MANOVA

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attach data:

```
Skull_data <- read.csv(file.choose(),header = T)
attach(Skull_data)
names(Skull_data)
```

```
## [1] "X"     "epoch" "mb"    "bh"    "bl"    "nh"
```

check normality :

```
library(moments)
skewness(Skull_data[,3:6])
```

```
##          mb          bh          bl          nh
## -0.02837297 -0.17603322  0.13948131  0.08255358
```

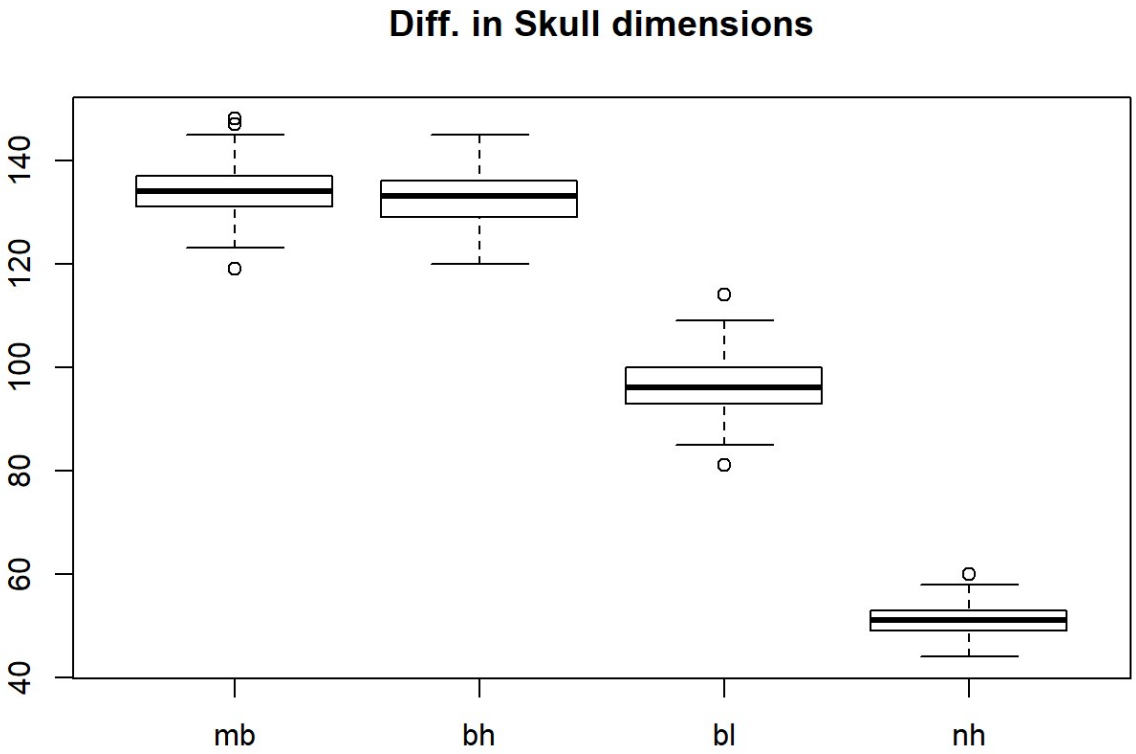
accepted range from -1 to +1

```
kurtosis(Skull_data[,3:6])
```

```
##       mb       bh       bl       nh
## 3.259550 2.889839 3.185601 2.830727
```

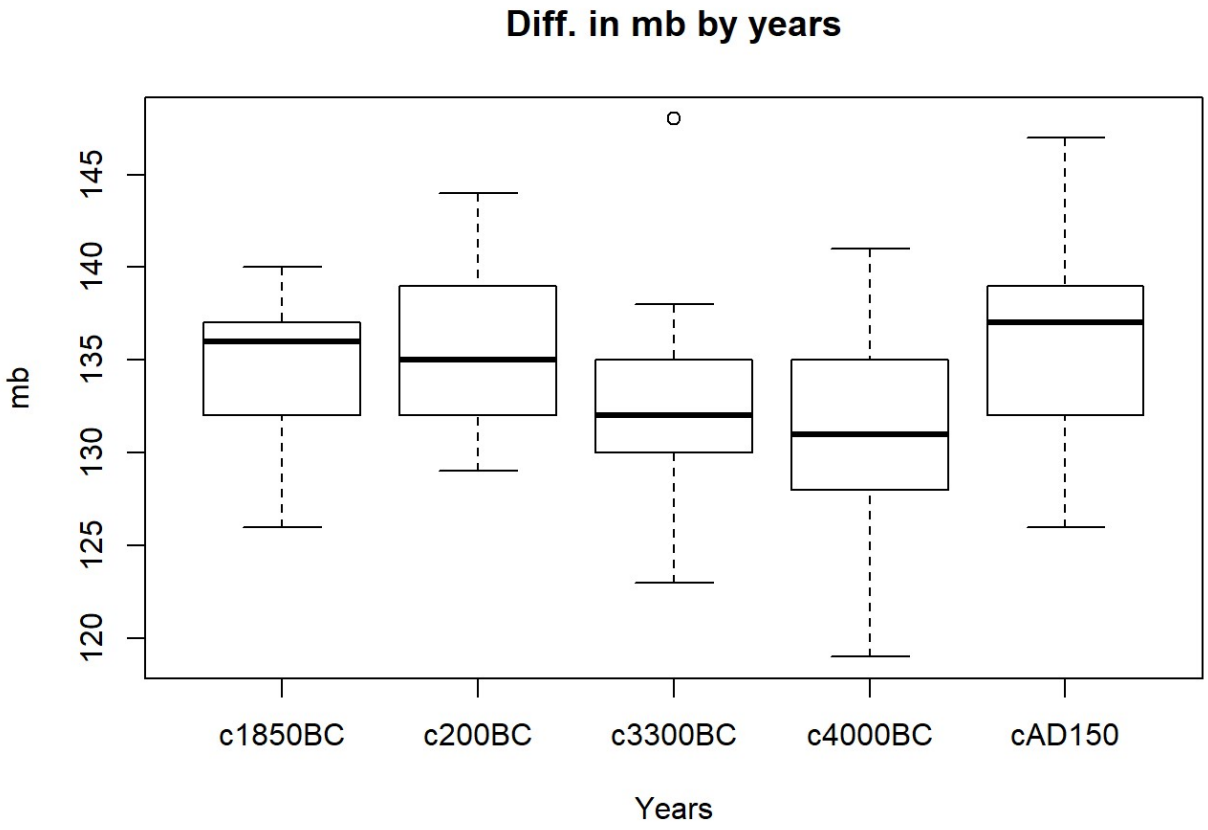
accepted range from -2 to +2 , may to +3

```
boxplot(Skull_data[,3:6],main= "Diff. in Skull dimensions")
```

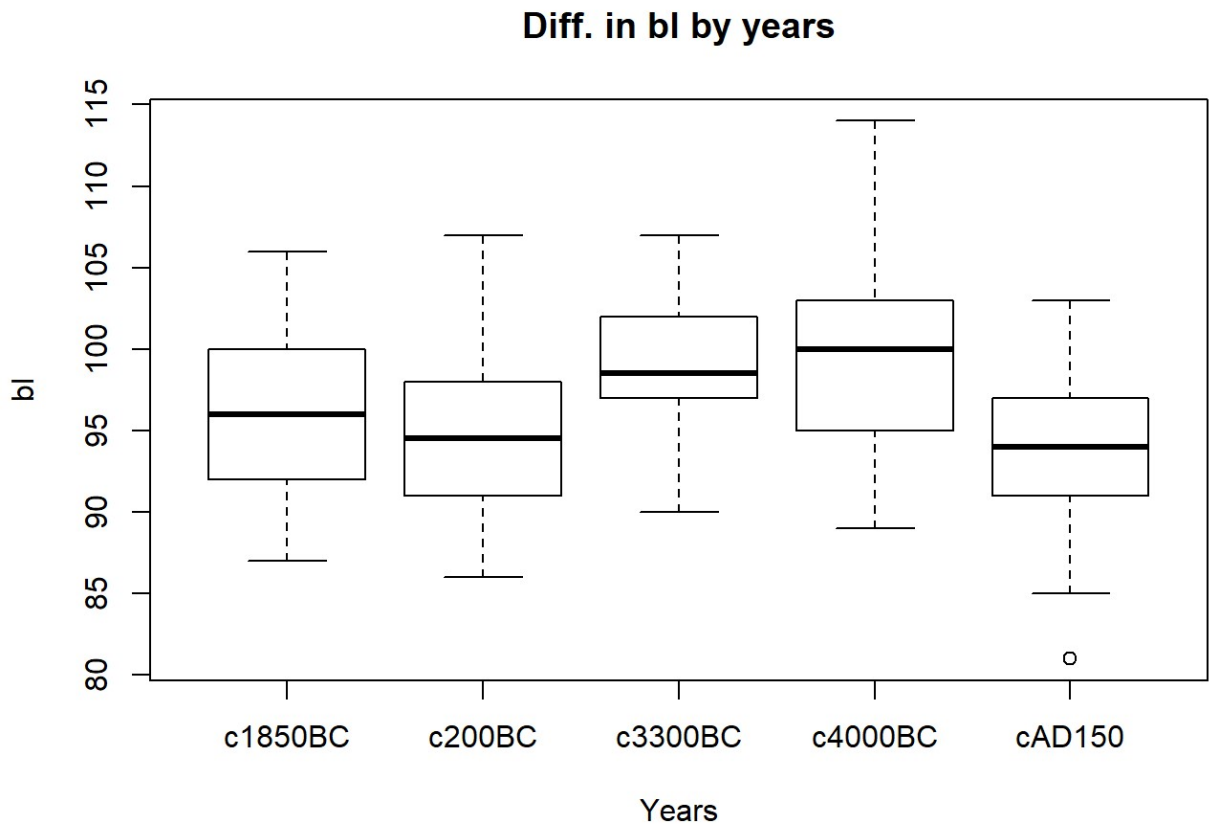


data is normally distributed

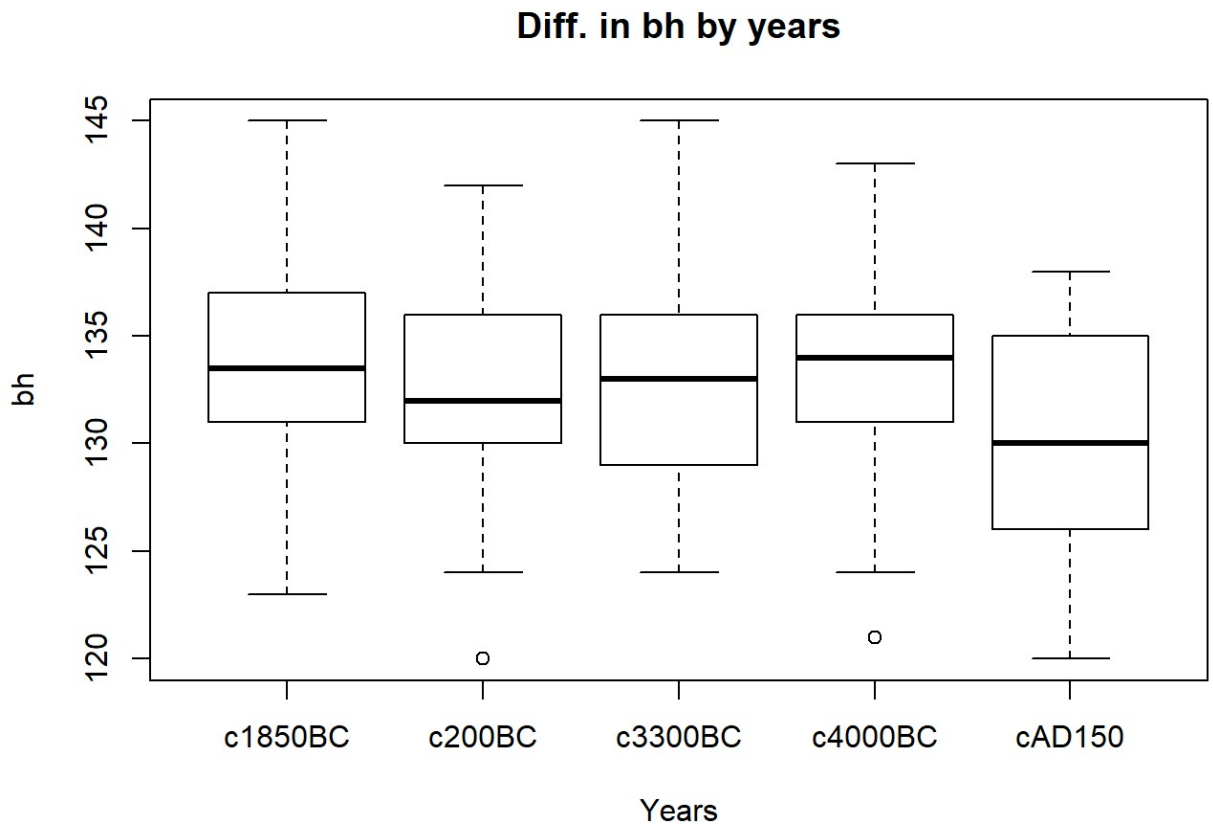
```
boxplot(mb~epoch,main="Diff. in mb by years",xlab = "Years")
```



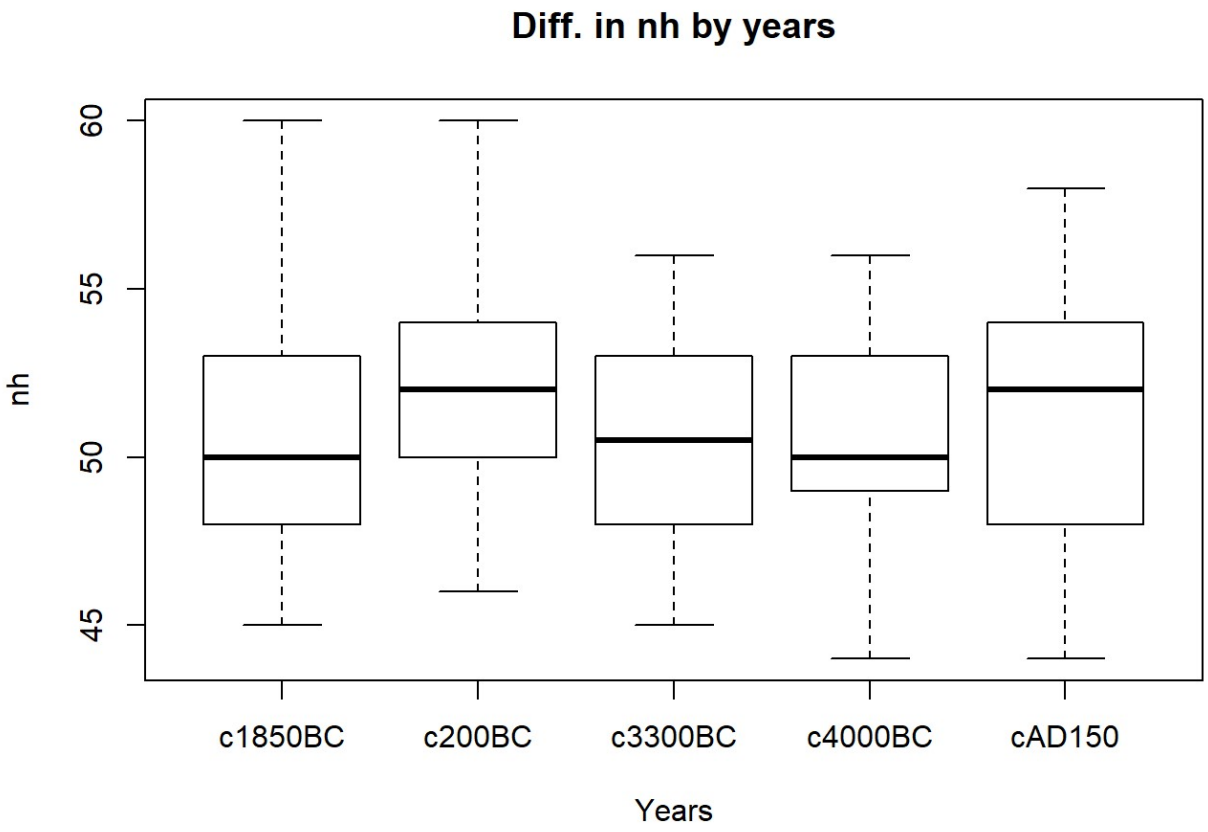

```
boxplot(bl~epoch,main="Diff. in bl by years",xlab = "Years")
```




```
boxplot(bh~epoch,main="Diff. in bh by years",xlab = "Years")
```




```
boxplot(nh~epoch,main="Diff. in nh by years",xlab = "Years")
```



test : H0 : diffrence in mean is the same in all years:

```
MANOVA1 <- manova(formula=(cbind(mb,bh,bl,nh))~as.factor(epoch) , data=Skull_data)
summary(MANOVA1)
```

```
##                   Df  Pillai approx F num Df den Df    Pr(>F)
## as.factor(epoch)   4 0.35331    3.512     16    580 4.675e-06 ***
## Residuals        145
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value < 0.05 , reject H0 , Skull dimensions differ by years

to know which is affected separetly :

```
summary.aov(MANOVA1)
```

```
##  Response mb :
##                   Df  Sum Sq Mean Sq F value    Pr(>F)
## as.factor(epoch)   4  502.83 125.707  5.9546 0.0001826 ***
## Residuals        145 3061.07  21.111
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response bh :
##                   Df Sum Sq Mean Sq F value  Pr(>F)
## as.factor(epoch)   4  229.9  57.477  2.4474 0.04897 *
## Residuals        145 3405.3  23.485
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response bl :
##                   Df Sum Sq Mean Sq F value    Pr(>F)
## as.factor(epoch)   4  803.3 200.823  8.3057 4.636e-06 ***
## Residuals        145 3506.0  24.179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response nh :
##                   Df Sum Sq Mean Sq F value Pr(>F)
## as.factor(epoch)   4   61.2  15.300   1.507 0.2032
## Residuals        145 1472.1  10.153
```

mb & bl are highly significant

bh is marginally significant

nh is not significant