Model 2: BMI

Running the crude model

crude\_bmi =   
 multinom(bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung + percent\_public\_source + percent\_private\_toilet + percent\_employed + percent\_without\_hs\_education + percent\_caste, data=total)

## # weights: 24 (14 variable)  
## initial value 147.214047   
## iter 10 value 103.295946  
## iter 20 value 71.570954  
## iter 30 value 68.734672  
## iter 40 value 64.698754  
## iter 50 value 64.252816  
## iter 60 value 64.222598  
## iter 70 value 64.212465  
## iter 80 value 64.198669  
## final value 64.174407   
## converged

summary(crude\_bmi)

## Call:  
## multinom(formula = bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung +   
## percent\_public\_source + percent\_private\_toilet + percent\_employed +   
## percent\_without\_hs\_education + percent\_caste, data = total)  
##   
## Coefficients:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 4.841509 30.86185  
## obese 15.710113 -24.42669  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight -0.2066547 0.08686193 -5.065361  
## obese -8.2269022 0.09332604 -20.342390  
## percent\_without\_hs\_education percent\_caste  
## overweight -4.150815 -0.03260152  
## obese -13.558556 0.08226105  
##   
## Std. Errors:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 2.587390 18.81813  
## obese 3.887663 33.47660  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight 0.1391141 0.7738523 4.205084  
## obese 3.1036858 0.7739189 6.639545  
## percent\_without\_hs\_education percent\_caste  
## overweight 2.485319 0.1456237  
## obese 3.725614 0.0842094  
##   
## Residual Deviance: 128.3488   
## AIC: 156.3488

crude\_model=  
 crude\_bmi %>%   
 broom::tidy() %>%   
 knitr::kable(digits = 3)  
  
crude\_or=  
 exp(coef(crude\_bmi)) %>%   
 knitr::kable(digits = 3)

crude\_model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| y.level | term | estimate | std.error | statistic | p.value |
| overweight | (Intercept) | 1.266600e+02 | 2.587 | 1.871 | 0.061 |
| overweight | fuel\_used\_for\_cooking\_percent\_wood\_dung | 2.530055e+13 | 18.818 | 1.640 | 0.101 |
| overweight | percent\_public\_source | 8.130000e-01 | 0.139 | -1.486 | 0.137 |
| overweight | percent\_private\_toilet | 1.091000e+00 | 0.774 | 0.112 | 0.911 |
| overweight | percent\_employed | 6.000000e-03 | 4.205 | -1.205 | 0.228 |
| overweight | percent\_without\_hs\_education | 1.600000e-02 | 2.485 | -1.670 | 0.095 |
| overweight | percent\_caste | 9.680000e-01 | 0.146 | -0.224 | 0.823 |
| obese | (Intercept) | 6.649903e+06 | 3.888 | 4.041 | 0.000 |
| obese | fuel\_used\_for\_cooking\_percent\_wood\_dung | 0.000000e+00 | 33.477 | -0.730 | 0.466 |
| obese | percent\_public\_source | 0.000000e+00 | 3.104 | -2.651 | 0.008 |
| obese | percent\_private\_toilet | 1.098000e+00 | 0.774 | 0.121 | 0.904 |
| obese | percent\_employed | 0.000000e+00 | 6.640 | -3.064 | 0.002 |
| obese | percent\_without\_hs\_education | 0.000000e+00 | 3.726 | -3.639 | 0.000 |
| obese | percent\_caste | 1.086000e+00 | 0.084 | 0.977 | 0.329 |

crude\_or

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | (Intercept) | fuel\_used\_for\_cooking\_percent\_wood\_dung | percent\_public\_source | percent\_private\_toilet | percent\_employed | percent\_without\_hs\_education | percent\_caste |
| overweight | 126.66 | 2.530055e+13 | 0.813 | 1.091 | 0.006 | 0.016 | 0.968 |
| obese | 6649902.54 | 0.000000e+00 | 0.000 | 1.098 | 0.000 | 0.000 | 1.086 |

Running the model with age as a confounder

age\_bmi =   
 multinom(bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung + percent\_public\_source + percent\_private\_toilet + percent\_employed + percent\_without\_hs\_education + percent\_caste + median\_age, data=total)

## # weights: 27 (16 variable)  
## initial value 147.214047   
## iter 10 value 85.386969  
## iter 20 value 67.175228  
## iter 30 value 63.067548  
## iter 40 value 62.449084  
## iter 50 value 59.512392  
## iter 60 value 59.442741  
## iter 70 value 59.329178  
## iter 80 value 59.297019  
## iter 90 value 59.273833  
## iter 100 value 59.198945  
## final value 59.198945   
## stopped after 100 iterations

summary(age\_bmi)

## Call:  
## multinom(formula = bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung +   
## percent\_public\_source + percent\_private\_toilet + percent\_employed +   
## percent\_without\_hs\_education + percent\_caste + median\_age,   
## data = total)  
##   
## Coefficients:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 0.2328355 33.51952  
## obese -1.8006463 -38.54670  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight -0.2191531 0.05917181 -4.075657  
## obese -8.5898073 0.05998602 -14.509443  
## percent\_without\_hs\_education percent\_caste median\_age  
## overweight -4.367041 -0.04364853 0.104234  
## obese -11.196266 0.09103370 0.342041  
##   
## Std. Errors:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 5.596398 15.752876  
## obese 7.258591 4.846254  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight 0.1265065 0.1917711 4.374845  
## obese 3.3405435 0.1919833 6.976795  
## percent\_without\_hs\_education percent\_caste median\_age  
## overweight 2.422494 0.2085175 0.1169568  
## obese 3.754732 0.0816814 0.1379280  
##   
## Residual Deviance: 118.3979   
## AIC: 150.3979

age\_model=  
 age\_bmi %>%   
 broom::tidy() %>%   
 knitr::kable(digits = 3)  
  
age\_or=  
 exp(coef(age\_bmi)) %>%   
 knitr::kable(digits = 3)

age\_model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| y.level | term | estimate | std.error | statistic | p.value |
| overweight | (Intercept) | 1.262000e+00 | 5.596 | 0.042 | 0.967 |
| overweight | fuel\_used\_for\_cooking\_percent\_wood\_dung | 3.608622e+14 | 15.753 | 2.128 | 0.033 |
| overweight | percent\_public\_source | 8.030000e-01 | 0.127 | -1.732 | 0.083 |
| overweight | percent\_private\_toilet | 1.061000e+00 | 0.192 | 0.309 | 0.758 |
| overweight | percent\_employed | 1.700000e-02 | 4.375 | -0.932 | 0.352 |
| overweight | percent\_without\_hs\_education | 1.300000e-02 | 2.422 | -1.803 | 0.071 |
| overweight | percent\_caste | 9.570000e-01 | 0.209 | -0.209 | 0.834 |
| overweight | median\_age | 1.110000e+00 | 0.117 | 0.891 | 0.373 |
| obese | (Intercept) | 1.650000e-01 | 7.259 | -0.248 | 0.804 |
| obese | fuel\_used\_for\_cooking\_percent\_wood\_dung | 0.000000e+00 | 4.846 | -7.954 | 0.000 |
| obese | percent\_public\_source | 0.000000e+00 | 3.341 | -2.571 | 0.010 |
| obese | percent\_private\_toilet | 1.062000e+00 | 0.192 | 0.312 | 0.755 |
| obese | percent\_employed | 0.000000e+00 | 6.977 | -2.080 | 0.038 |
| obese | percent\_without\_hs\_education | 0.000000e+00 | 3.755 | -2.982 | 0.003 |
| obese | percent\_caste | 1.095000e+00 | 0.082 | 1.114 | 0.265 |
| obese | median\_age | 1.408000e+00 | 0.138 | 2.480 | 0.013 |

age\_or

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (Intercept) | fuel\_used\_for\_cooking\_percent\_wood\_dung | percent\_public\_source | percent\_private\_toilet | percent\_employed | percent\_without\_hs\_education | percent\_caste | median\_age |
| overweight | 1.262 | 3.608622e+14 | 0.803 | 1.061 | 0.017 | 0.013 | 0.957 | 1.110 |
| obese | 0.165 | 0.000000e+00 | 0.000 | 1.062 | 0.000 | 0.000 | 1.095 | 1.408 |

Running the model with sex as a confounder

sex\_bmi =   
 multinom(bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung + percent\_public\_source + percent\_private\_toilet + percent\_employed + percent\_without\_hs\_education + percent\_caste + percent\_female, data=total)

## # weights: 27 (16 variable)  
## initial value 147.214047   
## iter 10 value 91.698791  
## iter 20 value 69.831614  
## iter 30 value 66.426622  
## iter 40 value 65.048422  
## iter 50 value 63.827600  
## iter 60 value 63.697417  
## iter 70 value 63.640356  
## iter 80 value 63.619764  
## iter 90 value 63.591148  
## iter 100 value 63.571797  
## final value 63.571797   
## stopped after 100 iterations

summary(sex\_bmi)

## Call:  
## multinom(formula = bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung +   
## percent\_public\_source + percent\_private\_toilet + percent\_employed +   
## percent\_without\_hs\_education + percent\_caste + percent\_female,   
## data = total)  
##   
## Coefficients:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 13.43468 33.51375  
## obese 15.39930 -21.92309  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight -0.2237155 0.06137072 -4.695264  
## obese -8.3095525 0.06863637 -19.695791  
## percent\_without\_hs\_education percent\_caste percent\_female  
## overweight -4.75726 -0.03148767 -12.9098479  
## obese -13.78988 0.08118686 0.1021692  
##   
## Std. Errors:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 9.095626 19.31279  
## obese 4.429304 33.55750  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight 0.1461252 0.2498667 4.181228  
## obese 3.1203122 0.2499311 6.644800  
## percent\_without\_hs\_education percent\_caste percent\_female  
## overweight 2.530732 0.13639351 13.040637  
## obese 3.738660 0.08580581 3.256491  
##   
## Residual Deviance: 127.1436   
## AIC: 159.1436

sex\_model=  
 sex\_bmi %>%   
 broom::tidy() %>%   
 knitr::kable(digits = 3)  
  
sex\_or=  
 exp(coef(sex\_bmi)) %>%   
 knitr::kable(digits = 3)

sex\_model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| y.level | term | estimate | std.error | statistic | p.value |
| overweight | (Intercept) | 6.832907e+05 | 9.096 | 1.477 | 0.140 |
| overweight | fuel\_used\_for\_cooking\_percent\_wood\_dung | 3.587870e+14 | 19.313 | 1.735 | 0.083 |
| overweight | percent\_public\_source | 8.000000e-01 | 0.146 | -1.531 | 0.126 |
| overweight | percent\_private\_toilet | 1.063000e+00 | 0.250 | 0.246 | 0.806 |
| overweight | percent\_employed | 9.000000e-03 | 4.181 | -1.123 | 0.261 |
| overweight | percent\_without\_hs\_education | 9.000000e-03 | 2.531 | -1.880 | 0.060 |
| overweight | percent\_caste | 9.690000e-01 | 0.136 | -0.231 | 0.817 |
| overweight | percent\_female | 0.000000e+00 | 13.041 | -0.990 | 0.322 |
| obese | (Intercept) | 4.873396e+06 | 4.429 | 3.477 | 0.001 |
| obese | fuel\_used\_for\_cooking\_percent\_wood\_dung | 0.000000e+00 | 33.558 | -0.653 | 0.514 |
| obese | percent\_public\_source | 0.000000e+00 | 3.120 | -2.663 | 0.008 |
| obese | percent\_private\_toilet | 1.071000e+00 | 0.250 | 0.275 | 0.784 |
| obese | percent\_employed | 0.000000e+00 | 6.645 | -2.964 | 0.003 |
| obese | percent\_without\_hs\_education | 0.000000e+00 | 3.739 | -3.688 | 0.000 |
| obese | percent\_caste | 1.085000e+00 | 0.086 | 0.946 | 0.344 |
| obese | percent\_female | 1.108000e+00 | 3.256 | 0.031 | 0.975 |

sex\_or

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (Intercept) | fuel\_used\_for\_cooking\_percent\_wood\_dung | percent\_public\_source | percent\_private\_toilet | percent\_employed | percent\_without\_hs\_education | percent\_caste | percent\_female |
| overweight | 683290.7 | 3.58787e+14 | 0.8 | 1.063 | 0.009 | 0.009 | 0.969 | 0.000 |
| obese | 4873396.2 | 0.00000e+00 | 0.0 | 1.071 | 0.000 | 0.000 | 1.085 | 1.108 |

Running the model with marital status as a confounder

marital\_bmi =   
 multinom(bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung + percent\_public\_source + percent\_private\_toilet + percent\_employed + percent\_without\_hs\_education + percent\_caste + percent\_marital\_status, data=total)

## # weights: 27 (16 variable)  
## initial value 147.214047   
## iter 10 value 106.922174  
## iter 20 value 73.993461  
## iter 30 value 66.997340  
## iter 40 value 65.717316  
## iter 50 value 63.595788  
## iter 60 value 63.435525  
## iter 70 value 63.405000  
## iter 80 value 63.388425  
## iter 90 value 63.370866  
## iter 100 value 63.347872  
## final value 63.347872   
## stopped after 100 iterations

summary(marital\_bmi)

## Call:  
## multinom(formula = bmi\_cat ~ fuel\_used\_for\_cooking\_percent\_wood\_dung +   
## percent\_public\_source + percent\_private\_toilet + percent\_employed +   
## percent\_without\_hs\_education + percent\_caste + percent\_marital\_status,   
## data = total)  
##   
## Coefficients:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 3.984556 31.96985  
## obese 15.138607 -23.05708  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight -0.213203 0.06273891 -4.818909  
## obese -9.263091 0.06945843 -22.098893  
## percent\_without\_hs\_education percent\_caste  
## overweight -4.135216 -0.03155531  
## obese -12.846249 0.08741653  
## percent\_marital\_status  
## overweight 0.8191388  
## obese 1.5274265  
##   
## Std. Errors:  
## (Intercept) fuel\_used\_for\_cooking\_percent\_wood\_dung  
## overweight 4.972651 19.29832  
## obese 6.876978 33.78763  
## percent\_public\_source percent\_private\_toilet percent\_employed  
## overweight 0.1409062 0.2653752 4.188066  
## obese 3.3188904 0.2654059 7.026320  
## percent\_without\_hs\_education percent\_caste  
## overweight 2.444694 0.14119997  
## obese 3.754602 0.08470863  
## percent\_marital\_status  
## overweight 4.946923  
## obese 6.513098  
##   
## Residual Deviance: 126.6957   
## AIC: 158.6957

marital\_model=  
 marital\_bmi %>%   
 broom::tidy() %>%   
 knitr::kable(digits = 3)  
  
marital\_or=  
 exp(coef(marital\_bmi)) %>%   
 knitr::kable(digits = 3)

marital\_model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| y.level | term | estimate | std.error | statistic | p.value |
| overweight | (Intercept) | 5.376100e+01 | 4.973 | 0.801 | 0.423 |
| overweight | fuel\_used\_for\_cooking\_percent\_wood\_dung | 7.661796e+13 | 19.298 | 1.657 | 0.098 |
| overweight | percent\_public\_source | 8.080000e-01 | 0.141 | -1.513 | 0.130 |
| overweight | percent\_private\_toilet | 1.065000e+00 | 0.265 | 0.236 | 0.813 |
| overweight | percent\_employed | 8.000000e-03 | 4.188 | -1.151 | 0.250 |
| overweight | percent\_without\_hs\_education | 1.600000e-02 | 2.445 | -1.692 | 0.091 |
| overweight | percent\_caste | 9.690000e-01 | 0.141 | -0.223 | 0.823 |
| overweight | percent\_marital\_status | 2.269000e+00 | 4.947 | 0.166 | 0.868 |
| obese | (Intercept) | 3.755031e+06 | 6.877 | 2.201 | 0.028 |
| obese | fuel\_used\_for\_cooking\_percent\_wood\_dung | 0.000000e+00 | 33.788 | -0.682 | 0.495 |
| obese | percent\_public\_source | 0.000000e+00 | 3.319 | -2.791 | 0.005 |
| obese | percent\_private\_toilet | 1.072000e+00 | 0.265 | 0.262 | 0.794 |
| obese | percent\_employed | 0.000000e+00 | 7.026 | -3.145 | 0.002 |
| obese | percent\_without\_hs\_education | 0.000000e+00 | 3.755 | -3.421 | 0.001 |
| obese | percent\_caste | 1.091000e+00 | 0.085 | 1.032 | 0.302 |
| obese | percent\_marital\_status | 4.606000e+00 | 6.513 | 0.235 | 0.815 |

marital\_or

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (Intercept) | fuel\_used\_for\_cooking\_percent\_wood\_dung | percent\_public\_source | percent\_private\_toilet | percent\_employed | percent\_without\_hs\_education | percent\_caste | percent\_marital\_status |
| overweight | 53.761 | 7.661796e+13 | 0.808 | 1.065 | 0.008 | 0.016 | 0.969 | 2.269 |
| obese | 3755031.361 | 0.000000e+00 | 0.000 | 1.072 | 0.000 | 0.000 | 1.091 | 4.606 |