```
## Program Name: Unified Fetal Growth Velocity Calculator
## Authors: Daniel He, Zhen Chen, Katherine Grantz
## Date: 01/23/2026
## Description:
## The unified estimated fetal velocity was calculated after weighting
for Race/Ethnicity.


## Race
race_index= c("Pooled","White", "Black" ,"Hispanic", "Asian")
Race=1 #"Pooled"

## Ultrasonograpy TypeUltrasonograpy
ultra_index= c("EFW1" , "EFW2" , "EFW3" , "EFW4" , "AC" , "BPD" , "FL",
"HC","HUMERUS")

###################################### Inputs
#################################
# input any two values here: e.g. 99
GA= scan(n=2)
99
99
Ultra_value= scan(n=2)
99
99

#set values at here
# GA "BPD" ,"HC", "AC" ,"FL", "HUMERUS" are:
# ultrasound measurement 1
meas1=  c(
  29,
  73.2,
  254.3,
  248.6,
  54.1,
  43.6
)
# ultrasound measurement 2
meas2=  c(
  30,
  80.5,
  279.4,
  286.8,
  63.1,
  46.5
)

# calculate EFW3
GA[1]= meas1[1]
BPD1=  meas1[2]
HC1=   meas1[3]
AC1=   meas1[4]
FL1=   meas1[5]
HUMERUS1= meas1[6]
```

```
GA[2]= meas2[1]
BPD2= meas2[2]
HC2=  meas2[3]
AC2=  meas2[4]
FL2=  meas2[5]
HUMERUS2= meas2[6]

# Estimated Fetal Weight (grams)
# EFW1_1 = 10 ** (1.304 + (0.05281*0.1*AC1) + (0.1938*0.1*FL1)-
(0.004*0.1*0.1*AC1*FL1))
# EFW2_1 = 10 ** (1.335-
0.0034*0.1*0.1*AC1*FL1+0.0316*0.1*BPD1+0.0457*0.1*AC1+0.1623*0.1*FL1)
EFW3_1 = 10 ** (1.326-
0.00326*0.1*0.1*AC1*FL1+0.0107*0.1*HC1+0.0438*0.1*AC1+0.158*0.1*FL1)
# EFW4_1 = 10 ** (1.3596-
0.00386*0.1*0.1*AC1*FL1+0.0064*0.1*HC1+0.00061*0.1*0.1*BPD1*AC1+0.0424*0.
1*AC1+0.174*0.1*FL1)
EFW3_2 = 10 ** (1.326-
0.00326*0.1*0.1*AC2*FL2+0.0107*0.1*HC2+0.0438*0.1*AC2+0.158*0.1*FL2)

uv1=c(1,2,EFW3_1,4,AC1,BPD1,FL1,HC1,HUMERUS1)
uv2=c(1,2,EFW3_2,4,AC2,BPD2,FL2,HC2,HUMERUS2)

for (ulr in c(6,8,5,7,9, 3)) {
  # # 1-EFW1, 2-EFW2, 3-EFW3, 4-EFW4, 5-AC, 6-BPD, 7-FL, 8-HC, 9-HUMERUS
  Ultra=ulr

  Ultra_value[1]=uv1[Ultra]
  Ultra_value[2]=uv2[Ultra]

  # generate the results
  for (w in 1) {

    Ultra_value=log(Ultra_value)*w

    ##################################### call files
################################
    # call the parameter estimates file
    # call the percentile calculator file
    #source(" ")
    #,("EFW1", "EFW2", "EFW3", "EFW4", "AC", "BPD", "FL",
"HC","HUMERUS"), (only use 3,5:9)
    # 1= pooled standard; 0= fake data
    # the 1, 2, 4th rows are fake data to make up 9 rows

    PE=c(
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-0.00000193388185431971, 0.00000293354591578490, -0.00377228165885911000,
0.00068046811992891000, -0.00003974515003004280, 0.00000075571458230148,
-0.00000091798322512408, 0.00000036424536953050, -0.00000056071365391704,
0.00021988941445219200, -0.00003974515003004280, 0.00000232566971171149,

```
-0.00000004428891862058, 0.00000005407908503482, -0.00000002224790491321,
0.00000003480769666819, -0.00000417449157193228, 0.00000075571458230148,
-0.00000004428891862058, 0.00000000084458452802, -0.00000000103628300049,
0.00000000044111394667, -0.00000000070163586945, 0.00000504554709082983,
-0.00000091798322512408, 0.00000005407908503482, -0.00000000103628300049,
0.00000000129538838623, -0.00000000063295716315, 0.00000000109599802557,
-0.00000193388185431971, 0.00000036424536953050, -0.00000002224790491321,
0.00000000044111394667, -0.00000000063295716315, 0.00000000065411717160,
-0.00000000173053211509, 0.00000293354591578490, -0.00000056071365391704,
0.00000003480769666819, -0.00000000070163586945, 0.00000000109599802557,
-0.00000000173053211509, 0.00000000671986227169
      )
    PE= matrix(PE,nrow=9,byrow = T)
    index= (Race-1)*10+Ultra; #
    info= PE[index,]#
    fcoef=info[3:9]; sigma=info[10];Sigmab=
matrix(info[11:26],4,4);Zeta=info[27:29];varfixed=
matrix(info[30:78],7,7)

    ################## Velocity calculator

    i = GA[1]
    j = GA[2]

    int <- 1
    t1 <- i
    t2 <- i**2
    t3 <- i**3
    tt1 <- (i - Zeta[1])**3 * (i > Zeta[1])
    tt2 <- (i - Zeta[2])**3 * (i > Zeta[2])
    tt3 <- (i - Zeta[3])**3 * (i > Zeta[3])

    Fxxi = cbind(int, t1, t2, t3, tt1, tt2, tt3)
    Rxxi = cbind(int, t1, t2, t3)

    int <- 1
    t1 <- j
    t2 <- j**2
    t3 <- j**3
    tt1 <- (j - Zeta[1])**3 * (j > Zeta[1])
    tt2 <- (j - Zeta[2])**3 * (j > Zeta[2])
    tt3 <- (j - Zeta[3])**3 * (j > Zeta[3])

    Fxxj = cbind(int, t1, t2, t3, tt1, tt2, tt3)
    Rxxj = cbind(int, t1, t2, t3)

    dFxx = Fxxj - Fxxi
    dRxx = Rxxj - Rxxi

    mean <- dFxx%*%fcoef
    var <- 2*sigma**2 + dRxx%*%Sigmab%*%t(dRxx) +
dFxx%*%varfixed%*%t(dFxx)
    std <- sqrt(var)
```

```
    percentile = round (pnorm(Ultra_value[2]-Ultra_value[1], mean = mean,
sd = std, lower.tail = TRUE, log.p = FALSE),3)

    # please compute percentile instead of median

    mean1=Fxxi%*%fcoef
    mean2=Fxxj%*%fcoef
    std1=sqrt(sigma**2 + Rxxi%*%Sigmab%*%t(Rxxi) +
Fxxi%*%varfixed%*%t(Fxxi))
    std2=sqrt(sigma**2 + Rxxj%*%Sigmab%*%t(Rxxj) +
Fxxj%*%varfixed%*%t(Fxxj))

    percentile1 = round  (pnorm(Ultra_value[1], mean = mean1, sd = std1,
lower.tail = TRUE, log.p = FALSE),3)
    percentile2 = round  (pnorm(Ultra_value[2], mean = mean2, sd = std2,
lower.tail = TRUE, log.p = FALSE),3)

    if (percentile1<0.03 ) {percentile1="<3" }
    if (percentile1>0.97 ) {percentile1=">97" }
    if (percentile1<=0.97 & percentile1>=0.03 )
{percentile1=percentile1*100}

    if (percentile2<0.03 ) {percentile2="<3" }
    if (percentile2>0.97 ) {percentile2=">97" }
    if (percentile2<=0.97 & percentile2>=0.03 )
{percentile2=percentile2*100}

    if (percentile<0.03 ) {percentile="<3" }
    if (percentile>0.97 ) {percentile=">97" }
    if (percentile<=0.97 & percentile>=0.03 ) {percentile=percentile*100}


    ######################################## Outputs
####################################
    options(digits=3)
     cat("when (",ultra_index[Ultra],":",
        exp(Ultra_value)[1]," ",exp(Ultra_value)[2],")","; ","m1, m2 and
velocity are respectively",percentile1,"% ","," ,percentile2,"%
","," ,percentile,"% ", sep="","          ")
  }
}
```