# Supplementary Online Material (SOM):

## Variability in energy expenditure is much greater in males than females

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**SOM S1**

**R script (R v. 3.5.3; R Core Team, 2013)**

```
library(MCMCglmm)
library(dplyr)
rm( list = ls())
#
#this annotated code accompanies the article:
#Title:
#"Variability in energy expenditure is much greater in males than females"
#
#Authors:
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#
#The code below can be used to reproduce results in the article,
#using the IAEA DLW database v. 3.1.2
#
DATA<-read.table(file="DLW database v3.1.1 abbreviated.csv", header=T, sep=",")
summary(DATA)
#
#
#################### PREPARING DATA
#################### PREPARING DATA
#TO ENSURE SAMPLE SIZE DOESN'T CHANGE DEPENDING ON WHICH COVARIATES IS INCLUDED
#WE NEED TO REMOVE ANY NAs IN THE COVARIATES
# get rid of rows without height as want this as a control variable
nrow(DATA) # 6787
DATA<-DATA[!is.na(DATA$ht),]
nrow(DATA)  # 6434
```

```
# get rid of rows without lean body mass as want this as a control variable
DATA<-DATA[!is.na(DATA$LBM),]
nrow(DATA)  # 6397
# get rid of rows without age as want this as a control variable
DATA<-DATA[!is.na(DATA$Age),]
nrow(DATA)  # 6397
#
# get rid of non-adults
DATA<-DATA[which(DATA$Age>17.999),]
nrow(DATA) # 5016
#
# Get rid of individuals that have repeated measures (thus multiple [two ] rows of data for each of them)
length(unique(DATA$IND_ID)) # 4647
nrow(DATA)                  # 5016
DATA.tmp<-DATA
DATA.tmp$NBR<-NA
for(i in unique(DATA.tmp$IND_ID)) DATA.tmp$NBR[which(DATA.tmp$IND_ID==i)]<-nrow(subset(DATA.tmp,IND_ID==i))
hist(DATA.tmp$NBR)
REPEAT<-subset(DATA.tmp, NBR>1)
SINGLE<-subset(DATA.tmp, NBR==1)
length(unique(REPEAT$IND_ID)) # 364
nrow(SINGLE)                  # 4283
length(unique(SINGLE$IND_ID)) # 4283
SINGLE2<-REPEAT[!duplicated(REPEAT$IND_ID),]
DATA<-rbind(SINGLE,SINGLE2)
nrow(DATA)                   # 4647
length(unique(DATA$IND_ID))  # 4647
#
#get rid of people engaged in extreme forms of physical activity
```

```
#(no need to do this with version 10.2 but seems to be required in version 3.1)
DATA$ath<-factor(DATA$ath)
summary(DATA$ath)
nrow(DATA)
DATA<-DATA[-which(DATA$ath=="NotAUA"),]
DATA<-DATA[-which(DATA$ath=="PA"),]
DATA<-DATA[-which(DATA$ath=="AANCT"),]
nrow(DATA) # 4612  # Number of TEE data points
length(which(DATA$BEE>0)) # Number of BEE data points = 1760
#
DATA<-DATA[!is.na(DATA$TEE),]
nrow(DATA)    #4602
#
# Derive additional variables for analysis
DATA$AEE<-0.9*DATA$TEE-DATA$BEE  #activity energy expenditure (AEE)
DATA$FAT<-DATA$wt_av-DATA$LBM    #fat mass
#
#description: percent AEE over TEE
DATA_AEE<-DATA[!is.na(DATA$AEE),]
nrow(DATA_AEE) #1756
mean(DATA_AEE$AEE)/mean(DATA_AEE$TEE)*100
MEANS<-aggregate(TEE~Sex,DATA_AEE,FUN=mean)
MEANS$AEE<-aggregate(AEE~Sex,DATA_AEE,FUN=mean)$AEE
MEANS$BEE<-aggregate(BEE~Sex,DATA_AEE,FUN=mean)$BEE
MEANS$PCT.AEE<-MEANS$AEE/MEANS$TEE*100
plot(BEE~AEE,DATA_AEE)
#
#
###### Descriptives about the sample (as requested by JHE referees) ######
dim(DATA) # 4602 independent data points
```

```
unique(DATA$ISO) # representing 30 different countries
dim(filter(DATA, ISO=="USA")) # But, the majority of those data points (3008) are from the USA
summarise(
  group_by(DATA, Sex), Tally=n())
#
# Age distributions?
summarise(
  group_by(DATA, Sex), Mean.age=mean(na.exclude(Age))) # females 5 years older
summarise(
  group_by(filter(DATA, Age>60), Sex), Tally=n())
#
### Centre each predictor variable
# note: the non-centred version will be used when they are an outcome variable
DATA$FATc <- DATA$FAT-mean(DATA$FAT, na.rm=TRUE)
DATA$Agec <- DATA$Age-mean(DATA$Age, na.rm=TRUE)
DATA$htc <- DATA$ht-mean(DATA$ht, na.rm=TRUE)
DATA$wt_avc <- DATA$wt_av-mean(DATA$wt_av, na.rm=TRUE)
DATA$LBMc <- DATA$LBM-mean(DATA$LBM, na.rm=TRUE)
#
#get "complete cases" sample sizes
test<-lm(TEE~0+Sex+
                    Sex*poly(LBMc,2,raw=TRUE)+
                    Sex*poly(FATc,2,raw=TRUE)+
                    Sex*poly(Agec,2,raw=TRUE)+
                    LBMc*poly(Agec,2,raw=TRUE)+
                    FATc*poly(Agec,2,raw=TRUE),data=DATA)
length(resid(test))   #4602 obersvations in total
DATA$RES_TEE<-resid(test)
nrow(DATA)
```

```
length(DATA$BEE[which(DATA$Sex=="F")])    #3108 observations in females AEE and BEE

length(DATA$BEE[which(DATA$Sex=="M")])    #1494  observations in   males AEE and BEE

#

#

DATA_BEE_focus<-DATA[!is.na(DATA$BEE),]


test<-lm(BEE~0+Sex+
                        Sex*poly(LBMc,2,raw=TRUE)+
                        Sex*poly(FATc,2,raw=TRUE)+
                        Sex*poly(Agec,2,raw=TRUE)+
                        LBMc*poly(Agec,2,raw=TRUE)+
                        FATc*poly(Agec,2,raw=TRUE),data=DATA_BEE_focus)
length(resid(test))   #1756 BEE obersvations in total
DATA_BEE_focus$RES_TEE<-resid(test)
nrow(DATA_BEE_focus)


### BEE
length(DATA_BEE_focus$BEE[which(DATA_BEE_focus$Sex=="F")])    #1063 observations in females AEE and BEE
length(DATA_BEE_focus$BEE[which(DATA_BEE_focus$Sex=="M")])    #693 observations in   males AEE and BEE




####################### RUN MODELS FOR EACH VARIABLE ###########################
####################### RUN MODELS FOR EACH VARIABLE ###########################
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####################### RUN MODELS FOR EACH VARIABLE ###########################
```

```
####################### RUN MODELS FOR EACH VARIABLE
###########################

####################### RUN MODELS FOR EACH VARIABLE
###########################

#run one model for the variables subsequently included as covariates:

#Height (cm)

#LBM (kg)

#Fat mass (kg)

#Age (y)

#

#then run models for the metabolic variables with different covariates

#TEE1 = TEE without covariates (MJ d-1)

#BEE1 = BEE without covariates (MJ d-1)

#AEE1 = AEE without covariates (MJ d-1)

#

#TEE2 = TEE        with Height and LBM as covariates

#BEE2 = BEE        with Height and LBM as covariates

#AEE2 = AEE        with Height and LBM as covariates

#

#TEE3 = TEE        with Height, LBM, fat mass, age as covariates

#BEE3 = BEE        with Height, LBM, fat mass, age as covariates

#AEE3 = AEE        with Height, LBM, fat mass, age as covariates

#

#TEE4 = TEE        with Height, LBM, fat mass, age, age-squared as covariates plus
all 2-way interactions

#BEE4 = BEE        with Height, LBM, fat mass, age, age-squared as covariates plus
all 2-way interactions

#AEE4 = AEE        with Height, LBM, fat mass, age, age-squared as covariates plus
all 2-way interactions



#set sampling to have good MCMC convergence
```

```
n=20; NITT=13000*n; BURN=3000*n; THIN=10*n # n=5
#note: instead of running the models each time, simlpy load the models (see below)

#covariates
MC.height<-MCMCglmm(ht~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.lean<-MCMCglmm(LBM~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.fat<-MCMCglmm(FAT~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.age<-MCMCglmm(Age~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
```

```
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
#TEE
MC.TEE1<-MCMCglmm(TEE~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.TEE2<-MCMCglmm(TEE~0+Sex+htc+LBMc,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.TEE3<-MCMCglmm(TEE~0+Sex+htc+LBMc+FATc+Agec,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.TEE4<-MCMCglmm(TEE~0+Sex+htc+
                  Sex*poly(LBMc,2,raw=TRUE)+
                  Sex*poly(FATc,2,raw=TRUE)+
                  Sex*poly(Agec,2,raw=TRUE)+
                  LBMc*poly(Agec,2,raw=TRUE)+
                  FATc*poly(Agec,2,raw=TRUE),
```

```
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
#BEE
MC.BEE1<-MCMCglmm(BEE~0+Sex,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.BEE2<-MCMCglmm(BEE~0+Sex+htc+LBMc,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.BEE3<-MCMCglmm(BEE~0+Sex+htc+LBMc+FATc+Agec,
            family="gaussian",
            random=~ISO,
            rcov=~idh(Sex):units,
            #prior =prior.2,
            nitt=NITT,thin=THIN,burnin=BURN,
            data=DATA)
MC.BEE4<-MCMCglmm(BEE~0+Sex+htc+
                  Sex*poly(LBMc,2,raw=TRUE)+
```

```
          Sex*poly(FATc,2,raw=TRUE)+
          Sex*poly(Agec,2,raw=TRUE)+
          LBMc*poly(Agec,2,raw=TRUE)+
          FATc*poly(Agec,2,raw=TRUE),
      family="gaussian",
      random=~ISO,
      rcov=~idh(Sex):units,
      #prior =prior.2,
      nitt=NITT,thin=THIN,burnin=BURN,
      data=DATA)

#AEE
MC.AEE1<-MCMCglmm(AEE~0+Sex,
      family="gaussian",
      random=~ISO,
      rcov=~idh(Sex):units,
      #prior =prior.2,
      nitt=NITT,thin=THIN,burnin=BURN,
      data=DATA)
MC.AEE2<-MCMCglmm(AEE~0+Sex+htc+LBMc,
      family="gaussian",
      random=~ISO,
      rcov=~idh(Sex):units,
      #prior =prior.2,
      nitt=NITT,thin=THIN,burnin=BURN,
      data=DATA)
MC.AEE3<-MCMCglmm(AEE~0+Sex+htc+LBMc+FATc+Agec,
      family="gaussian",
      random=~ISO,
      rcov=~idh(Sex):units,
```

```
                #prior =prior.2,
                nitt=NITT,thin=THIN,burnin=BURN,
                data=DATA)
MC.AEE4<-MCMCglmm(AEE~0+Sex+htc+
                        Sex*poly(LBMc,2,raw=TRUE)+
                        Sex*poly(FATc,2,raw=TRUE)+
                        Sex*poly(Agec,2,raw=TRUE)+
                        LBMc*poly(Agec,2,raw=TRUE)+
                        FATc*poly(Agec,2,raw=TRUE),
                family="gaussian",
                random=~ISO,
                rcov=~idh(Sex):units,
                #prior =prior.2,
                nitt=NITT,thin=THIN,burnin=BURN,
                data=DATA)

#save the models as R objects
save(MC.height,
   MC.lean,
  MC.fat,
  MC.age,
  MC.TEE1,
  MC.TEE2,
  MC.TEE3,
  MC.TEE4,
  MC.BEE1,
  MC.BEE2,
  MC.BEE3,
  MC.BEE4,
  MC.AEE1,
```

```
  MC.AEE2,
  MC.AEE3,
  MC.AEE4, file="MCMC_models.RData")

load("MCMC_models.RData")

################# check model convergence ############################
#check effective sample sizes for sex-specific averages
EFF.sample.fixed<-
c(summary(MC.height)$solutions[1:2,4],
  summary(MC.lean)$solutions[1:2,4],
  summary(MC.fat)$solutions[1:2,4],
  summary(MC.age)$solutions[1:2,4],
  summary(MC.TEE1)$solutions[1:2,4],
  summary(MC.TEE2)$solutions[1:2,4],
  summary(MC.TEE3)$solutions[1:2,4],
  summary(MC.TEE4)$solutions[1:2,4],
  summary(MC.BEE1)$solutions[1:2,4],
  summary(MC.BEE2)$solutions[1:2,4],
  summary(MC.BEE3)$solutions[1:2,4],
  summary(MC.BEE4)$solutions[1:2,4],
  summary(MC.AEE1)$solutions[1:2,4],
  summary(MC.AEE2)$solutions[1:2,4],
  summary(MC.AEE3)$solutions[1:2,4],
  summary(MC.AEE4)$solutions[1:2,4])

range(EFF.sample.fixed)

#check effective sample sizes for sex-specific variances
EFF.sample.resid<-
```

```
c(summary(MC.height)$Rcovariances[,4],
  summary(MC.lean)$Rcovariances[,4],
  summary(MC.fat)$Rcovariances[,4],
  summary(MC.age)$Rcovariances[,4],
  summary(MC.TEE1)$Rcovariances[,4],
  summary(MC.TEE2)$Rcovariances[,4],
  summary(MC.TEE3)$Rcovariances[,4],
  summary(MC.TEE4)$Rcovariances[,4],
  summary(MC.BEE1)$Rcovariances[,4],
  summary(MC.BEE2)$Rcovariances[,4],
  summary(MC.BEE3)$Rcovariances[,4],
  summary(MC.BEE4)$Rcovariances[,4],
  summary(MC.AEE1)$Rcovariances[,4],
  summary(MC.AEE2)$Rcovariances[,4],
  summary(MC.AEE3)$Rcovariances[,4],
  summary(MC.AEE4)$Rcovariances[,4])

range(EFF.sample.resid)
#[1]  860.3274 1529.8571

#check mode summaries
summary(MC.height)
summary(MC.lean)
summary(MC.fat)
summary(MC.age)
summary(MC.TEE1)
summary(MC.TEE2)
summary(MC.TEE3)
summary(MC.TEE4)
summary(MC.BEE1)
```

```
summary(MC.BEE2)
summary(MC.BEE3)
summary(MC.BEE4)
summary(MC.AEE1)
summary(MC.AEE2)
summary(MC.AEE3)
summary(MC.AEE4)


#explanation of model outputs
summary(MC.height)
#SexF.units is the variance in females
#SexF is the female mean
#these can be retreived from
mean(MC.height$VCV[,"SexF.units"])
mean(MC.height$Sol[,"SexF"])
#you can look at the posterior distribution for these by doing:
plot(MC.height$VCV[,"SexF.units"])
plot(MC.height$Sol[,"SexF"])
#To get the Coefficient of Variation, we can divide the mean variance by the mean average:
mean(MC.height$VCV[,"SexF.units"])/mean(MC.height$Sol[,"SexF"])
#But even better, divide the variance by the mean for each posterior,
POST.F<-MC.height$VCV[,"SexF.units"]/MC.height$Sol[,"SexF"]
plot(POST.F) #this is the posterior distribution for the Coefficient of Variation
#therefore, we can calculate the mean and 95% CI for Coefficient of Variation like this:
posterior.mode(POST.F)
HPDinterval(POST.F)
#in one go we can do:
posterior.mode(MC.height$VCV[,"SexF.units"]/MC.height$Sol[,"SexF"])
```

```
HPDinterval(MC.height$VCV[,"SexF.units"]/MC.height$Sol[,"SexF"])


#below we will extract sex-specific means, variances, and coefficient of variances
from each model

#first, set up a data.frame to receive the estimates

ESTIMATES<-data.frame(Trait=c("Height","LBM","Fat mass","Age",

                          "TEE1","TEE2","TEE3","TEE4",

                          "BEE1","BEE2","BEE3","BEE4",

                          "AEE1","AEE2","AEE3","AEE4"),

                 Mean.M=NA,

                 Mean.M.LC=NA,

                 Mean.M.UC=NA,

                 Mean.F=NA,

                 Mean.F.LC=NA,

                 Mean.F.UC=NA,

                 V.M=NA,

                 V.M.LC=NA,

                 V.M.UC=NA,

                 V.F=NA,

                 V.F.LC=NA,

                 V.F.UC=NA,

                 CV.M=NA,

                 CV.M.LC=NA,

                 CV.M.UC=NA,

                 CV.F=NA,

                 CV.F.LC=NA,

                 CV.F.UC=NA,

                 Ratio=NA,

                 Ratio.LC=NA,

                 Ratio.UC=NA)
```

```
#compile estimates from each model
#Average in males
Mean.M<-c(
posterior.mode(MC.height$Sol)["SexM"],
posterior.mode(MC.lean$Sol)["SexM"],
posterior.mode(MC.fat$Sol)["SexM"],
posterior.mode(MC.age$Sol)["SexM"],
posterior.mode(MC.TEE1$Sol)["SexM"],
posterior.mode(MC.TEE2$Sol)["SexM"],
posterior.mode(MC.TEE3$Sol)["SexM"],
posterior.mode(MC.TEE4$Sol)["SexM"],
posterior.mode(MC.BEE1$Sol)["SexM"],
posterior.mode(MC.BEE2$Sol)["SexM"],
posterior.mode(MC.BEE3$Sol)["SexM"],
posterior.mode(MC.BEE4$Sol)["SexM"],
posterior.mode(MC.AEE1$Sol)["SexM"],
posterior.mode(MC.AEE2$Sol)["SexM"],
posterior.mode(MC.AEE3$Sol)["SexM"],
posterior.mode(MC.AEE4$Sol)["SexM"])
ESTIMATES$Mean.M<-round(Mean.M,2)
#95% credible intervals
Mean.M.CI<-rbind(
HPDinterval(MC.height$Sol[,2]),
HPDinterval(MC.lean$Sol[,2]),
HPDinterval(MC.fat$Sol[,2]),
HPDinterval(MC.age$Sol[,2]),
HPDinterval(MC.TEE1$Sol[,2]),
HPDinterval(MC.TEE2$Sol[,2]),
HPDinterval(MC.TEE3$Sol[,2]),
```

```
HPDinterval(MC.TEE4$Sol[,2]),
HPDinterval(MC.BEE1$Sol[,2]),
HPDinterval(MC.BEE2$Sol[,2]),
HPDinterval(MC.BEE3$Sol[,2]),
HPDinterval(MC.BEE4$Sol[,2]),
HPDinterval(MC.AEE1$Sol[,2]),
HPDinterval(MC.AEE2$Sol[,2]),
HPDinterval(MC.AEE3$Sol[,2]),
HPDinterval(MC.AEE4$Sol[,2]))
ESTIMATES$Mean.M.LC<-round(Mean.M.CI[,1],2)
ESTIMATES$Mean.M.UC<-round(Mean.M.CI[,2],2)
#Average in females
Mean.F<-c(
posterior.mode(MC.height$Sol)["SexF"],
posterior.mode(MC.lean$Sol)["SexF"],
posterior.mode(MC.fat$Sol)["SexF"],
posterior.mode(MC.age$Sol)["SexF"],
posterior.mode(MC.TEE1$Sol)["SexF"],
posterior.mode(MC.TEE2$Sol)["SexF"],
posterior.mode(MC.TEE3$Sol)["SexF"],
posterior.mode(MC.TEE4$Sol)["SexF"],
posterior.mode(MC.BEE1$Sol)["SexF"],
posterior.mode(MC.BEE2$Sol)["SexF"],
posterior.mode(MC.BEE3$Sol)["SexF"],
posterior.mode(MC.BEE4$Sol)["SexF"],
posterior.mode(MC.AEE1$Sol)["SexF"],
posterior.mode(MC.AEE2$Sol)["SexF"],
posterior.mode(MC.AEE3$Sol)["SexF"],
posterior.mode(MC.AEE4$Sol)["SexF"])
ESTIMATES$Mean.F<-round(Mean.F,2)
```

```
#95% credible intervals
Mean.F.CI<-rbind(
HPDinterval(MC.height$Sol[,1]),
HPDinterval(MC.lean$Sol[,1]),
HPDinterval(MC.fat$Sol[,1]),
HPDinterval(MC.age$Sol[,1]),
HPDinterval(MC.TEE1$Sol[,1]),
HPDinterval(MC.TEE2$Sol[,1]),
HPDinterval(MC.TEE3$Sol[,1]),
HPDinterval(MC.TEE4$Sol[,1]),
HPDinterval(MC.BEE1$Sol[,1]),
HPDinterval(MC.BEE2$Sol[,1]),
HPDinterval(MC.BEE3$Sol[,1]),
HPDinterval(MC.BEE4$Sol[,1]),
HPDinterval(MC.AEE1$Sol[,1]),
HPDinterval(MC.AEE2$Sol[,1]),
HPDinterval(MC.AEE3$Sol[,1]),
HPDinterval(MC.AEE4$Sol[,1]))
ESTIMATES$Mean.F.LC<-round(Mean.F.CI[,1],2)
ESTIMATES$Mean.F.UC<-round(Mean.F.CI[,2],2)
#variance in males
V.M<-c(
posterior.mode(MC.height$VCV[,"SexM.units"]),
posterior.mode(MC.lean$VCV[,"SexM.units"]),
posterior.mode(MC.fat$VCV[,"SexM.units"]),
posterior.mode(MC.age$VCV[,"SexM.units"]),
posterior.mode(MC.TEE1$VCV[,"SexM.units"]),
posterior.mode(MC.TEE2$VCV[,"SexM.units"]),
posterior.mode(MC.TEE3$VCV[,"SexM.units"]),
posterior.mode(MC.TEE4$VCV[,"SexM.units"]),
```

```
posterior.mode(MC.BEE1$VCV[,"SexM.units"]),
posterior.mode(MC.BEE2$VCV[,"SexM.units"]),
posterior.mode(MC.BEE3$VCV[,"SexM.units"]),
posterior.mode(MC.BEE4$VCV[,"SexM.units"]),
posterior.mode(MC.AEE1$VCV[,"SexM.units"]),
posterior.mode(MC.AEE2$VCV[,"SexM.units"]),
posterior.mode(MC.AEE3$VCV[,"SexM.units"]),
posterior.mode(MC.AEE4$VCV[,"SexM.units"]))
ESTIMATES$V.M<-round(V.M,2)
#95% credible intervals in residual variance in males
V.M.CI<-rbind(
HPDinterval(MC.height$VCV[,"SexM.units"]),
HPDinterval(MC.lean$VCV[,"SexM.units"]),
HPDinterval(MC.fat$VCV[,"SexM.units"]),
HPDinterval(MC.age$VCV[,"SexM.units"]),
HPDinterval(MC.TEE1$VCV[,"SexM.units"]),
HPDinterval(MC.TEE2$VCV[,"SexM.units"]),
HPDinterval(MC.TEE3$VCV[,"SexM.units"]),
HPDinterval(MC.TEE4$VCV[,"SexM.units"]),
HPDinterval(MC.BEE1$VCV[,"SexM.units"]),
HPDinterval(MC.BEE2$VCV[,"SexM.units"]),
HPDinterval(MC.BEE3$VCV[,"SexM.units"]),
HPDinterval(MC.BEE3$VCV[,"SexM.units"]),
HPDinterval(MC.AEE1$VCV[,"SexM.units"]),
HPDinterval(MC.AEE2$VCV[,"SexM.units"]),
HPDinterval(MC.AEE3$VCV[,"SexM.units"]),
HPDinterval(MC.AEE4$VCV[,"SexM.units"]))
ESTIMATES$V.M.LC<-round(V.M.CI[,1],2)
ESTIMATES$V.M.UC<-round(V.M.CI[,2],2)
# variance in females
```

```
V.F<-c(
posterior.mode(MC.height$VCV[,"SexF.units"]),
posterior.mode(MC.lean$VCV[,"SexF.units"]),
posterior.mode(MC.fat$VCV[,"SexF.units"]),
posterior.mode(MC.age$VCV[,"SexF.units"]),
posterior.mode(MC.TEE1$VCV[,"SexF.units"]),
posterior.mode(MC.TEE2$VCV[,"SexF.units"]),
posterior.mode(MC.TEE3$VCV[,"SexF.units"]),
posterior.mode(MC.TEE4$VCV[,"SexF.units"]),
posterior.mode(MC.BEE1$VCV[,"SexF.units"]),
posterior.mode(MC.BEE2$VCV[,"SexF.units"]),
posterior.mode(MC.BEE3$VCV[,"SexF.units"]),
posterior.mode(MC.BEE4$VCV[,"SexF.units"]),
posterior.mode(MC.AEE1$VCV[,"SexF.units"]),
posterior.mode(MC.AEE2$VCV[,"SexF.units"]),
posterior.mode(MC.AEE3$VCV[,"SexF.units"]),
posterior.mode(MC.AEE4$VCV[,"SexF.units"]))
ESTIMATES$V.F<-round(V.F,2)
#95% credible intervals in residual variance in females
V.F.CI<-rbind(
HPDinterval(MC.height$VCV[,"SexF.units"]),
HPDinterval(MC.lean$VCV[,"SexF.units"]),
HPDinterval(MC.fat$VCV[,"SexF.units"]),
HPDinterval(MC.age$VCV[,"SexF.units"]),
HPDinterval(MC.TEE1$VCV[,"SexF.units"]),
HPDinterval(MC.TEE2$VCV[,"SexF.units"]),
HPDinterval(MC.TEE3$VCV[,"SexF.units"]),
HPDinterval(MC.TEE4$VCV[,"SexF.units"]),
HPDinterval(MC.BEE1$VCV[,"SexF.units"]),
HPDinterval(MC.BEE2$VCV[,"SexF.units"]),
```

```
HPDinterval(MC.BEE3$VCV[,"SexF.units"]),
HPDinterval(MC.BEE4$VCV[,"SexF.units"]),
HPDinterval(MC.AEE1$VCV[,"SexF.units"]),
HPDinterval(MC.AEE2$VCV[,"SexF.units"]),
HPDinterval(MC.AEE3$VCV[,"SexF.units"]),
HPDinterval(MC.AEE4$VCV[,"SexF.units"]))
ESTIMATES$V.F.LC<-round(V.F.CI[,1],2)
ESTIMATES$V.F.UC<-round(V.F.CI[,2],2)
#CoV in males
CV.M<-c(
posterior.mode(MC.height$VCV[,"SexM.units"]/MC.height$Sol[,"SexM"]),
posterior.mode(MC.lean$VCV[,"SexM.units"]  /MC.lean$Sol[,"SexM"]),
posterior.mode(MC.fat$VCV[,"SexM.units"]   /MC.fat$Sol[,"SexM"]),
posterior.mode(MC.age$VCV[,"SexM.units"]   /MC.age$Sol[,"SexM"]),
posterior.mode(MC.TEE1$VCV[,"SexM.units"]  /MC.TEE1$Sol[,"SexM"]),
posterior.mode(MC.TEE2$VCV[,"SexM.units"]  /MC.TEE2$Sol[,"SexM"]),
posterior.mode(MC.TEE3$VCV[,"SexM.units"]  /MC.TEE3$Sol[,"SexM"]),
posterior.mode(MC.TEE4$VCV[,"SexM.units"]  /MC.TEE4$Sol[,"SexM"]),
posterior.mode(MC.BEE1$VCV[,"SexM.units"]  /MC.BEE1$Sol[,"SexM"]),
posterior.mode(MC.BEE2$VCV[,"SexM.units"]  /MC.BEE2$Sol[,"SexM"]),
posterior.mode(MC.BEE3$VCV[,"SexM.units"]  /MC.BEE3$Sol[,"SexM"]),
posterior.mode(MC.BEE4$VCV[,"SexM.units"]  /MC.BEE4$Sol[,"SexM"]),
posterior.mode(MC.AEE1$VCV[,"SexM.units"]  /MC.AEE1$Sol[,"SexM"]),
posterior.mode(MC.AEE2$VCV[,"SexM.units"]  /MC.AEE2$Sol[,"SexM"]),
posterior.mode(MC.AEE3$VCV[,"SexM.units"]  /MC.AEE3$Sol[,"SexM"]),
posterior.mode(MC.AEE4$VCV[,"SexM.units"]  /MC.AEE4$Sol[,"SexM"]))
ESTIMATES$CV.M<-round(CV.M,2)
#95% credible intervals in CoV males
CV.M.CI<-rbind(
HPDinterval(MC.height$VCV[,"SexM.units"]/MC.height$Sol[,"SexM"]),
```

```
HPDinterval(MC.lean$VCV[,"SexM.units"]  /MC.lean$Sol[,"SexM"]),
HPDinterval(MC.fat$VCV[,"SexM.units"]   /MC.fat$Sol[,"SexM"]),
HPDinterval(MC.age$VCV[,"SexM.units"]   /MC.age$Sol[,"SexM"]),
HPDinterval(MC.TEE1$VCV[,"SexM.units"]  /MC.TEE1$Sol[,"SexM"]),
HPDinterval(MC.TEE2$VCV[,"SexM.units"]  /MC.TEE2$Sol[,"SexM"]),
HPDinterval(MC.TEE3$VCV[,"SexM.units"]  /MC.TEE3$Sol[,"SexM"]),
HPDinterval(MC.TEE4$VCV[,"SexM.units"]  /MC.TEE4$Sol[,"SexM"]),
HPDinterval(MC.BEE1$VCV[,"SexM.units"]  /MC.BEE1$Sol[,"SexM"]),
HPDinterval(MC.BEE2$VCV[,"SexM.units"]  /MC.BEE2$Sol[,"SexM"]),
HPDinterval(MC.BEE3$VCV[,"SexM.units"]  /MC.BEE3$Sol[,"SexM"]),
HPDinterval(MC.BEE4$VCV[,"SexM.units"]  /MC.BEE4$Sol[,"SexM"]),
HPDinterval(MC.AEE1$VCV[,"SexM.units"]  /MC.AEE1$Sol[,"SexM"]),
HPDinterval(MC.AEE2$VCV[,"SexM.units"]  /MC.AEE2$Sol[,"SexM"]),
HPDinterval(MC.AEE3$VCV[,"SexM.units"]  /MC.AEE3$Sol[,"SexM"]),
HPDinterval(MC.AEE4$VCV[,"SexM.units"]  /MC.AEE4$Sol[,"SexM"]))
ESTIMATES$CV.M.LC<-round(CV.M.CI[,1],2)
ESTIMATES$CV.M.UC<-round(CV.M.CI[,2],2)
#CoV in females
CV.F<-c(
posterior.mode(MC.height$VCV[,"SexM.units"]/MC.height$Sol[,"SexF"]),
posterior.mode(MC.lean$VCV[,"SexF.units"]  /MC.lean$Sol[,"SexF"]),
posterior.mode(MC.fat$VCV[,"SexF.units"]   /MC.fat$Sol[,"SexF"]),
posterior.mode(MC.age$VCV[,"SexF.units"]   /MC.age$Sol[,"SexF"]),
posterior.mode(MC.TEE1$VCV[,"SexF.units"]  /MC.TEE1$Sol[,"SexF"]),
posterior.mode(MC.TEE2$VCV[,"SexF.units"]  /MC.TEE2$Sol[,"SexF"]),
posterior.mode(MC.TEE3$VCV[,"SexF.units"]  /MC.TEE3$Sol[,"SexF"]),
posterior.mode(MC.TEE4$VCV[,"SexF.units"]  /MC.TEE4$Sol[,"SexF"]),
posterior.mode(MC.BEE1$VCV[,"SexF.units"]  /MC.BEE1$Sol[,"SexF"]),
posterior.mode(MC.BEE2$VCV[,"SexF.units"]  /MC.BEE2$Sol[,"SexF"]),
posterior.mode(MC.BEE3$VCV[,"SexF.units"]  /MC.BEE3$Sol[,"SexF"]),
```

```
posterior.mode(MC.BEE4$VCV[,"SexF.units"]  /MC.BEE4$Sol[,"SexF"]),
posterior.mode(MC.AEE1$VCV[,"SexF.units"]  /MC.AEE1$Sol[,"SexF"]),
posterior.mode(MC.AEE2$VCV[,"SexF.units"]  /MC.AEE2$Sol[,"SexF"]),
posterior.mode(MC.AEE3$VCV[,"SexF.units"]  /MC.AEE3$Sol[,"SexF"]),
posterior.mode(MC.AEE4$VCV[,"SexF.units"]  /MC.AEE4$Sol[,"SexF"]))
ESTIMATES$CV.F<-round(CV.F,2)
#95% credible intervals in CoV males
CV.F.CI<-rbind(
HPDinterval(MC.height$VCV[,"SexF.units"]/MC.height$Sol[,"SexF"]),
HPDinterval(MC.lean$VCV[,"SexF.units"]  /MC.lean$Sol[,"SexF"]),
HPDinterval(MC.fat$VCV[,"SexF.units"]   /MC.fat$Sol[,"SexF"]),
HPDinterval(MC.age$VCV[,"SexF.units"]   /MC.age$Sol[,"SexF"]),
HPDinterval(MC.TEE1$VCV[,"SexF.units"]  /MC.TEE1$Sol[,"SexF"]),
HPDinterval(MC.TEE2$VCV[,"SexF.units"]  /MC.TEE2$Sol[,"SexF"]),
HPDinterval(MC.TEE3$VCV[,"SexF.units"]  /MC.TEE3$Sol[,"SexF"]),
HPDinterval(MC.TEE4$VCV[,"SexF.units"]  /MC.TEE4$Sol[,"SexF"]),
HPDinterval(MC.BEE1$VCV[,"SexF.units"]  /MC.BEE1$Sol[,"SexF"]),
HPDinterval(MC.BEE2$VCV[,"SexF.units"]  /MC.BEE2$Sol[,"SexF"]),
HPDinterval(MC.BEE3$VCV[,"SexF.units"]  /MC.BEE3$Sol[,"SexF"]),
HPDinterval(MC.BEE4$VCV[,"SexF.units"]  /MC.BEE4$Sol[,"SexF"]),
HPDinterval(MC.AEE1$VCV[,"SexF.units"]  /MC.AEE1$Sol[,"SexF"]),
HPDinterval(MC.AEE2$VCV[,"SexF.units"]  /MC.AEE2$Sol[,"SexF"]),
HPDinterval(MC.AEE3$VCV[,"SexF.units"]  /MC.AEE3$Sol[,"SexF"]),
HPDinterval(MC.AEE4$VCV[,"SexF.units"]  /MC.AEE4$Sol[,"SexF"]))
ESTIMATES$CV.F.LC<-round(CV.F.CI[,1],2)
ESTIMATES$CV.F.UC<-round(CV.F.CI[,2],2)
#Ratio Male/female
Ratio<-c(
posterior.mode(MC.height$VCV[,"SexM.units"]/MC.height$VCV[,"SexF.units"]),
posterior.mode(MC.lean$VCV[,"SexM.units"]/MC.lean$VCV[,"SexF.units"]),
```

```
posterior.mode(MC.fat$VCV[,"SexM.units"]/MC.fat$VCV[,"SexF.units"]),
posterior.mode(MC.age$VCV[,"SexM.units"]/MC.age$VCV[,"SexF.units"]),
posterior.mode(MC.TEE1$VCV[,"SexM.units"]/MC.TEE1$VCV[,"SexF.units"]),
posterior.mode(MC.TEE2$VCV[,"SexM.units"]/MC.TEE2$VCV[,"SexF.units"]),
posterior.mode(MC.TEE3$VCV[,"SexM.units"]/MC.TEE3$VCV[,"SexF.units"]),
posterior.mode(MC.TEE4$VCV[,"SexM.units"]/MC.TEE4$VCV[,"SexF.units"]),
posterior.mode(MC.BEE1$VCV[,"SexM.units"]/MC.BEE1$VCV[,"SexF.units"]),
posterior.mode(MC.BEE2$VCV[,"SexM.units"]/MC.BEE2$VCV[,"SexF.units"]),
posterior.mode(MC.BEE3$VCV[,"SexM.units"]/MC.BEE3$VCV[,"SexF.units"]),
posterior.mode(MC.BEE4$VCV[,"SexM.units"]/MC.BEE4$VCV[,"SexF.units"]),
posterior.mode(MC.AEE1$VCV[,"SexM.units"]/MC.AEE1$VCV[,"SexF.units"]),
posterior.mode(MC.AEE2$VCV[,"SexM.units"]/MC.AEE2$VCV[,"SexF.units"]),
posterior.mode(MC.AEE3$VCV[,"SexM.units"]/MC.AEE3$VCV[,"SexF.units"]),
posterior.mode(MC.AEE4$VCV[,"SexM.units"]/MC.AEE4$VCV[,"SexF.units"]))
ESTIMATES$Ratio<-round(Ratio,2)
#95% credible intervals of Ratio
Ratio.CI<-rbind(
HPDinterval(MC.height$VCV[,"SexM.units"]/MC.height$VCV[,"SexF.units"]),
HPDinterval(MC.lean$VCV[,"SexM.units"]/MC.lean$VCV[,"SexF.units"]),
HPDinterval(MC.fat$VCV[,"SexM.units"]/MC.fat$VCV[,"SexF.units"]),
HPDinterval(MC.age$VCV[,"SexM.units"]/MC.age$VCV[,"SexF.units"]),
HPDinterval(MC.TEE1$VCV[,"SexM.units"]/MC.TEE1$VCV[,"SexF.units"]),
HPDinterval(MC.TEE2$VCV[,"SexM.units"]/MC.TEE2$VCV[,"SexF.units"]),
HPDinterval(MC.TEE3$VCV[,"SexM.units"]/MC.TEE3$VCV[,"SexF.units"]),
HPDinterval(MC.TEE4$VCV[,"SexM.units"]/MC.TEE4$VCV[,"SexF.units"]),
HPDinterval(MC.BEE1$VCV[,"SexM.units"]/MC.BEE1$VCV[,"SexF.units"]),
HPDinterval(MC.BEE2$VCV[,"SexM.units"]/MC.BEE2$VCV[,"SexF.units"]),
HPDinterval(MC.BEE3$VCV[,"SexM.units"]/MC.BEE3$VCV[,"SexF.units"]),
HPDinterval(MC.BEE4$VCV[,"SexM.units"]/MC.BEE4$VCV[,"SexF.units"]),
HPDinterval(MC.AEE1$VCV[,"SexM.units"]/MC.AEE1$VCV[,"SexF.units"]),
```

```
HPDinterval(MC.AEE2$VCV[,"SexM.units"]/MC.AEE2$VCV[,"SexF.units"]),
HPDinterval(MC.AEE3$VCV[,"SexM.units"]/MC.AEE3$VCV[,"SexF.units"]),
HPDinterval(MC.AEE4$VCV[,"SexM.units"]/MC.AEE4$VCV[,"SexF.units"]))
ESTIMATES$Ratio.LC<-round(Ratio.CI[,1],2)
ESTIMATES$Ratio.UC<-round(Ratio.CI[,2],2)
############## Save for Table for manuscript ############
ESTIMATES.round<-round(ESTIMATES[,2:22],1)


#write.table(ESTIMATES, file="ESTIMATES_with_country_as_random_effect.csv", sep=",")
#write.table(ESTIMATES.round, file="ESTIMATES.round.csv", sep=",")
############################################################


#################### make figure 1 ##########################################
#################### make figure 1 ##########################################
#################### make figure 1 ##########################################
#################### make figure 1 ##########################################
#################### make figure 1 ##########################################
#################### make figure 1 ##########################################
ESTIMATES$Xmale  <-c(0.9,1.9,2.9,3.9,5.9,6.9,7.9,8.9,10.9,11.9,12.9,13.9,15.9,16.9,17.9,18.9)
ESTIMATES$Xfemale<-c(1.1,2.1,3.1,4.1,6.1,7.1,8.1,9.1,11.1,12.1,13.1,14.1,16.1,17.1,18.1,19.1)
#
  par(las=1,mar=c(5,5,0.5,0.5))
    plot(V.M~Xmale,  ESTIMATES, pch=16,col=1,cex=1.25,ylim=c(0.26,6.85),xlim=c(6,19),xaxt="n",xlab="",ylab="Variance (±95%CI)")
```

```
  points(V.F~Xfemale,ESTIMATES, pch=17,col=1,cex=1.25)

  arrows(ESTIMATES$Xmale,  ESTIMATES$V.M.LC, ESTIMATES$Xmale, ESTIMATES$V.M.UC,col=1,code=3,length=0.05,angle=90)


arrows(ESTIMATES$Xfemale,ESTIMATES$V.F.LC,ESTIMATES$Xfemale,ESTIMATES$V.F.UC,col=1,code=3,length=0.05,angle=90)

  abline(v=10)

  abline(v=15)

  mtext("TEE",side=3,adj=0.125,line=-1.2)

  mtext("BEE",side=3,adj=0.5,line=-1.2)

  mtext("AEE",side=3,adj=0.875,line=-1.2)

  axis(1,c(6,7,8,9,11,12,13,14,16,17,18,19), las=3,

  labels=c("none","set 1","set 2","set 3",

          "none","set 1","set 2","set 3",

          "none","set 1","set 2","set 3"))

  mtext("Covariates", side=1,line=3.5)




######################  testing for a sex x age interaction in variance #############

######################  testing for a sex x age interaction in variance #############

######################  testing for a sex x age interaction in variance #############

######################  testing for a sex x age interaction in variance #############

######################  testing for a sex x age interaction in variance #############

######################  testing for a sex x age interaction in variance #############

#reviewer comment:
```

```
#The effect of age on EE is controlled for in some of the analyses, but is the variance ratio affected by age?
#Sexual selection based explanations would predict that variance would be relatively higher among young men.
hist(DATA$Age)


#split the data into 4 equal age periods
quantile(DATA$Age)
DATA$AGE_cat<-1
DATA$AGE_cat[which(DATA$Age>32)]<-2
DATA$AGE_cat[which(DATA$Age>48)]<-3
DATA$AGE_cat[which(DATA$Age>69)]<-4
DATA$AGE_cat<-factor(DATA$AGE_cat)
plot(Age~AGE_cat,DATA)
DATA$n<-1
aggregate(n~AGE_cat,DATA,FUN=sum)


#look at sex-specific sample sizes
DATA$SEX_AGE<-factor(paste(DATA$Sex,DATA$AGE_cat,sep="_"))
aggregate(n~SEX_AGE,DATA,FUN=sum)


#set priors for 8 separate residual variances
prior.3<-list(R=list(R1=list(V=diag(8), nu=1.002)))
#run the model with 8 separate residual variances (4 for females and 4 for males)
MC.hete.5<-MCMCglmm(TEE~0+SEX_AGE+
                    Sex*poly(LBMc,2,raw=TRUE)+
                    Sex*poly(FATc,2,raw=TRUE)+
                    Sex*poly(Agec,2,raw=TRUE)+
                    LBMc*poly(Agec,2,raw=TRUE)+
                    FATc*poly(Agec,2,raw=TRUE),
             family="gaussian",
```

```
                random=~ISO,
                rcov=~idh(SEX_AGE):units,
               # prior =prior.3,
                nitt=NITT,thin=THIN,burnin=BURN,
                data=DATA)

save(MC.hete.5,file="MC.hete.5.RData")
load(file="MC.hete.5.RData")
summary(MC.hete.5)

V<-c(
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_1.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_2.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_3.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_4.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_1.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_2.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_3.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_4.units"]))
#
CI<-rbind(
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_1.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_2.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_3.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_4.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_1.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_2.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_3.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_4.units"]))
#
```

```
CV<-c(
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_1.units"]/MC.hete.5$Sol[,"SEX_AGEF_1"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_2.units"]/MC.hete.5$Sol[,"SEX_AGEF_2"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_3.units"]/MC.hete.5$Sol[,"SEX_AGEF_3"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEF_4.units"]/MC.hete.5$Sol[,"SEX_AGEF_4"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_1.units"]/MC.hete.5$Sol[,"SEX_AGEM_1"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_2.units"]/MC.hete.5$Sol[,"SEX_AGEM_2"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_3.units"]/MC.hete.5$Sol[,"SEX_AGEM_3"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_4.units"]/MC.hete.5$Sol[,"SEX_AGEM_4"]))
#
CV.CI<-rbind(
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_1.units"]/MC.hete.5$Sol[,"SEX_AGEF_1"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_2.units"]/MC.hete.5$Sol[,"SEX_AGEF_2"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_3.units"]/MC.hete.5$Sol[,"SEX_AGEF_3"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEF_4.units"]/MC.hete.5$Sol[,"SEX_AGEF_4"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_1.units"]/MC.hete.5$Sol[,"SEX_AGEM_1"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_2.units"]/MC.hete.5$Sol[,"SEX_AGEM_2"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_3.units"]/MC.hete.5$Sol[,"SEX_AGEM_3"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_4.units"]/MC.hete.5$Sol[,"SEX_AGEM_4"]))
#
```

```
V.AGE<-data.frame(cbind(V,CI,CV,CV.CI))
V.AGE$x<-c(0.95,1.95,2.95,3.95,1.05,2.05,3.05,4.05)
V.AGE$COL<-c("pink2","pink2","pink2","pink2","paleturquoise3","paleturquoise3","paleturquoise3","paleturquoise3")
V.AGE$PCH<-c(17,17,17,17,16,16,16,16)
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
RATIO<-c(
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_1.units"]/MC.hete.5$VCV[,"SEX_AGEF_1.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_2.units"]/MC.hete.5$VCV[,"SEX_AGEF_2.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_3.units"]/MC.hete.5$VCV[,"SEX_AGEF_3.units"]),
posterior.mode(MC.hete.5$VCV[,"SEX_AGEM_4.units"]/MC.hete.5$VCV[,"SEX_AGEF_4.units"]))
RATIO.CI<-rbind(
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_1.units"]/MC.hete.5$VCV[,"SEX_AGEF_1.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_2.units"]/MC.hete.5$VCV[,"SEX_AGEF_2.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_3.units"]/MC.hete.5$VCV[,"SEX_AGEF_3.units"]),
HPDinterval(MC.hete.5$VCV[,"SEX_AGEM_4.units"]/MC.hete.5$VCV[,"SEX_AGEF_4.units"]))

# Figure 3
x11(7,3)
par(mfrow=c(1,3),las=1,mar=c(6,5,0.5,0.5))
  plot(V~x, V.AGE, pch=PCH,col=1,ylim=c(0,4.5),xlim=c(0.5,4.54),xaxt="n",xlab="",ylab="Variance (±95%CI)")
```

```
arrows(V.AGE$x,  V.AGE$lower,  V.AGE$x,  V.AGE$upper,
col=1,code=3,length=0.05,angle=90)
axis(1,c(1,2,3,4), las=3,labels=c("18 to 32","33 to 48","49 to 69","70 to 96"))
mtext("Age category", side=1,line=4.5)
mtext("A", side=3,line=-1.2,adj=0.02)
#add sample sizes
text(1,1.40,"734",cex=0.8)
text(2,1.25,"677",cex=0.8)
text(3,0.95,"797",cex=0.8)
text(4,0.70,"900",cex=0.8)
#
text(1,3.1,"413",cex=0.8)
text(2,3.3,"441",cex=0.8)
text(3,2.1,"364",cex=0.8)
text(4,1.6,"276",cex=0.8)
#plot CVs
  plot(CV~x, V.AGE,
pch=PCH,col=1,ylim=c(0,0.8),xlim=c(0.5,4.5),xaxt="n",xlab="",ylab="Coefficient of
variance (±95%CI)")
arrows(V.AGE$x,  V.AGE$lower.1,  V.AGE$x,  V.AGE$upper.1,
col=1,code=3,length=0.05,angle=90)
axis(1,c(1,2,3,4), las=3,labels=c("18 to 32","33 to 48","49 to 69","70 to 96"))
mtext("Age category", side=1,line=4.5)
mtext("B", side=3,line=-1.2,adj=0.02)
#
  plot(1:4,RATIO,
pch=16,col=1,ylim=c(1.5,3.1),xlim=c(0.5,4.54),xaxt="n",xlab="",ylab="M:F variance
ratio (±95%CI)")
arrows(1:4,  RATIO.CI[,1],  1:4,  RATIO.CI[,2],  col=1,code=3,length=0.05,angle=90)
axis(1,c(1,2,3,4), las=3,labels=c("18 to 32","33 to 48","49 to 69","70 to 96"))
mtext("C", side=3,line=-1.2,adj=0.02)
mtext("Age category", side=1,line=4.5)
```

```
#check country  if USA (or USA as 'West') have different variance than elsewhere in the world

#check country  if USA (or USA as 'West') have different variance than elsewhere in the world

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#check country  if USA (or USA as 'West') have different variance than elsewhere in the world

#check country  if USA (or USA as 'West') have different variance than elsewhere in the world

#check country  if USA (or USA as 'West') have different variance than elsewhere in the world

summary(DATA)

DATA$ISO<-factor(DATA$ISO)

plot(TEE~ISO,DATA)

DATA$n<-1

aggregate(n~ISO,DATA,FUN=sum)

DATA$USA<-"USA"

DATA$USA[which(DATA$ISO=="BOL")]<-"other" #Bolivia

#DATA$USA[which(DATA$ISO=="CHE")]<-"other" #Switzerland ### Removed by Lewis 21.12.10th

DATA$USA[which(DATA$ISO=="Chile")]<-"other" #Chile

DATA$USA[which(DATA$ISO=="CHN")]<-"other" #China

DATA$USA[which(DATA$ISO=="ECU")]<-"other" #Ecuador

DATA$USA[which(DATA$ISO=="GHA")]<-"other" #Ghana

DATA$USA[which(DATA$ISO=="JAM")]<-"other" #Jamaica

DATA$USA[which(DATA$ISO=="JPN")]<-"other" #Japan

DATA$USA[which(DATA$ISO=="KEN")]<-"other" #Kenya

DATA$USA[which(DATA$ISO=="MUS")]<-"other" #Mauritius ### Added by Lewis 21.12.10th
```

```
DATA$USA[which(DATA$ISO=="NGA")]<-"other" #Nigeria
DATA$USA[which(DATA$ISO=="NPL")]<-"other" #Nepal
DATA$USA[which(DATA$ISO=="SYC")]<-"other" #Seychelles
DATA$USA[which(DATA$ISO=="TZA")]<-"other" #Tanzania
DATA$USA[which(DATA$ISO=="ZAF")]<-"other" #South Africa
## Thee above leaves the following countries under USA (aka West): USA, DEU, NLD, AUS, FIN, BEL, SWE, FRA,
## GBR, NOR, GRC, CHE[Switz]

# Ethnicity within Western v. other
summarise(
  group_by(DATA, eth1, USA), Tally=n())

# Occupation within Western v. Other.   DATA TOO PIECEMEAL? ALSO SHOULDN'T R (RETIRED) BY IN THE JAPAN
# PART OF THE NON-WEST GROUP?
summarise(
  group_by(DATA, occ_ISCO, USA), Tally=n())

DATA$USA<-factor(DATA$USA)
plot(TEE~USA,DATA)
aggregate(n~USA,DATA,FUN=sum)

DATA$SEX_USA<-factor(paste(DATA$Sex,DATA$USA,sep="_"))
aggregate(n~SEX_USA,DATA,FUN=sum)


#run the model with 8 separate residual variances (4 for females and 4 for males)
MC.hete.USA<-MCMCglmm(TEE~0+Sex+
                          Sex*poly(LBMc,2,raw=TRUE)+
                          Sex*poly(FATc,2,raw=TRUE)+
```

```
            Sex*poly(Agec,2,raw=TRUE)+
            LBMc*poly(Agec,2,raw=TRUE)+
            FATc*poly(Agec,2,raw=TRUE),
        family="gaussian",
        random=~ISO,
        rcov=~idh(SEX_USA):units,
        #prior =prior.3,
        #nitt=NITT,thin=THIN,burnin=BURN,
        data=DATA)

summary(MC.hete.USA)
V.USA<-c(
posterior.mode(MC.hete.USA$VCV[,"SEX_USAM_USA.units"]),
posterior.mode(MC.hete.USA$VCV[,"SEX_USAF_USA.units"]),
posterior.mode(MC.hete.USA$VCV[,"SEX_USAM_other.units"]),
posterior.mode(MC.hete.USA$VCV[,"SEX_USAF_other.units"]))

V.USA.CI<-rbind(
HPDinterval(MC.hete.USA$VCV[,"SEX_USAM_USA.units"]),
HPDinterval(MC.hete.USA$VCV[,"SEX_USAF_USA.units"]),
HPDinterval(MC.hete.USA$VCV[,"SEX_USAM_other.units"]),
HPDinterval(MC.hete.USA$VCV[,"SEX_USAF_other.units"]))

USA<-data.frame(cbind(V.USA,V.USA.CI))
USA$x<-c(0.95,1.05,1.95,2.05)
USA$COL<-1
USA$PCH<-c(16,17,16,17)
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
#Ratio Male/female   #Ratio Male/female   #Ratio Male/female   #Ratio Male/female
```

```
#make figure S1

x11(4,4)

par(las=1,mar=c(5,5,1,1))

  plot(V.USA~x, USA, pch=PCH,col=COL,ylim=c(0.5,4),xlim=c(0.5,2.5),xaxt="n",xlab="",ylab="Variance (±95%CI)")

arrows(USA$x,  USA$lower,  USA$x,  USA$upper, col=USA$COL,code=3,length=0.05,angle=90)

axis(1,c(1,2), las=1,labels=c("West","Other"))

#add sample sizes

text(0.95,2.90,"1226",cex=0.8)

text(1.05,1.0,"2689",cex=0.8)

text(1.95,3.10,"268",cex=0.8)

text(2.05,0.9,"419",cex=0.8)




####################### TWO-STEP ANALYSIS using residuals ######################

####################### TWO-STEP ANALYSIS using residuals ######################

####################### TWO-STEP ANALYSIS using residuals ######################

####################### TWO-STEP ANALYSIS using residuals ######################

####################### TWO-STEP ANALYSIS using residuals ######################

####################### TWO-STEP ANALYSIS using residuals ######################


#covariates

LM.height<-lm(htc~Sex,data=DATA)
```

```
LM.lean<-lm(LBM~Sex,data=DATA)
LM.fat<-lm(FAT~Sex,data=DATA)
LM.age<-lm(Age~Sex,data=DATA)
#Tee
LM.TEE1<-lm(TEE~Sex,data=DATA)
LM.TEE2<-lm(TEE~Sex+htc+LBM,data=DATA)
LM.TEE3<-lm(TEE~Sex+htc+LBM+FAT+Age,data=DATA)

#BEE
LM.BEE1<-lm(BEE~Sex,data=DATA_BEE_focus)
LM.BEE2<-lm(BEE~Sex+htc+LBM,data=DATA_BEE_focus)
LM.BEE3<-lm(BEE~Sex+htc+LBM+FAT+Age,data=DATA_BEE_focus)

DATA_AEE_focus<-DATA[!is.na(DATA$AEE),]
#AEE
LM.AEE1<-lm(AEE~Sex,data=DATA_BEE_focus)
LM.AEE2<-lm(AEE~Sex+htc+LBM,data=DATA_BEE_focus)
LM.AEE3<-lm(AEE~Sex+htc+LBM+FAT+Age,data=DATA_BEE_focus)



DATA$res.height <- resid(LM.height)
DATA$res.lean  <-resid(LM.lean)
DATA$res.fat   <-resid(LM.fat)
DATA$res.age   <-resid(LM.age)
#
DATA$res.TEE1<-resid(LM.TEE1)
DATA$res.TEE2<-resid(LM.TEE2)
DATA$res.TEE3<-resid(LM.TEE3)
#
DATA_BEE_focus$res.BEE1<-resid(LM.BEE1)
```

```
DATA_BEE_focus$res.BEE2<-resid(LM.BEE2)
DATA_BEE_focus$res.BEE3<-resid(LM.BEE3)
#
DATA_AEE_focus$res.AEE1<-resid(LM.AEE1)
DATA_AEE_focus$res.AEE2<-resid(LM.AEE2)
DATA_AEE_focus$res.AEE3<-resid(LM.AEE3)

LM.ESTIMATES<-data.frame(Trait=c("Height","LBM","Fat mass","Age",
                         "TEE1","TEE2","TEE3",
                         "BEE1","BEE2","BEE3",
                         "AEE1","AEE2","AEE3"),
                     Vmale=NA,
                     Vfemale=NA)

LM.Vmale<-c(
var(DATA$res.height[which(DATA$Sex=="M")]),
var(DATA$res.lean[which(DATA$Sex=="M")])  ,
var(DATA$res.fat[which(DATA$Sex=="M")])   ,
var(DATA$res.age[which(DATA$Sex=="M")])   ,
var(DATA$res.TEE1[which(DATA$Sex=="M")])  ,
var(DATA$res.TEE2[which(DATA$Sex=="M")])  ,
var(DATA$res.TEE3[which(DATA$Sex=="M")])  ,
var(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="M")])  ,
var(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="M")])  ,
var(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="M")])  ,
var(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="M")])  ,
var(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="M")])  ,
var(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="M")])  )
LM.ESTIMATES$Vmale<-LM.Vmale
```

```
LM.Vfemale<-c(
var(DATA$res.height[which(DATA$Sex=="F")]),
var(DATA$res.lean[which(DATA$Sex=="F")])  ,
var(DATA$res.fat[which(DATA$Sex=="F")])   ,
var(DATA$res.age[which(DATA$Sex=="F")])   ,
var(DATA$res.TEE1[which(DATA$Sex=="F")])  ,
var(DATA$res.TEE2[which(DATA$Sex=="F")])  ,
var(DATA$res.TEE3[which(DATA$Sex=="F")])  ,
var(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="F")])  ,
var(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="F")])  ,
var(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="F")])  ,
var(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="F")])  ,
var(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="F")])  ,
var(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="F")])  )
LM.ESTIMATES$Vfemale<-LM.Vfemale

LM.meanmale<-c(
  mean(DATA$res.height[which(DATA$Sex=="M")]),
  mean(DATA$res.lean[which(DATA$Sex=="M")])  ,
  mean(DATA$res.fat[which(DATA$Sex=="M")])   ,
  mean(DATA$res.age[which(DATA$Sex=="M")])   ,
  mean(DATA$res.TEE1[which(DATA$Sex=="M")])  ,
  mean(DATA$res.TEE2[which(DATA$Sex=="M")])  ,
  mean(DATA$res.TEE3[which(DATA$Sex=="M")])  ,
  mean(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="M")])  ,
  mean(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="M")])  ,
  mean(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="M")])  ,
  mean(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="M")])  ,
  mean(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="M")])  ,
  mean(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="M")])  )
```

```
LM.ESTIMATES$meanmale<-LM.meanmale

LM.meanfemale<-c(
  mean(DATA$res.height[which(DATA$Sex=="F")]),
  mean(DATA$res.lean[which(DATA$Sex=="F")])  ,
  mean(DATA$res.fat[which(DATA$Sex=="F")])   ,
  mean(DATA$res.age[which(DATA$Sex=="F")])   ,
  mean(DATA$res.TEE1[which(DATA$Sex=="F")])  ,
  mean(DATA$res.TEE2[which(DATA$Sex=="F")])  ,
  mean(DATA$res.TEE3[which(DATA$Sex=="F")])  ,
  mean(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="F")])  ,
  mean(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="F")])  ,
  mean(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="F")])  ,
  mean(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="F")])  ,
  mean(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="F")])  ,
  mean(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="F")])  )
LM.ESTIMATES$meanfemale<-LM.meanfemale



################## Calculating means for male and female
###################
# See Schielzeth et al. (2010)
# Create dummy variable for sex M=0, F=1
DATA$Dummy <- DATA$Sex
DATA$Dummy <- gsub("M", "0", DATA$Dummy)
DATA$Dummy <- gsub("F", "1", DATA$Dummy)

DATA_BEE_focus$Dummy <- DATA_BEE_focus$Sex
DATA_BEE_focus$Dummy <- gsub("M", "0", DATA_BEE_focus$Dummy)
DATA_BEE_focus$Dummy <- gsub("F", "1", DATA_BEE_focus$Dummy)
```

```
DATA_AEE_focus$Dummy <- DATA_AEE_focus$Sex
DATA_AEE_focus$Dummy <- gsub("M", "0", DATA_AEE_focus$Dummy)
DATA_AEE_focus$Dummy <- gsub("F", "1", DATA_AEE_focus$Dummy)

# Run lm's, without predictor variable centring, to calculate means and SEs
LM.ht.mean<-summary(LM.height<-lm(ht~0+Dummy, data=DATA))
LM.LBM.mean<-summary(LM.LBM<-lm(LBM~0+Dummy, data=DATA))
LM.FAT.mean<-summary(LM.FAT<-lm(FAT~0+Dummy, data=DATA))
LM.Age.mean<-summary(LM.Age<-lm(Age~0+Dummy, data=DATA))
LM.TEE1.mean<-summary(LM.TEE1<-lm(TEE~0+Dummy, data=DATA))
LM.TEE2.mean<-summary(LM.TEE2<-lm(TEE~0+Dummy+ht+LBM, data=DATA))
LM.TEE3.mean<-summary(LM.TEE3<-lm(TEE~0+Dummy+ht+LBM+FAT+Age,
data=DATA))
LM.BEE1.mean<-summary(LM.BEE1<-lm(BEE~0+Dummy,
data=DATA_BEE_focus))
LM.BEE2.mean<-summary(LM.BEE2<-lm(BEE~0+Dummy+ht+LBM,
data=DATA_BEE_focus))
LM.BEE3.mean<-summary(LM.BEE3<-lm(BEE~0+Dummy+ht+LBM+FAT+Age,
data=DATA_BEE_focus))
LM.AEE1.mean<-summary(LM.AEE1<-lm(AEE~0+Dummy,
data=DATA_AEE_focus))
LM.AEE2.mean<-summary(LM.AEE2<-lm(AEE~0+Dummy+ht+LBM,
data=DATA_AEE_focus))
LM.AEE3.mean<-summary(LM.AEE3<-lm(AEE~0+Dummy+ht+LBM+FAT+Age,
data=DATA_AEE_focus))

MEANS <- data.frame(variables=c("height", "LBM", "FAT", "Age", "TEE1", "TEE2",
"TEE3",
                    "BEE1", "BEE2", "BEE3", "AEE1", "AEE2", "AEE3"),
"MeanM"=NA)

MEANS$MeanM <- round(c(LM.ht.mean$coefficients[1],
LM.LBM.mean$coefficients[1],LM.FAT.mean$coefficients[1],
```

```
            LM.Age.mean$coefficients[1], LM.TEE1.mean$coefficients[1],
LM.TEE2.mean$coefficients[1],

            LM.TEE3.mean$coefficients[1], LM.BEE1.mean$coefficients[1],
LM.BEE2.mean$coefficients[1],

            LM.BEE3.mean$coefficients[1], LM.AEE1.mean$coefficients[1],
LM.AEE2.mean$coefficients[1],

            LM.AEE3.mean$coefficients[1]),2)

MEANS$MeanF <- round(c(LM.ht.mean$coefficients[2],
LM.LBM.mean$coefficients[2],LM.FAT.mean$coefficients[2],

            LM.Age.mean$coefficients[2], LM.TEE1.mean$coefficients[2],
LM.TEE2.mean$coefficients[2],

            LM.TEE3.mean$coefficients[2], LM.BEE1.mean$coefficients[2],
LM.BEE2.mean$coefficients[2],

            LM.BEE3.mean$coefficients[2], LM.AEE1.mean$coefficients[2],
LM.AEE2.mean$coefficients[2],

            LM.AEE3.mean$coefficients[2]),2)

MEANS$SE.M <- round(c(LM.ht.mean$coefficients[3],
LM.LBM.mean$coefficients[3],LM.FAT.mean$coefficients[3],

            LM.Age.mean$coefficients[3], LM.TEE1.mean$coefficients[3],
LM.TEE2.mean$coefficients[5],

            LM.TEE3.mean$coefficients[7], LM.BEE1.mean$coefficients[3],
LM.BEE2.mean$coefficients[5],

            LM.BEE3.mean$coefficients[7], LM.AEE1.mean$coefficients[3],
LM.AEE2.mean$coefficients[5],

            LM.AEE3.mean$coefficients[7]),2)

MEANS$SE.F <- round(c(LM.ht.mean$coefficients[4],
LM.LBM.mean$coefficients[4],LM.FAT.mean$coefficients[4],

           LM.Age.mean$coefficients[4], LM.TEE1.mean$coefficients[4],
LM.TEE2.mean$coefficients[6],

           LM.TEE3.mean$coefficients[8], LM.BEE1.mean$coefficients[4],
LM.BEE2.mean$coefficients[6],

           LM.BEE3.mean$coefficients[8], LM.AEE1.mean$coefficients[4],
LM.AEE2.mean$coefficients[6],

           LM.AEE3.mean$coefficients[8]),2)


write.table(file="MEANS.txt", MEANS, sep=",")
```

```
ALL <- cbind(ESTIMATES,MEANS)
write.table(file="ALL.txt", ALL, sep=",")

LM.ESTIMATES$Xmale  <-c(0.9,1.9,2.9,3.9,5.9,6.9,7.9,9.9,10.9,11.9,13.9,14.9,15.9)
LM.ESTIMATES$Xfemale<-
c(1.1,2.1,3.1,4.1,6.1,7.1,8.1,10.1,11.1,12.1,14.1,15.1,16.1)

#check LM.ESTIMATES versus MCMC. ESTIMATES
library(png)
library("ggplot2")


  ############################################################
  ################ Plot figures of variance ################
  ############################################################
  library(gridExtra)


  # dev.new()

  get_png <- function(filename) {
    grid::rasterGrob(png::readPNG(filename), interpolate = TRUE)  #
https://www.markhw.com/blog/logos
  }
  #standing.pic <- get_png("Person standing.png")
  #basal.pic <- get_png("Person basal.png")
  #active1.pic <- get_png("Person activity 1.png")
  #active2.pic <- get_png("Person activity 2.png")

 # jpeg(file="Figure 2.jpg", units = "in", width = 12, height = 12, res=300)
```

```
 pdf(file="Figure 2.pdf",              width = 12, height = 12)

 f1 <- ggplot(DATA, aes(res.TEE1, fill = Sex)) + geom_density(alpha = 0.2) +
  #geom_vline(xintercept = mean(DATA$res.TEE1[which(DATA$Sex=="F")], na.rm=TRUE),
  #        linetype="dotted", color = "pink", size=1.25) +
  #geom_vline(xintercept = mean(DATA$res.TEE1[which(DATA$Sex=="M")], na.rm=TRUE),
  #        linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-8, y=0.4, label="A", size=8) +
  annotate(geom="text", x=-8, y=0.5, label="      Adjusted for sex", size=6) +
  coord_cartesian(xlim = c(-8, 22), ylim = c(0, 0.4)) +
  theme_bw() +
  theme(legend.position = "none", panel.grid.major = element_blank(), panel.grid.minor = element_blank()) +
  xlab("") +
  ylab("") +
  ggtitle("")
  #annotation_custom(standing.pic, xmin = 15, xmax = 20, ymin = 0.1, ymax = 0.25)

 f2 <- ggplot(DATA, aes(res.TEE2, fill = Sex)) + geom_density(alpha = 0.2) +
  #geom_vline(xintercept = mean(DATA$res.TEE2[which(DATA$Sex=="F")], na.rm=TRUE),
  #        linetype="dotted", color = "pink", size=1.25) +
  #geom_vline(xintercept = mean(DATA$res.TEE2[which(DATA$Sex=="M")], na.rm=TRUE),
  #        linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-8, y=0.4, label="B", size=8) +
  annotate(geom="text", x=-8, y=0.5, label="Adjusted for sex, height and lean mass", size=6) +
  coord_cartesian(xlim = c(-8, 22), ylim = c(0, 0.4)) +
```

```
  theme_bw() +
  theme(legend.position = "none", panel.grid.major = element_blank(),
     panel.grid.minor = element_blank(), plot.title = element_text(size = 13.5),
     axis.title.x = element_text(size = 17)) +
  xlab("Total energy expenditure (MJ/d)") +
  ylab("") +
  ggtitle("Adj. for height and fat free mass")
 #annotation_custom(standing.pic, xmin = 15, xmax = 20, ymin = 0.1, ymax = 0.25)


 f3 <- ggplot(DATA, aes(res.TEE3, fill = Sex)) + geom_density(alpha = 0.2) +
  #geom_vline(xintercept = mean(DATA$res.TEE3[which(DATA$Sex=="F")],
na.rm=TRUE),
  #        linetype="dotted", color = "pink", size=1.25) +
  #geom_vline(xintercept = mean(DATA$res.TEE3[which(DATA$Sex=="M")],
na.rm=TRUE),
  #        linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-8, y=0.4, label="C", size=8) +
  #annotate(geom="text", x=-8, y=0.4, label="Adjusted for sex, height, lean mass,
fat mass and age", size=5) +
  coord_cartesian(xlim = c(-8, 22), ylim = c(0, 0.4)) +
  theme_bw() +
  theme(legend.position = "none", panel.grid.major = element_blank(),
     panel.grid.minor = element_blank(), plot.title = element_text(size = 13.5)) +
  xlab("") +
  ylab("") +
  ggtitle("Adj. height, fat free mass, fat mass, age")
  #annotation_custom(standing.pic, xmin = 15, xmax = 20, ymin = 0.1, ymax = 0.25)


 g1 <- ggplot(DATA_BEE_focus, aes(res.BEE1, fill = Sex)) + geom_density(alpha =
0.2) +
```

```
   #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="F")], na.rm=TRUE),
   #         linetype="dotted", color = "pink", size=1.25) +
   #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE1[which(DATA_BEE_focus$Sex=="M")], na.rm=TRUE),
   #         linetype="dotted", color = "cyan", size=1.2) +
   annotate(geom="text", x=-4, y=0.7, label="D", size=8) +
   coord_cartesian(xlim = c(-4, 7), ylim = c(0, 0.7)) +
   theme_bw() +
   theme(legend.position = "none", panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
        axis.title.y = element_text(size = 17)) +
   xlab("") +
   ylab("Density")
   #annotation_custom(basal.pic, xmin = 3.0, xmax = 6.5, ymin = 0.2, ymax = 0.6)

  g2 <- ggplot(DATA_BEE_focus, aes(res.BEE2, fill = Sex)) + geom_density(alpha = 0.2) +
   #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="F")], na.rm=TRUE),
   #         linetype="dotted", color = "pink", size=1.25) +
   #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE2[which(DATA_BEE_focus$Sex=="M")], na.rm=TRUE),
   #         linetype="dotted", color = "cyan", size=1.2) +
   annotate(geom="text", x=-4, y=0.7, label="E", size=8) +
   coord_cartesian(xlim = c(-4, 7), ylim = c(0, 0.7)) +
   theme_bw() +
   theme(legend.position = "none", panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
        axis.title.x = element_text(size = 17)) +
```

```
  xlab("Basal energy expenditure (MJ/d)") +
  ylab("")
  #annotation_custom(basal.pic, xmin = 3.0, xmax = 6.5, ymin = 0.2, ymax = 0.6)


 g3 <- ggplot(DATA_BEE_focus, aes(res.BEE3, fill = Sex)) + geom_density(alpha = 0.2) +
  #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="F")], na.rm=TRUE),
  #         linetype="dotted", color = "pink", size=1.25) +
  #geom_vline(xintercept = mean(DATA_BEE_focus$res.BEE3[which(DATA_BEE_focus$Sex=="M")], na.rm=TRUE),
  #         linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-4, y=0.7, label="F", size=8) +
  coord_cartesian(xlim = c(-4, 7), ylim = c(0, 0.7)) +
  theme_bw() +
  theme(legend.position = "none", panel.grid.major = element_blank(),
        panel.grid.minor = element_blank(), axis.title.x = element_text(size = 9)) +
  xlab("") +
  ylab("")
  #annotation_custom(basal.pic, xmin = 3.0, xmax = 6.5, ymin = 0.2, ymax = 0.6)


 h1 <- ggplot(DATA_AEE_focus, aes(res.AEE1, fill = Sex)) + geom_density(alpha = 0.2) +
  #geom_vline(xintercept = mean(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="F")], na.rm=TRUE),
  #         linetype="dotted", color = "pink", size=1.25) +
  #geom_vline(xintercept = mean(DATA_AEE_focus$res.AEE1[which(DATA_AEE_focus$Sex=="M")], na.rm=TRUE),
  #         linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-6, y=0.4, label="G", size=8) +
```

```
   coord_cartesian(xlim = c(-6, 9), ylim = c(0, 0.4)) +
   theme_bw() +
   theme(legend.position = "none", panel.grid.major = element_blank(),
panel.grid.minor = element_blank()) +
   xlab("") +
   ylab("")
   #annotation_custom(active1.pic, xmin = 3.5, xmax = 8, ymin = 0.1, ymax = 0.3)

  h2 <- ggplot(DATA_AEE_focus, aes(res.AEE2, fill = Sex)) + geom_density(alpha =
0.2) +
   #geom_vline(xintercept =
mean(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="F")],
na.rm=TRUE),
   #         linetype="dotted", color = "pink", size=1.25) +
   #geom_vline(xintercept =
mean(DATA_AEE_focus$res.AEE2[which(DATA_AEE_focus$Sex=="M")],
na.rm=TRUE),
   #         linetype="dotted", color = "cyan", size=1.2) +
   annotate(geom="text", x=-6, y=0.4, label="H", size=8) +
   coord_cartesian(xlim = c(-6, 9), ylim = c(0, 0.4)) +
   theme_bw() +
   theme(legend.position = "none", panel.grid.major = element_blank(),
panel.grid.minor = element_blank(),
        axis.title.x = element_text(size = 17)) +
   xlab("Activity energy expenditure (MJ/d)") +
   ylab("")
   #annotation_custom(active1.pic, xmin = 3.5, xmax = 8, ymin = 0.1, ymax = 0.3)

  h3 <- ggplot(DATA_AEE_focus, aes(res.AEE3, fill = Sex)) + geom_density(alpha =
0.2) +
   #geom_vline(xintercept =
mean(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="F")],
na.rm=TRUE),
   #         linetype="dotted", color = "pink", size=1.25) +
```

```
  #geom_vline(xintercept =
mean(DATA_AEE_focus$res.AEE3[which(DATA_AEE_focus$Sex=="M")],
na.rm=TRUE),
  #         linetype="dotted", color = "cyan", size=1.2) +
  annotate(geom="text", x=-6, y=0.4, label="I", size=8) +
  coord_cartesian(xlim = c(-6, 9), ylim = c(0, 0.4)) +
  theme_bw() +
  theme(legend.position = "none", panel.grid.major = element_blank(),
        panel.grid.minor = element_blank(), axis.title.x = element_text(size = 9)) +
  xlab("") +
  ylab("")
  #annotation_custom(active1.pic, xmin = 3.5, xmax = 8, ymin = 0.1, ymax = 0.3)

 grid.arrange(f1, f2, f3, g1, g2, g3, h1, h2, h3, nrow=3)

 dev.off()
```

**SOM Table S1**

**Unique participant identifiers for the IAEA DLW database v. 3.1.2.**

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## SOM Table S2

Disaggregation of the data into ‘Western’ and ‘non-Western’ countries. Western countries: United States, Germany, The Netherlands, Australia, Finland, Belgium, Sweden, France, UK, Norway, Greece. Non-western countries: Bolivia, Chile, China, Ecuador, Ghana, Jamaica, Japan, Kenya, Mauritius, Nigeria, Nepal, Seychelles, Tanzania, South Africa.

**SOM Table S3**

The ethnic makeup of Western and non-Western countries based on available data.

| Ethnicity | Western/non-Western countries | % |
|---|---|---|
| African | non-West | 61.0 |
| African American | West | 18.0 |
| Asian | non-West | 26.0 |
| Asian | West | 1.7 |
| Caucasian | non-West | 1.3 |
| Caucasian | West | 77.0 |
| Hunter-gatherer | non-West | 0.9 |
| Hunter-gatherer | West | 2.7 |
| Other | non-West | 10.7 |
| Other | West | 0.7 |

## SOM References

R Core Team, 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/