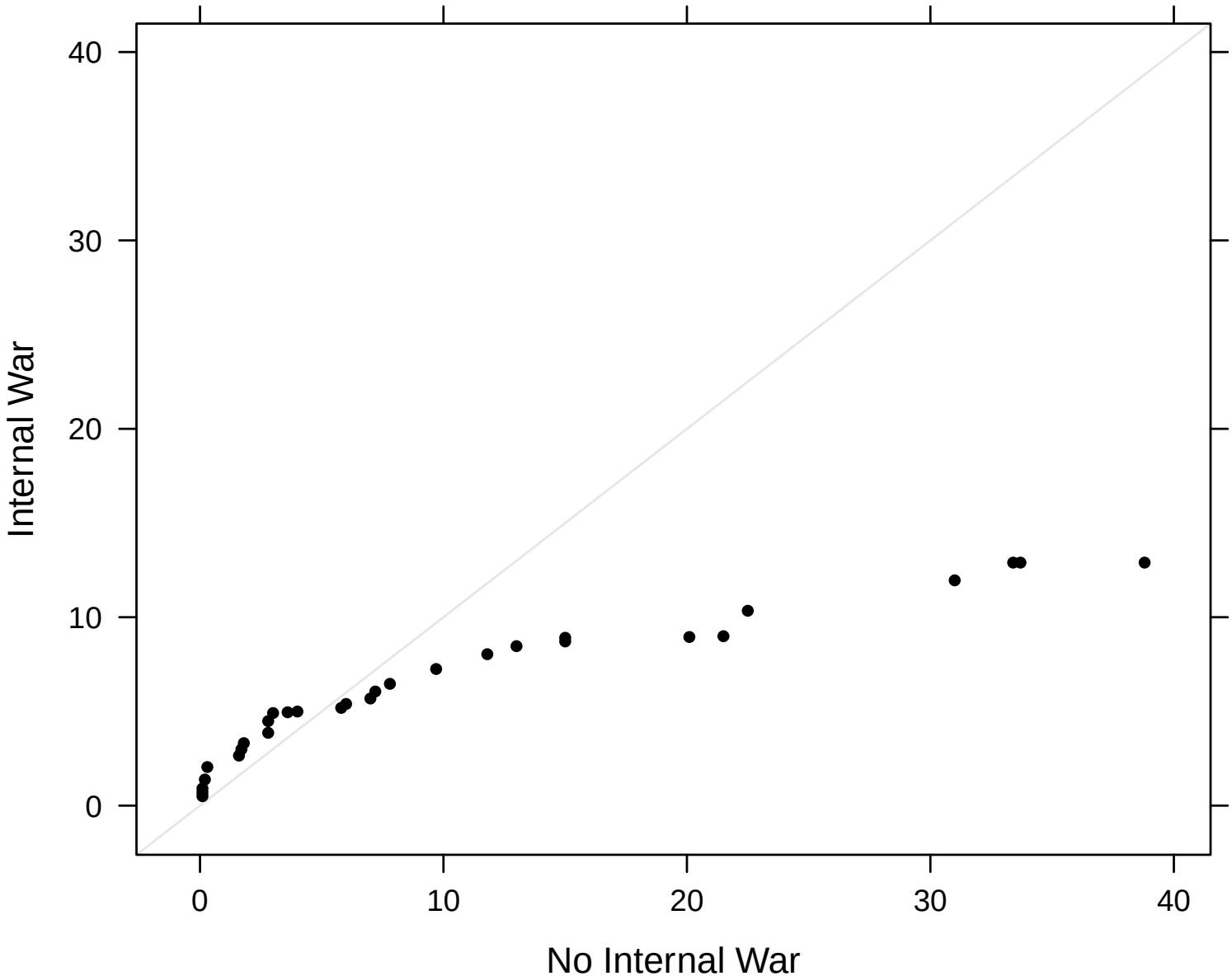
Conditioned Boxplots



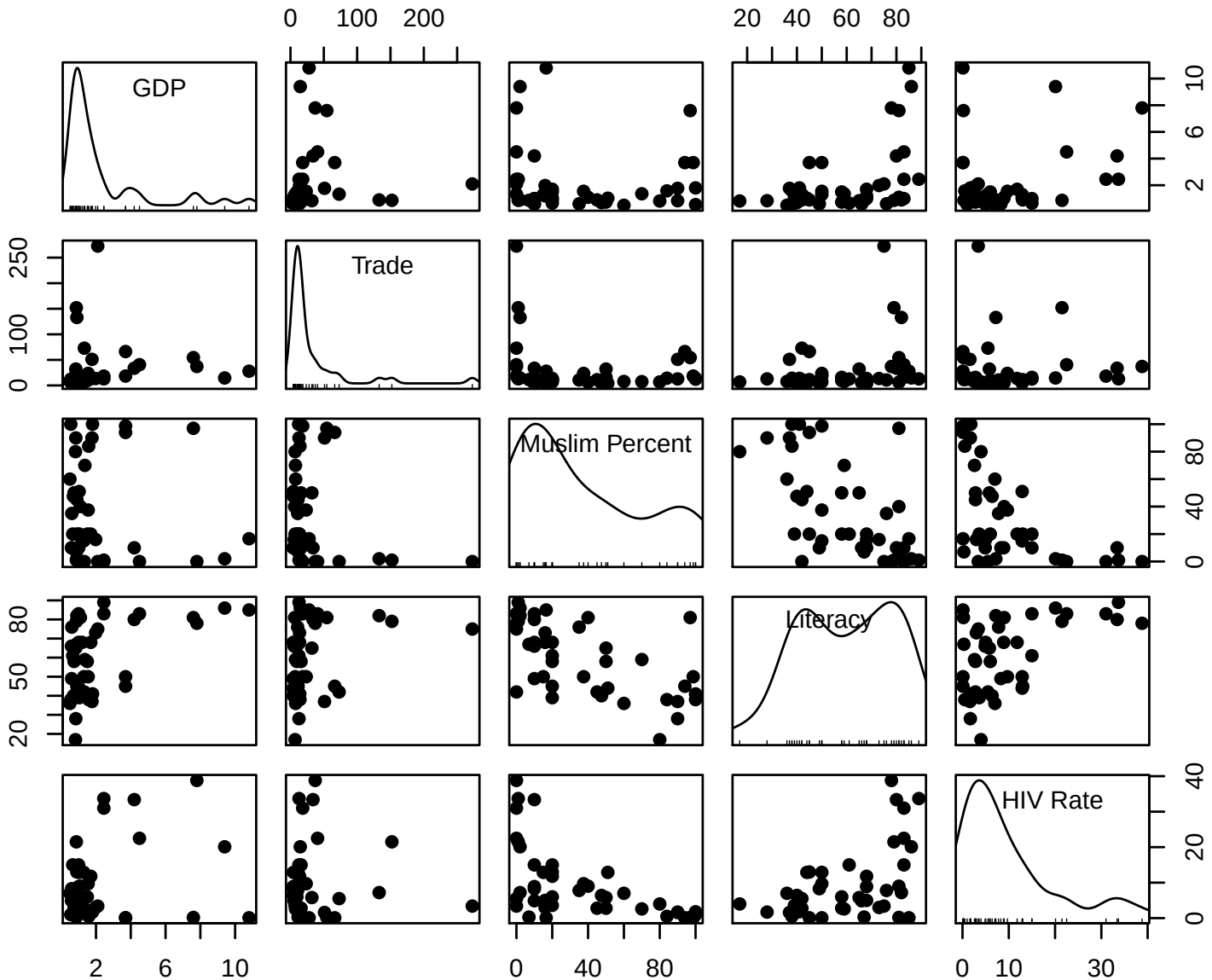
Multiple Conditioned Boxplots



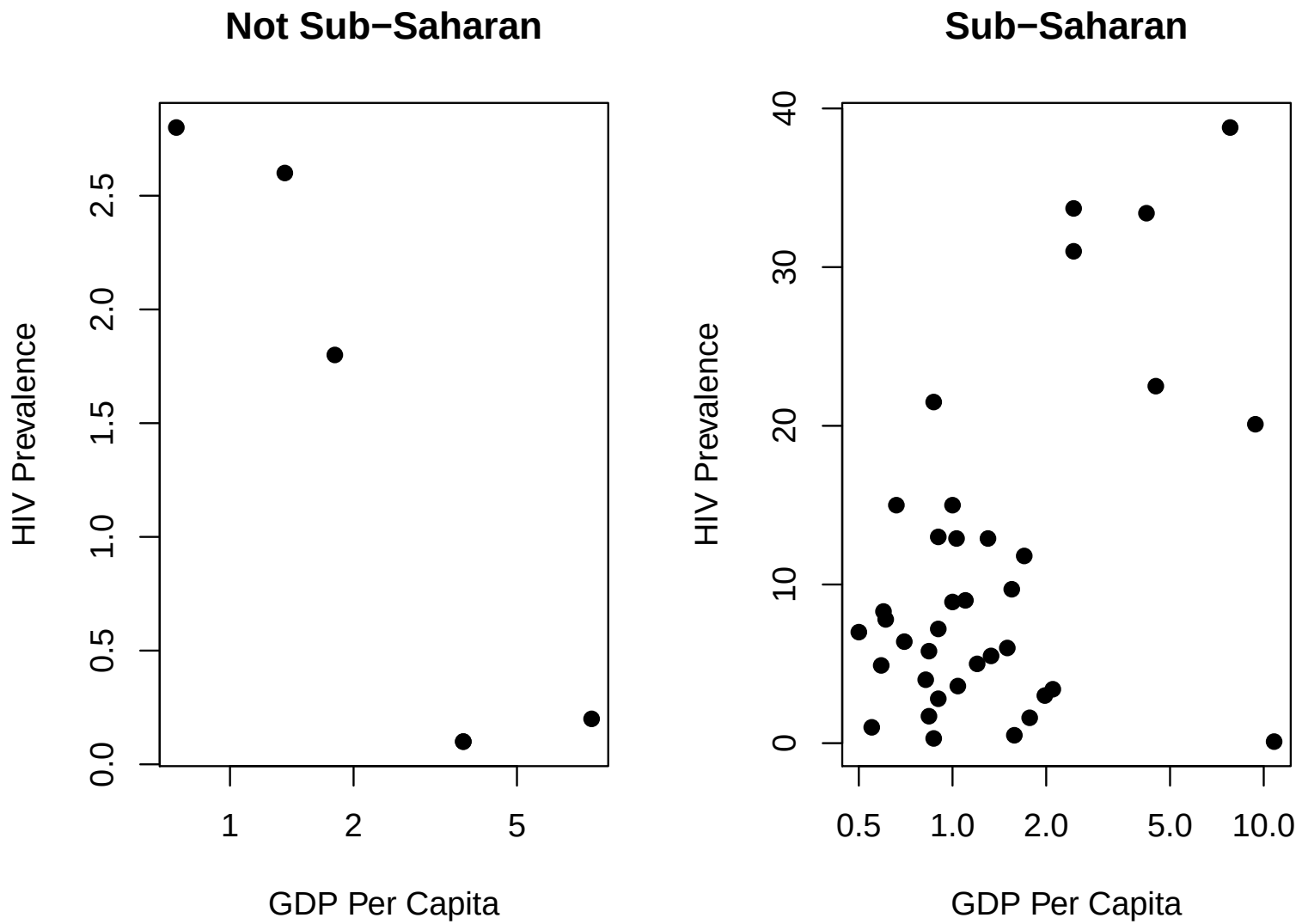
Empirical Q-Q Plots



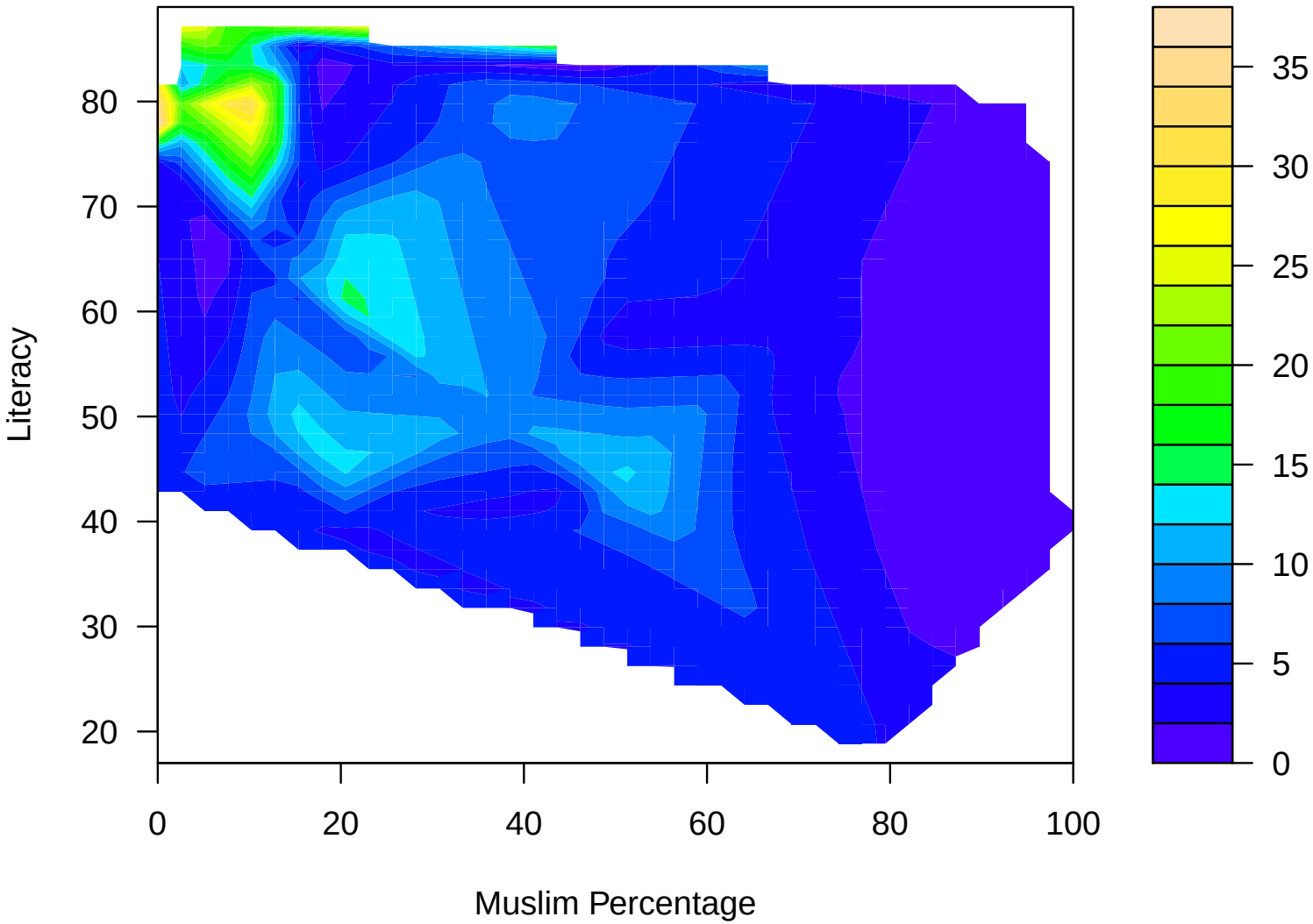
Scatterplot Matrix



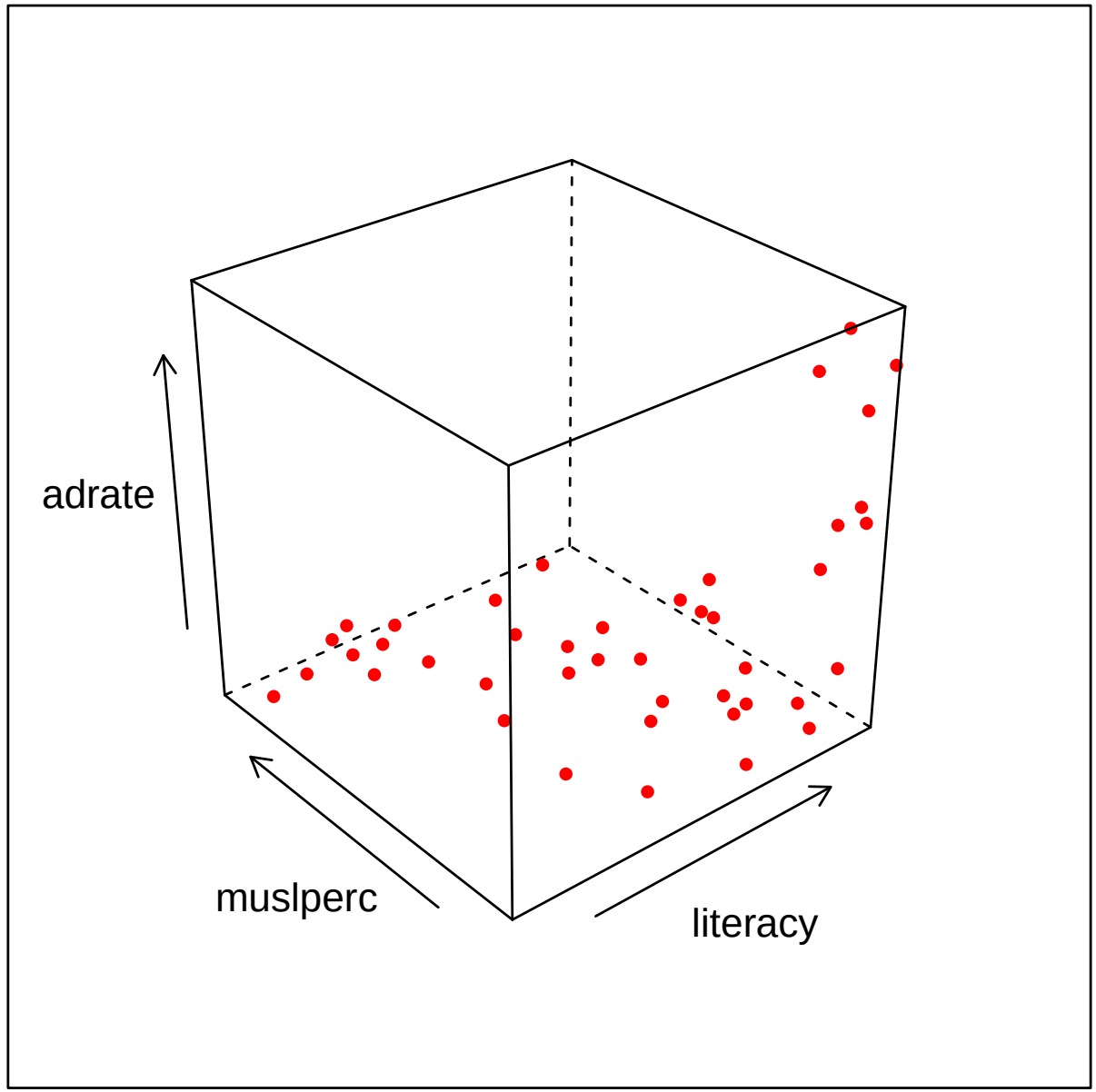
Conditional Scatterplots



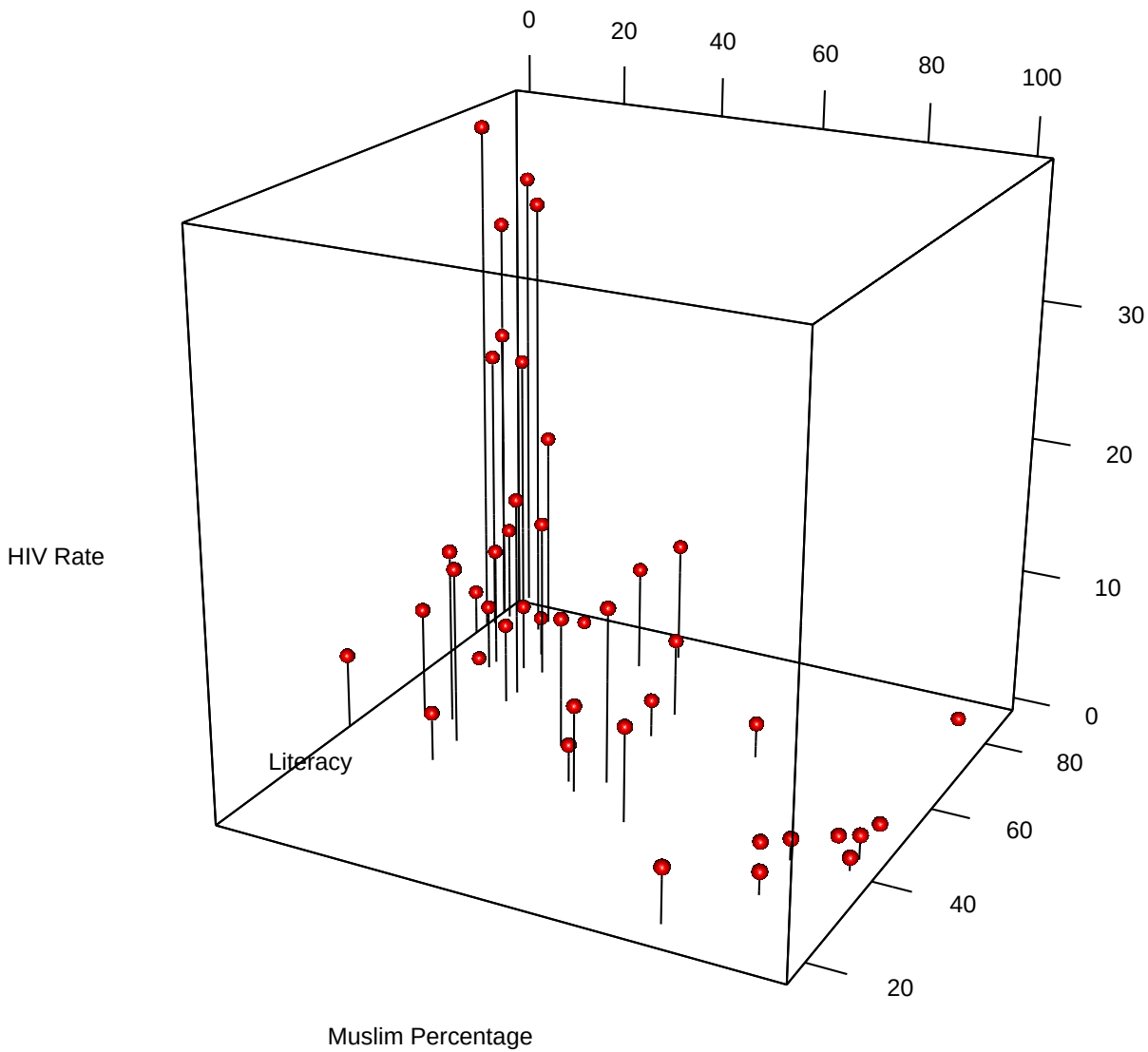
Contour Plot (HIV Rates)



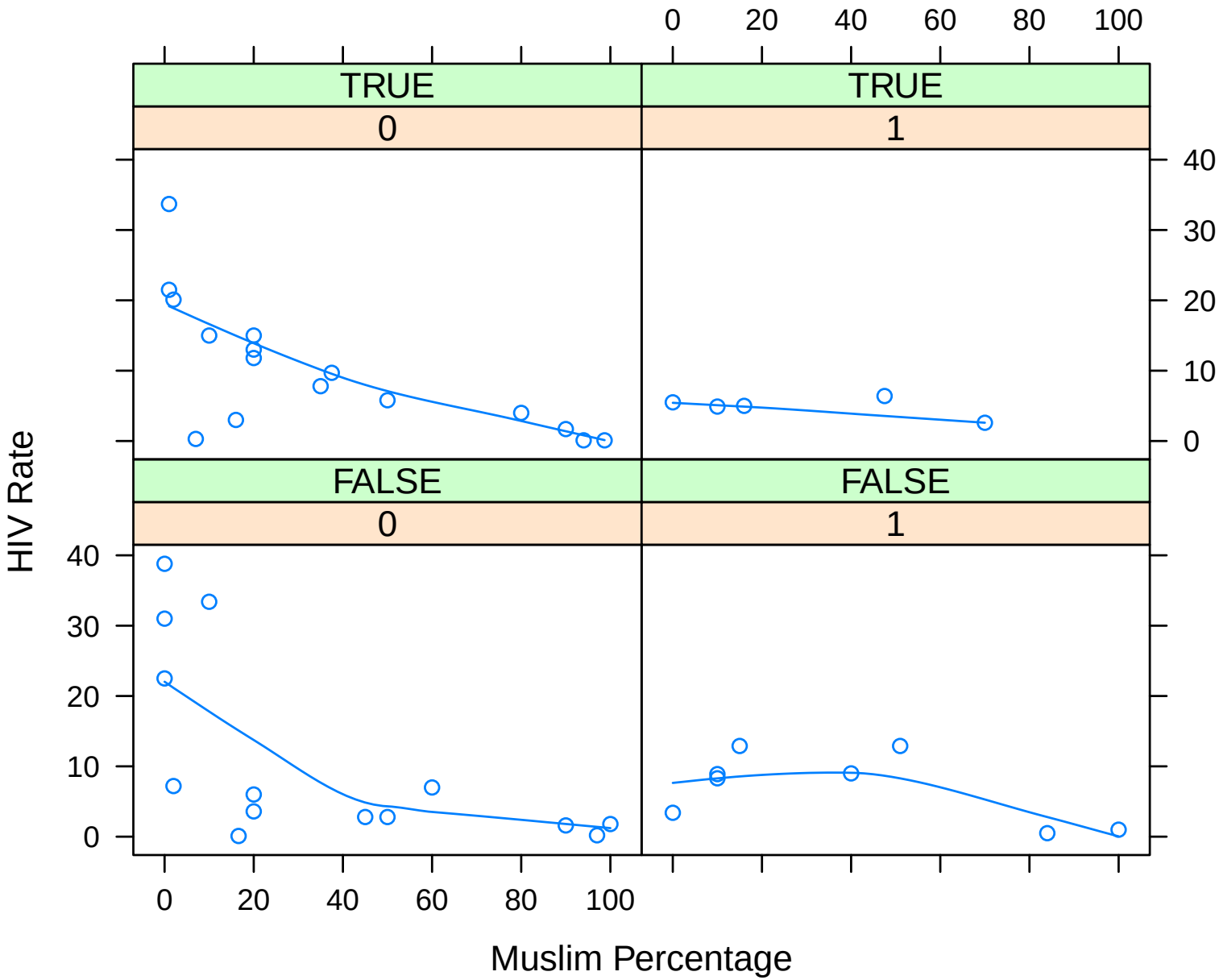
"3-D" Scatterplot



Interactive 3-D Scatterplot



"Four-Way" Scatterplots



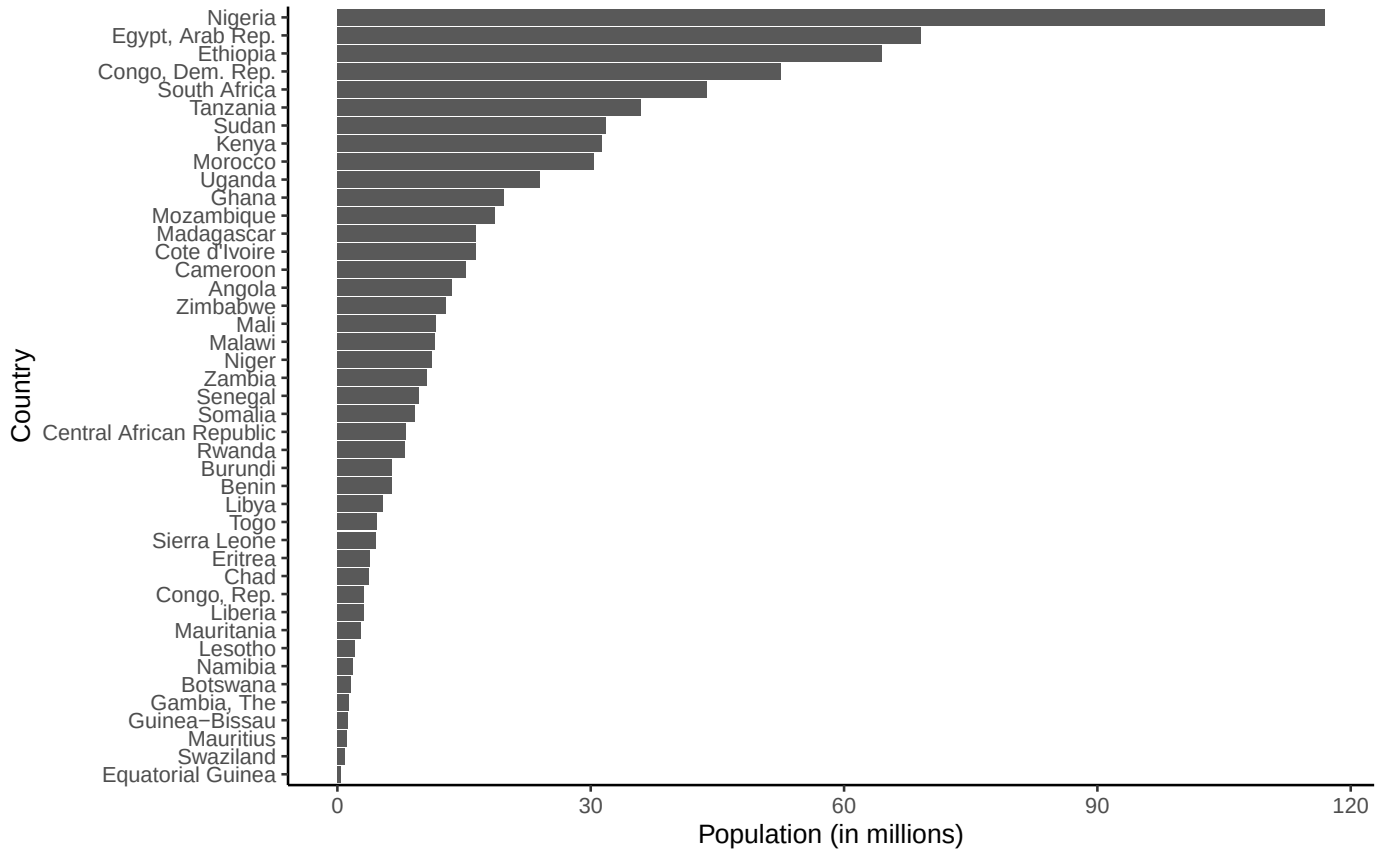
"Tidy" Graphics / Visualization

Visualization in the Tidyverse^{tm}:

- Loosely based on Wilkinson's "Grammar of Graphics"
- `ggplot2` is the core package for doing graphics in the Tidyverse^{tm}...
- ...but there are many others (check that page for any package starting with the letters gg...)
- Syntax is very different, and more "modular"
- Visualizations are built in layers / stages

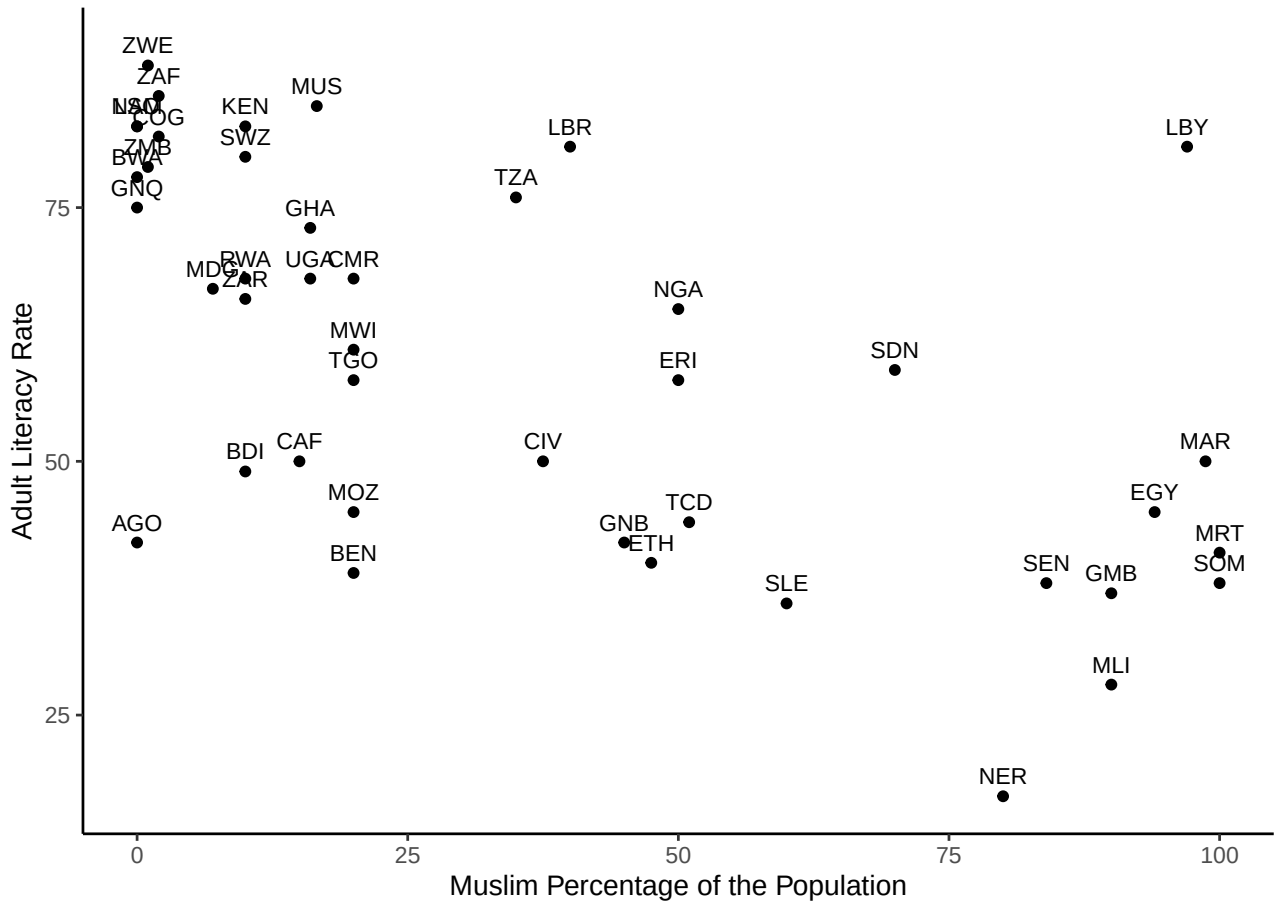
ggplot Example 1: Barchart

```
p<-ggplot(data=Africa, aes(x=reorder(country,popthou),y=popthou/1000)) +
  geom_bar(stat="identity") +
  labs(y="Population (in millions)",x="Country") +
  coord_flip()
p
```



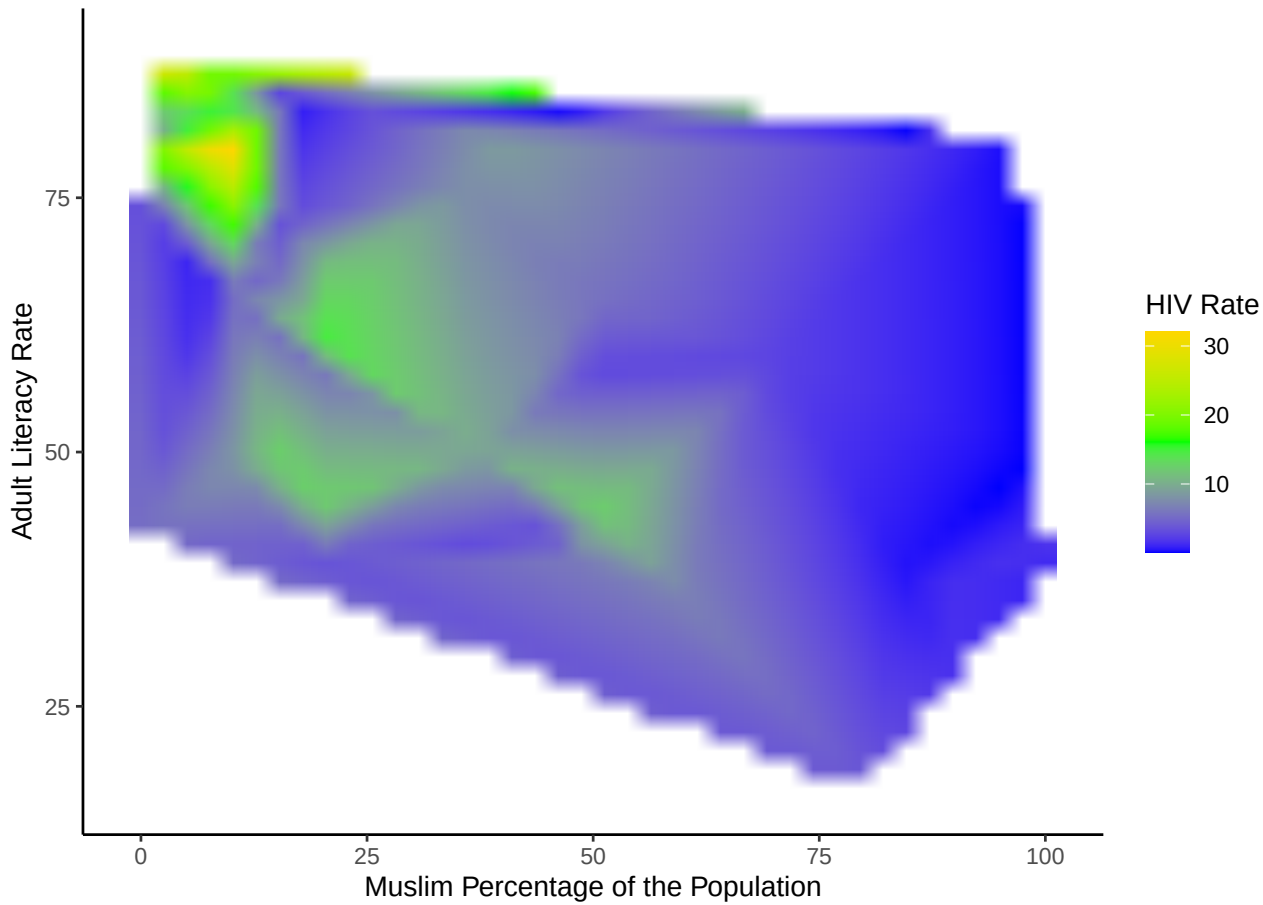
ggplot Example 2: Scatterplot

```
p2<-ggplot(data=Africa, aes(x=muslperc,y=literacy)) +
  geom_point() +
  labs(y="Adult Literacy Rate",x="Muslim Percentage of the Population") +
  theme_classic() +
  geom_text(label=Africa$cabbr,size=3,nudge_y=2)
p2
```



ggplot Example 3: Contour Plot

```
p3<-ggplot(data=df,aes(x=x,y=y,fill=z)) +
  geom_raster(interpolate = TRUE) +
  scale_fill_gradientn(colours = c("blue","green","gold"),
                       na.value = "#FFFFFF",name="HIV Rate") +
  labs(y="Adult Literacy Rate",x="Muslim Percentage of the Population") +
  theme_classic()
p3
```



R Graphics: The Power of `plot`

`plot`:

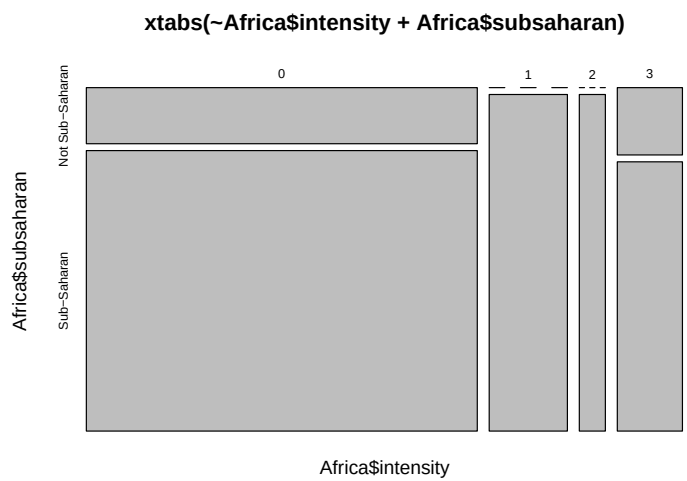
- `plot` (formally, `plot.default`) is the base-R graphics central command for visualization
- `plot()` is also a *method* – it does different things depending on what kind of object is placed inside the `()`s

Example:

```
> plot(xtabs(~Africa$intensity+Africa$subsaharan))
```

Crosstable:

```
> xtabs(~Africa$intensity+Africa$subsaharan)
                Africa$subsaharan
Africa$intensity Not Sub-Saharan Sub-Saharan
               0                5          25
               1                0           6
               2                0           2
               3                1           4
```



R Graphics: Parameters

The `par` command sets graphical parameters; type `?par` on the R command line for more...

A few common / useful `par` commands:

- `par(mar(a,b,c,d))` sets the *margins* of the plot (`a` = bottom, `b` = left, `c` = top, `d` = right)
- `par(mfrow=c(x,y))` draws multiple figures on the same plot; `x` is the number of rows of figures, `y` is the number of columns
- `par(new)` allows for overplotting (drawing multiple graphs "on top of" each other)
- `xlog`, `ylog` allow for logarithmic scales on plots

R Graphics: Making Things

To create a graphic, you have to open a *graphics device*...

- The command sequence is basically (a) open the device, (b) do the things, (c) close the device (which outputs the file).
- Example:

```
> # Make a PDF in the local / working directory:
>
> pdf("MyPDF.pdf",7,5) # Turn on the PDF device; make the aspect ratio 7:5
> plot(muslperc,adrate,data=Africa) # Make the plot
> dev.off()  # Turn off the PDF-maker device
```

Available graphics devices include:

- `pdf()` (PDFs)
- `png()` (PNGs)
- `bmp()` (bitmaps)
- `jp()` (JPEGs)
- `tiff()` (TIFFs)