Do children born to teenage parents have lower adult intelligence? A prospective birth cohort study

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Reference link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5344312/

Study setting and Participants described in paper

The study investigates the long-term cognitive status (IQ) among 21 year adult offspring born to teen-age parents. This population study is a prospective birth cohort sub-sample derived from the Mater University Study of Pregnancy, comprising of 2643 mother-offspring pair recruited during 1981 to 1983 in Brisbane, Australia. Baseline data were collected at the mother's first obstetric clinic visit (mean 18 weeks gestation) and follow up data were gathered prospectively on mothers and offspring at 3–5 days postpartum, six months, five, 14, and 21 years of age. Offspring IQ was measured using the Peabody Picture Vocabulary Test at 21 year.

Introduction

This Data Simulation Project references the above link and simulates the data based on the paper. Teenage motherhood has been associated with a wide variety of negative offspring outcomes including poorer cognitive development. The paper concludes that offspring born to teenage mothers (<20 years) have -3.0 (95% Confidence Interval (CI): -4.3, -1.8) points lower IQ in comparison to children born to mothers 20 years. Adjustment for a range of confounding and mediating factors including parental socioeconomic status, maternal IQ, maternal smoking and binge drinking in pregnancy, birthweight, breastfeeding and parenting style attenuates the association, though the effect remains statistically significant (-1.4 IQ points; 95% CI: -2.8,-0.1). Interestingly, teenage fatherhood is not associated with adult offspring IQ, when adjusted for maternal age.

Features in the dataset

1. Living with same partner as birth of child (factor: yes, no)
2. Planned pregnancy (factor: yes, no)
3. Child gender (factor: male, female)
4. Maternal education (factor: incomplete high, complete high, post high)
5. Paternal education (factor: incomplete high, complete high, post high)
6. Family income (factor: low, med, high)
7. Smoking during pregnancy (factor: never, few, many)
8. Binge drinking (factor: yes, no)
9. Maternal depression (factor: yes, no)
10. Breastfeeding (factor: never, < 4 months, 4 months)
11. Child attended at preschool (factor: yes, no)
12. Mother-child interaction (factor: yes, no)
13. Physical punishment (factor: yes, no)
14. Explaining for child bad behavior (factor: yes, no)
15. Maternal IQ (96.2±8.4 for <20 years maternal age, 97.0±10.6 for 20 years maternal age)
16. Office IQ at 21y (100.5±10.0 for <20 years maternal age, 103.8±10.3 for 20 years maternal age)

17. Birth weight in kg (3.3±0.5 for <20 years maternal age, 3.4±0.5 for 20 years maternal age)
18. Maternal Age
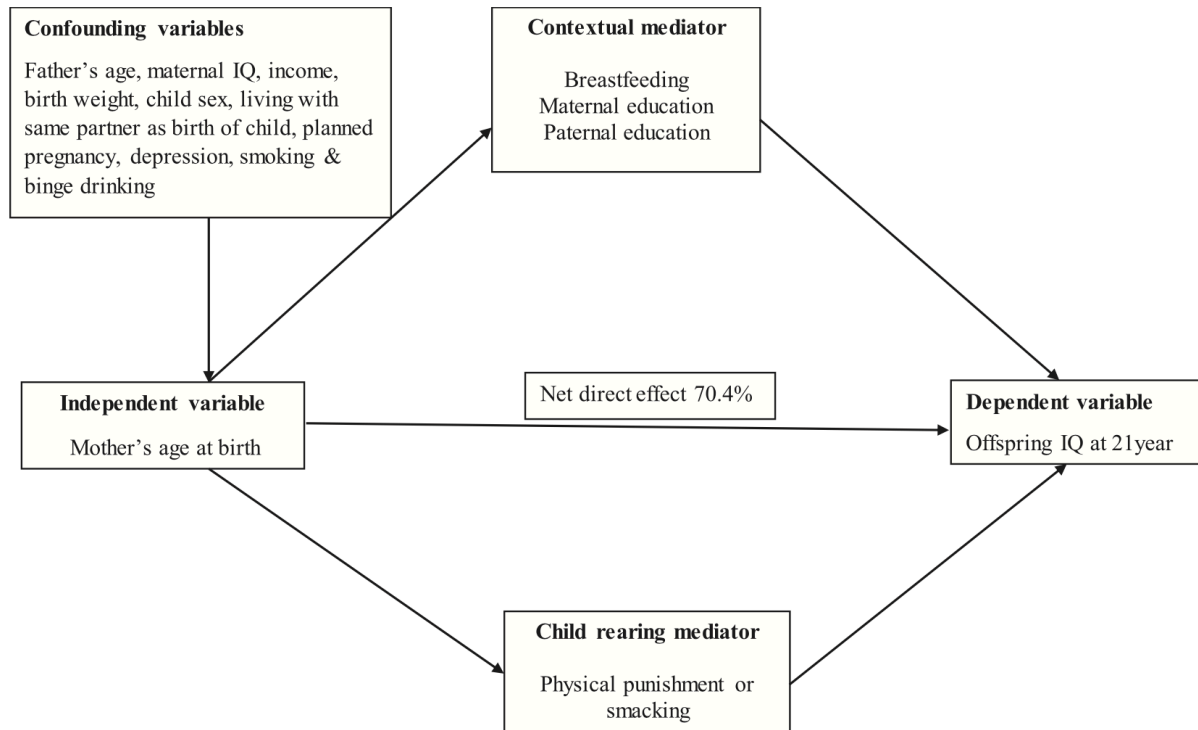
Confounders and Mediators

Fig 1. Direct and indirect effect of mother's age on offspring IQ at 21 year, mediated by breastfeeding and parental education and child rearing.

Figure 1:

The following code chunk is used to create the model data

```
library(truncnorm)

# statistical data for maternal age <20 years
generate_dataset_teen <- function(N){
  # categorical variables
  same_partner <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.527, .473))
  planned_preg <- sample(c("Y", "N"), N, replace=TRUE, prob=c(.221, .779))
  child_sex <- sample(c("M", "F"), N, replace=TRUE, prob=c(.485, .515))
  m_edu <- sample(c("Incom_high", "Comp_high", "Post_high"), N, replace=TRUE,
                  prob=c(.202, .693, .105))
  p_edu <- sample(c("Incom_high", "Comp_high", "Post_high"), N, replace=TRUE,
                  prob=c(.171, .709, .12))
  income <- sample(c("Low", "Med", "High"), N, replace=TRUE,
                   prob=c(.544, .301, .155))
  smoke <- sample(c("Never", "Few", "Many"), N, replace=TRUE,
                  prob=c(.508, .271, .221))
```

```r
    drink <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.8, .2))
    depression <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.641, .359))
    breastfeed <- sample(c("Never", "<4months", " 4months"), N, replace=TRUE,
                       prob=c(.249, .50, .252))
    preschool <- sample(c("Y", "N"), N, replace=TRUE, prob=c(.625, .375))
    interaction <- sample(c("Always", "Not_always"), N, replace=TRUE, prob=c(.885, .115))
    phys_punishment <- sample(c("Always", "Sometimes", "Never"), N, replace=TRUE,
                            prob=c(.066, .822, .113))
    bad_behaviors <- sample(c("Always", "Not_always"), N, replace=TRUE, prob=c(.465, .535))
    # continuous variables
    maternal_iq <- runif(N, min=(96.2-8.4), max=(96.2+8.4))
    offspring_iq <- runif(N, min=(100.5-10), max=(100.5+10))
    birth_weight <- runif(N, min=(3.3-.5), max=(3.3+.5))
    mom_age <- rtruncnorm(n=363, a=12, b=19.9, mean=18, sd=2)
    return(data.frame(same_partner,planned_preg,child_sex,m_edu,p_edu,income,smoke,drink,depression,
            breastfeed,preschool,interaction,phys_punishment,bad_behaviors,maternal_iq,offspring_iq,birth_we
}


# dataframe for maternal age <20 years
df_teen <- generate_dataset_teen(363)

# statistical data for maternal age  20 years
generate_dataset_adult <- function(N){
    # categorical variables
    same_partner <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.276, .724))
    planned_preg <- sample(c("Y", "N"), N, replace=TRUE, prob=c(.519, .481))
    child_sex <- sample(c("M", "F"), N, replace=TRUE, prob=c(.493, .507))
    m_edu <- sample(c("Incom_high", "Comp_high", "Post_high"), N, replace=TRUE,
                  prob=c(.153, .633, .214))
    p_edu <- sample(c("Incom_high", "Comp_high", "Post_high"), N, replace=TRUE,
                  prob=c(.174, .584, .242))
    income <- sample(c("Low", "Med", "High"), N, replace=TRUE,
                   prob=c(.263, .410, .326))
    smoke <- sample(c("Never", "Few", "Many"), N, replace=TRUE,
                  prob=c(.669, .141, .190))
    drink <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.795, .206))
    depression <- sample(c("N", "Y"), N, replace=TRUE, prob=c(.835, .165))
    breastfeed <- sample(c("Never", "<4months", " 4months"), N, replace=TRUE,
                       prob=c(.174, .356, .470))
    preschool <- sample(c("Y", "N"), N, replace=TRUE, prob=c(.648, .352))
    interaction <- sample(c("Always", "Not_always"), N, replace=TRUE, prob=c(.857, .143))
    phys_punishment <- sample(c("Always", "Sometimes", "Never"), N, replace=TRUE,
                            prob=c(.076, .723, .201))
    bad_behaviors <- sample(c("Always", "Not_always"), N, replace=TRUE, prob=c(.548, .452))

    # continuous variables
    maternal_iq <- runif(N, min=(97.0-10.6), max=(97.0+10.6))
    offspring_iq <- runif(N, min=(103.8-10.3), max=(103.8+10.3))
    birth_weight <- runif(N, min=(3.4-.5), max=(3.4+.5))
    mom_age <- rtruncnorm(n=2280, a=20, b=40, mean=25, sd=14) # min age is set at 20, and max age at 40

    return(data.frame(same_partner,planned_preg,child_sex,m_edu,p_edu,income,smoke,drink,depression,breast
}
```

```r
# dataframe for maternal age  20 years
df_adult <- generate_dataset_adult(2280)

# adding outliers
df_adult$mom_age[500] <- 43
df_adult$mom_age[1026] <- 47
df_adult$offspring_iq[4] <- 88
df_adult$offspring_iq[20] <- 90
df_adult$offspring_iq[40] <- 117
df_adult$offspring_iq[25] <- 114
df_teen$offspring_iq[5] <- 84
df_teen$offspring_iq[8] <- 82
df_teen$offspring_iq[44] <- 116
df_teen$offspring_iq[26] <- 119

# combine dataframe of df_teen and df_adult
df <- rbind(df_teen, df_adult)
df$maternal.age.level <- factor(rep("teens", nrow(df)), ordered=T, levels =c("teens", "equal or older th
df$maternal.age.level[df$mom_age>=20] <- "equal or older than 20yrs"

summary(df)
```

```
##   same_partner planned_preg child_sex        m_edu             p_edu
##   N: 790       N:1398       F:1386    Comp_high :1714    Comp_high :1577
##   Y:1853       Y:1245       M:1257    Incom_high: 412    Incom_high: 453
##                                       Post_high : 517    Post_high : 613
##
##
##
##    income      smoke         drink     depression    breastfeed    preschool
##   High: 809   Few  : 407   N:2092    N:2119      <4months:1015   N: 876
##   Low : 777   Many : 559   Y: 551    Y: 524       4months:1172   Y:1767
##   Med :1057   Never:1677                         Never   : 456
##
##
##
##      interaction       phys_punishment    bad_behaviors    maternal_iq
##   Always    :2256   Always   : 199    Always    :1390   Min.   : 86.46
##   Not_always: 387   Never    : 497    Not_always:1253   1st Qu.: 91.83
##                     Sometimes:1947                      Median : 97.21
##                                                         Mean   : 97.01
##                                                         3rd Qu.:101.93
##                                                         Max.   :107.59
##   offspring_iq    birth_weight       mom_age
##   Min.   : 82.0   Min.   :2.801   Min.   :12.58
##   1st Qu.: 98.4   1st Qu.:3.124   1st Qu.:22.24
##   Median :103.2   Median :3.371   Median :27.56
##   Mean   :103.3   Mean   :3.373   Mean   :27.54
##   3rd Qu.:108.5   3rd Qu.:3.619   3rd Qu.:32.78
##   Max.   :119.0   Max.   :3.898   Max.   :47.00
##                   maternal.age.level
##   teens                 : 363
##   equal or older than 20yrs:2280
##
```
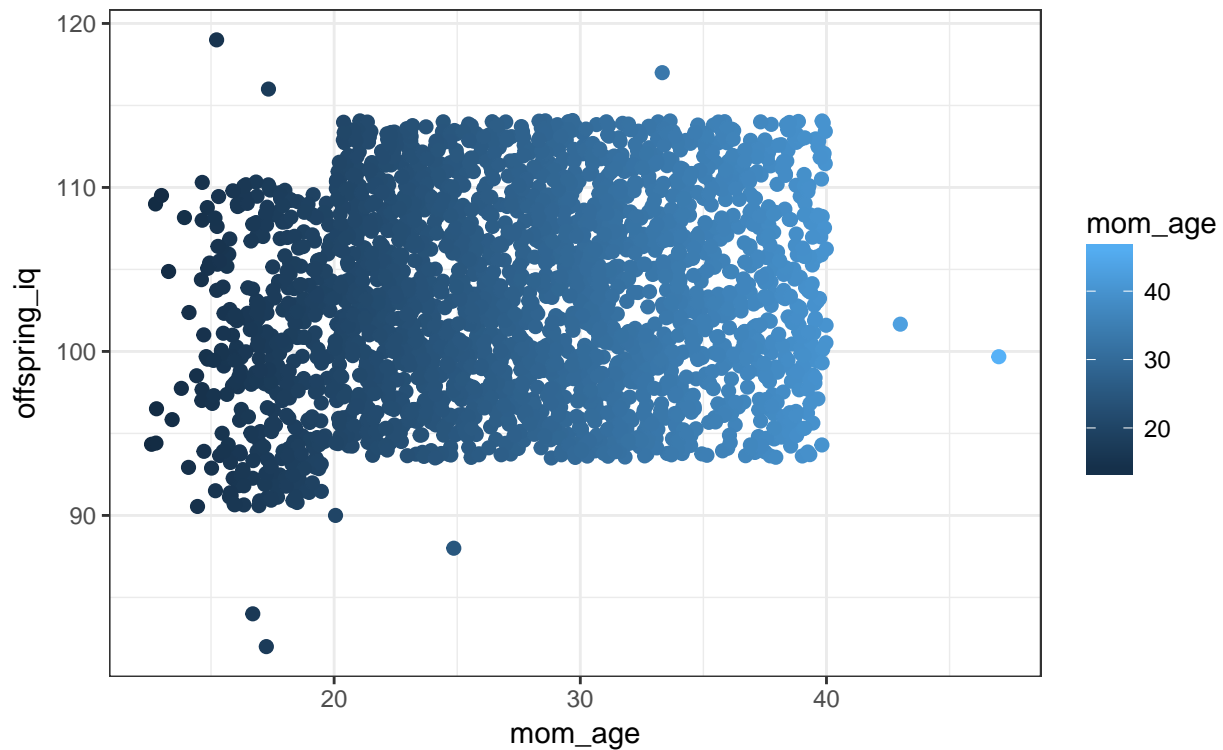
```
##
##
##
```

```
# Histogram of Maternal Age
hist(df$mom_age)
```

Histogram of df$mom_age
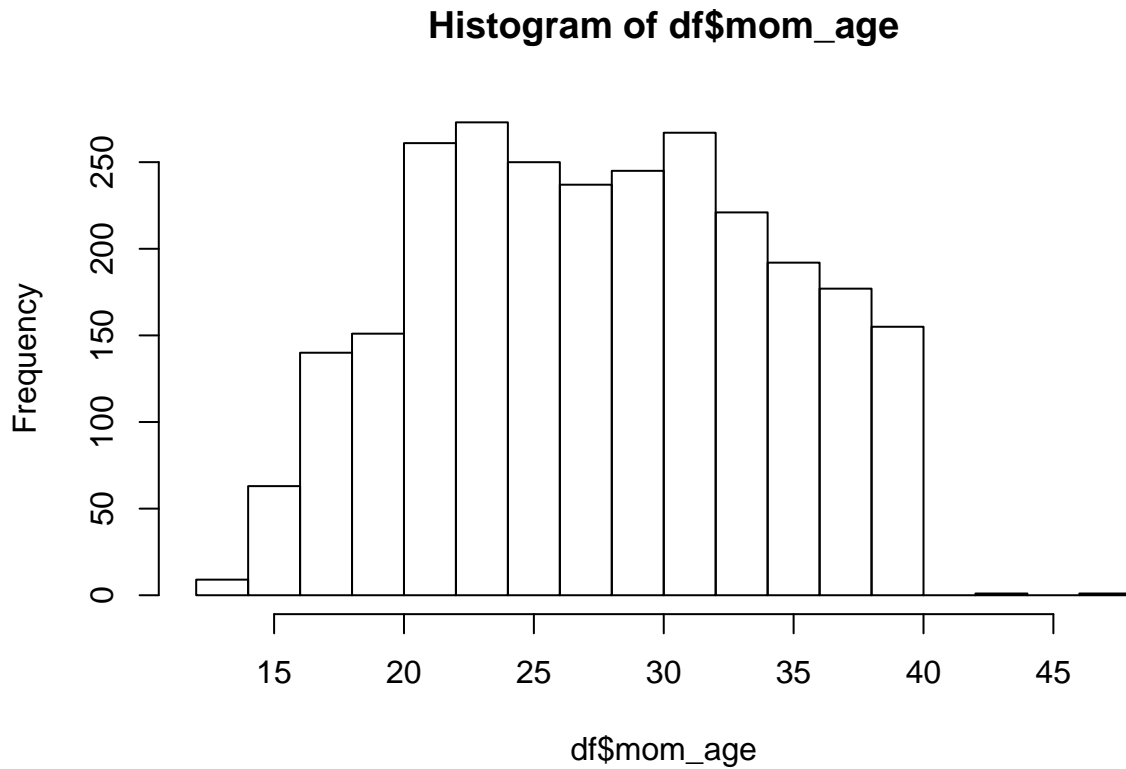

```
library(ggplot2)
# Scatter plot
ggplot(df, aes(x=mom_age,y=offspring_iq)) +
  geom_point(aes(fill=mom_age, color=mom_age), size=2) +
  labs(title="Offspring IQ as a Function of Maternal Age\n") +
  theme_bw() +
  theme(plot.title=element_text(hjust=0.5, size=16, face="bold", color="darkgreen"))
```

Offspring IQ as a Function of Maternal Age


```
ggplot(df, aes(x=maternal.age.level,y=offspring_iq)) +
  geom_boxplot(aes(fill=maternal.age.level, color=maternal.age.level), size=2) +
  labs(title="Offspring IQ as a Function of Age Level\n") +
  theme_bw() +
  theme(plot.title=element_text(hjust=0.5, size=16, face="bold", color="darkgreen"))
```

Offspring IQ as a Function of Age Level
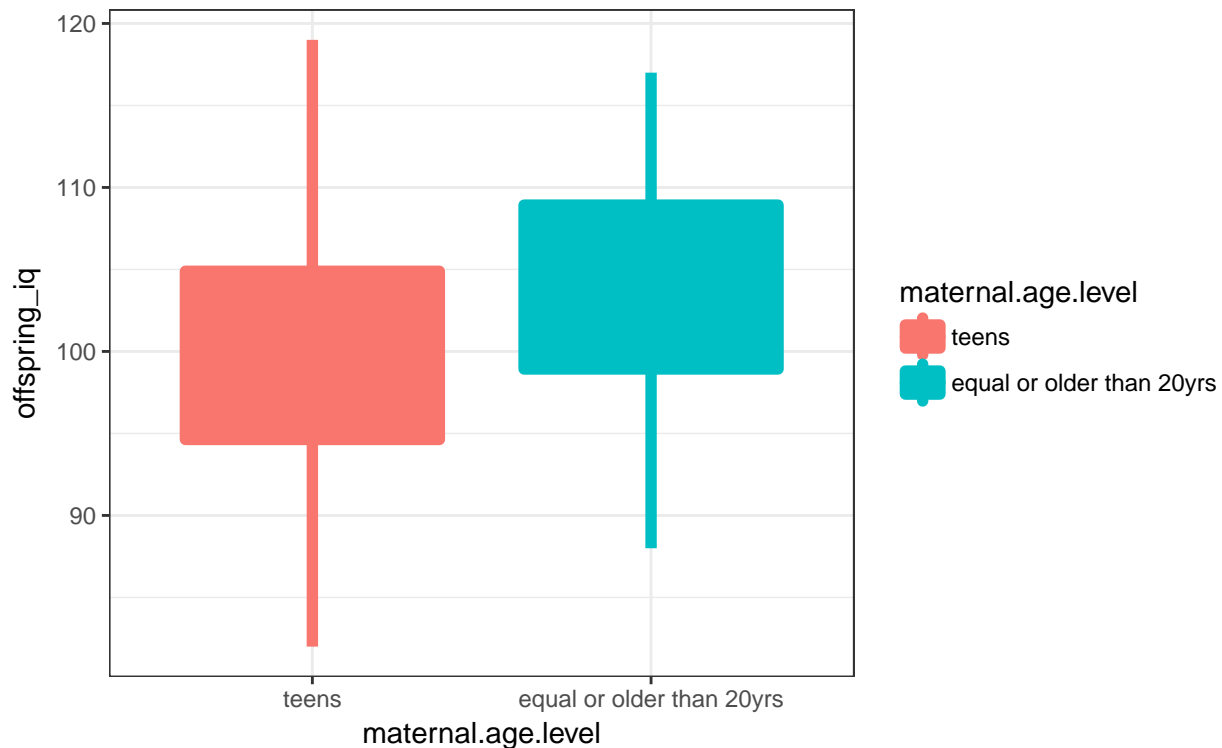
Linear Regression Analysis

```
# model 1
fit <- lm(offspring_iq ~ maternal.age.level, data=df)
summary(fit)
```

```
##
## Call:
## lm(formula = offspring_iq ~ maternal.age.level, data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -18.0637  -4.9800  -0.2504   5.0466  18.9363
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)         101.9591     0.1668  611.36   <2e-16 ***
## maternal.age.level.L  2.6806     0.2359   11.37   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.902 on 2641 degrees of freedom
## Multiple R-squared:  0.04663,    Adjusted R-squared:  0.04627
## F-statistic: 129.2 on 1 and 2641 DF,  p-value: < 2.2e-16
```

```r
# model 1 + confounders
fit1 <-
  lm(
    offspring_iq ~ maternal.age.level + maternal_iq + income + birth_weight +
      child_sex + same_partner + planned_preg + depression + smoke + drink,
    data = df
  )
summary(fit1)
```

```
##
## Call:
## lm(formula = offspring_iq ~ maternal.age.level + maternal_iq +
##     income + birth_weight + child_sex + same_partner + planned_preg +
##     depression + smoke + drink, data = df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -17.5646  -5.0153  -0.2009   4.9850  18.5914
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)          103.504495   2.336012  44.308   <2e-16 ***
## maternal.age.level.L   2.733381   0.255077  10.716   <2e-16 ***
## maternal_iq           -0.004819   0.019462  -0.248   0.8044
## incomeLow              0.190191   0.302505   0.629   0.5296
## incomeMed             -0.118946   0.276868  -0.430   0.6675
## birth_weight          -0.170994   0.398911  -0.429   0.6682
## child_sexM            -0.449587   0.230366  -1.952   0.0511 .
## same_partnerY         -0.182942   0.254370  -0.719   0.4721
## planned_pregY          0.158956   0.236311   0.673   0.5012
## depressionY           -0.117047   0.292766  -0.400   0.6893
## smokeMany             -0.442930   0.386691  -1.145   0.2521
## smokeNever            -0.321747   0.330843  -0.973   0.3309
## drinkY                 0.248451   0.283250   0.877   0.3805
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.905 on 2630 degrees of freedom
## Multiple R-squared:  0.04975,    Adjusted R-squared:  0.04542
## F-statistic: 11.48 on 12 and 2630 DF,  p-value: < 2.2e-16
```

```r
# model 1 + confounders + mediators
new_df <- subset(df, select = -mom_age)
fit2 <- lm(offspring_iq ~ ., data = new_df)
summary(fit2)
```

```
##
## Call:
## lm(formula = offspring_iq ~ ., data = new_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -17.8446  -4.9354  -0.2129   4.9584  18.0350
##
```

```
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)             103.160954   2.390572  43.153   <2e-16 ***
## same_partnerY            -0.190011   0.254691  -0.746   0.4557
## planned_pregY             0.148420   0.236367   0.628   0.5301
## child_sexM               -0.480605   0.230640  -2.084   0.0373 *
## m_eduIncom_high          -0.033931   0.324757  -0.104   0.9168
## m_eduPost_high           -0.273073   0.298844  -0.914   0.3609
## p_eduIncom_high           0.232625   0.316366   0.735   0.4622
## p_eduPost_high           -0.072067   0.282788  -0.255   0.7989
## incomeLow                 0.225210   0.303879   0.741   0.4587
## incomeMed                -0.109073   0.277802  -0.393   0.6946
## smokeMany                -0.397855   0.386981  -1.028   0.3040
## smokeNever               -0.275617   0.331834  -0.831   0.4063
## drinkY                    0.249430   0.283677   0.879   0.3793
## depressionY              -0.090223   0.293165  -0.308   0.7583
## breastfeed 4months        0.493668   0.256612   1.924   0.0545 .
## breastfeedNever          -0.500912   0.334415  -1.498   0.1343
## preschoolY                0.015594   0.244794   0.064   0.9492
## interactionNot_always    -0.032353   0.325513  -0.099   0.9208
## phys_punishmentNever     -0.092156   0.496959  -0.185   0.8529
## phys_punishmentSometimes  0.398886   0.440422   0.906   0.3652
## bad_behaviorsNot_always   0.025416   0.231671   0.110   0.9126
## maternal_iq              -0.003875   0.019476  -0.199   0.8423
## birth_weight             -0.219626   0.399370  -0.550   0.5824
## maternal.age.level.L      2.715617   0.261465  10.386   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.901 on 2619 degrees of freedom
## Multiple R-squared:  0.05495,    Adjusted R-squared:  0.04665
## F-statistic: 6.621 on 23 and 2619 DF,  p-value: < 2.2e-16
```

Conclusion

With adjustment for confounders and mediators, although the association between maternal age and offspring IQ at 21years old remains significant, but it has attenuated to -1.4 points (95% CI: -2.8, -0.01). Given that an IQ between 90 and 110 is considered average, the reduction in 1.4 IQ points is quantitatively small.