Mind Analytics Final RMD- Han & Holthouser

DIFFERENCES IN ATTITUDES AND BEHAVIOURS ABOUT THE COVID-19 PANDEMIC AMONG GENDER AND COUNTRIES

COVID-19 and Gender Dataset:

The dataset used for this study is from a survey run by Vincenzo Galasso, Vincent Pons, Paola Profeta, Michael Becher, Sylvain Brouard and Martial Foucault in August 2020. The survey was given to people in various countries around the world (United States, Australia, New Zealand, France, Germany, Italy, Austria, and the United Kingdom). The survey collected attitudes regarding changes brought about by the COVID-19 pandemic, as well as what kind of behaviors related to the pandemic the individual was engaging in. Aside from attitude and behavior data, demographics, regional information, income statistics, and political/religious data was also collected from the sample.

Data Acquisition and Reading:

The *COVID-19 and Gender Dataset* was acquired courtesy of a Box folder from Sarah Gratzmiller, the Lab Technician in the Department of Cognitive & Behavioral Science at Washington and Lee University. The files provided in the folder were .dta files, so the function read_dta was taken from the *haven* package. Aside from that package, the other packages shown below are standard packages used to read and format data, run statistical analyses, and make visualizations. There are multiple datasets within the Box folder, one for each country mentioned as well as an overall dataset with every country's data. For the dake of this study, we investigated the US, Italy, and New Zealand, so only those datasets as well as the overall dataset (dubbed CCpanel) were extracted from the folder. The main analyses will be ran off of the CCpanel dataset, the other datasets accessed were purely just to see what unique variables may have existed between the three countries.

Research Questions:

How do women and men differ in attitudes and behaviors regarding the changes in daily life caused by COVID-19? How does the US, Italy, and New Zealand differ in attitudes and behaviors regarding the changes in daily life caused by COVID-19?

```
library(dplyr)
library(readr)
library(tidyr)
library(stringr)
library(tibble)
library(ggplot2)
library(psych)
library(yarrr)
library(lavaan)
library(GPArotation)
library(haven)

USA_data <- read_dta("/cloud/project/COVIDsurvey_USApanel.dta")
ITA_data <- read_dta("/cloud/project/COVIDsurvey_ITApanel.dta")
NZ_data <- read_dta("/cloud/project/COVIDsurvey_NZpanel.dta")
CC_data <- read_dta("/cloud/project/COVIDsurvey_CCpanel.dta")
```

Creation of the Attitude Dataset:

Below you can find the steps taken to create the dataset for the attitudes of respondents to COVID-19. There were a number of variables that measured to what degree the individual agreed with a rule/guideline put in place by governments, as well as general attitudes regarding the pandemic. Each item in the survey were scored as 0 (No/Disagree) or 1 (Yes/Agree). First, we extracted the variables that we wanted to analyze (we left out country- or region-specific questions, like "do you agree that the EU borders should be closed). After pulling out the variables we wanted to investigate, we then created a preliminary dataset (dataset_correl_attitude) to see to which of the variables correlated with each other, so that we could create latent variables that represented a broader attitude by combining similar items from the survey.

Once the correlations were ran, the four latent variables were created: Health Attitudes, Restriction Attitudes, Industry Attitudes, and National Attitudes. Health Attitudes was concerned with the individual's agreement with general health guidelines put in place by experts, with items like *trustscientists* and *agreesystematictesting* constituting the latent variable. Restriction Attitudes were more so focused on the individual's agreement with local regulations placed on daily life, such as *agreecurfew* and *agreewearingmask*. Industry Attitudes were focused on the agreement with changes in industry as a result of COVID-19, with examples of items included being *agreeschoolclosed* and *agreebusinessclosed*. And lastly, National Attitudes reflected a broader sentiment toward government handling of COVID-19, with items including *agreepostponeelection* and *serioushealthcons*. Once the latent variables were created, the new dataset was created (dataset_attitude). All the items included in the latent variables can be found below, in addition to the correlation values between the items. Finally, we filtered out any "NA" items in this dataset in order to perform data analysis later on.

```
dataset_correl_attitude <- CC_data %>%
  select(
    country,
    agreequarantine,
    agreeinfectedquarantine,
    agreesystematictesting,
    agreewearingmask,
    agreehealthcheck,
    serioushealthcons,
    healthmeasures,
    trustscientists,
    agreeschoolclosed,
    agreebusinessclosed,
    agreecloseactivities,
    agreepostponeelection,
    agreeforbidgroups,
    agreecellphonedata,
    agreecurfew,
    agreepublictransportstop) %>%
  filter(country %in% c("USA", "NZ", "Italy")) %>%
  select(-(country))

cor(dataset_correl_attitude, use = "complete.obs")
```

```
##                          agreequarantine agreeinfectedquarantine
## agreequarantine               1.00000000              0.32460270
## agreeinfectedquarantine       0.32460270              1.00000000
## agreesystematictesting        0.33256910              0.38001984
## agreewearingmask              0.34306283              0.28626830
## agreehealthcheck              0.28078445              0.39919484
## serioushealthcons             0.18612461              0.16822048
## healthmeasures                0.05455080              0.04001881
## trustscientists               0.07159367              0.07508140
## agreeschoolclosed             0.39641504              0.39046320
```

```
## agreebusinessclosed           0.44980762             0.36418456
## agreecloseactivities          0.47424102             0.37363511
## agreepostponeelection         0.31006518             0.31114066
## agreeforbidgroups             0.49600979             0.35334151
## agreecellphonedata            0.33405967             0.24341632
## agreecurfew                   0.46137750             0.32852848
## agreepublictransportstop      0.40476502             0.32592988
##                          agreesystematictesting agreewearingmask
## agreequarantine                       0.3325691       0.34306283
## agreeinfectedquarantine               0.3800198       0.28626830
## agreesystematictesting                1.0000000       0.31591940
## agreewearingmask                      0.3159194       1.00000000
## agreehealthcheck                      0.4508771       0.26501886
## serioushealthcons                     0.2332630       0.29067948
## healthmeasures                        0.1613834       0.19607564
## trustscientists                       0.1196298       0.05378777
## agreeschoolclosed                     0.4306328       0.33964895
## agreebusinessclosed                   0.4095195       0.34086838
## agreecloseactivities                  0.3867986       0.37881424
## agreepostponeelection                 0.3154385       0.33891830
## agreeforbidgroups                     0.3940451       0.36071543
## agreecellphonedata                    0.2269191       0.25399535
## agreecurfew                           0.2857977       0.36519444
## agreepublictransportstop              0.2875496       0.30308848
##                          agreehealthcheck serioushealthcons healthmeasures
## agreequarantine               0.28078445        0.18612461    0.054550804
## agreeinfectedquarantine       0.39919484        0.16822048    0.040018814
## agreesystematictesting        0.45087713        0.23326305    0.161383448
## agreewearingmask              0.26501886        0.29067948    0.196075643
## agreehealthcheck              1.00000000        0.16394877    0.043582331
## serioushealthcons             0.16394877        1.00000000    0.209515638
## healthmeasures                0.04358233        0.20951564    1.000000000
## trustscientists               0.12920289        0.05944507    0.020324225
## agreeschoolclosed             0.46467010        0.22891818    0.106399241
## agreebusinessclosed           0.41161134        0.25920265    0.126157680
## agreecloseactivities          0.34598039        0.24304863    0.116863539
## agreepostponeelection         0.27708656        0.16342636    0.016382390
## agreeforbidgroups             0.36741670        0.23780755    0.080024496
## agreecellphonedata            0.15464951        0.12534899   -0.002893724
## agreecurfew                   0.24794193        0.17949010    0.064549012
## agreepublictransportstop      0.27243600        0.20615846    0.068158058
##                          trustscientists agreeschoolclosed agreebusinessclosed
## agreequarantine               0.07159367         0.3964150           0.4498076
## agreeinfectedquarantine       0.07508140         0.3904632           0.3641846
## agreesystematictesting        0.11962978         0.4306328           0.4095195
## agreewearingmask              0.05378777         0.3396490           0.3408684
## agreehealthcheck              0.12920289         0.4646701           0.4116113
## serioushealthcons             0.05944507         0.2289182           0.2592027
## healthmeasures                0.02032422         0.1063992           0.1261577
## trustscientists               1.00000000         0.1100024           0.1233430
## agreeschoolclosed             0.11000243         1.0000000           0.5880499
## agreebusinessclosed           0.12334303         0.5880499           1.0000000
## agreecloseactivities          0.09824382         0.5283974           0.6024751
## agreepostponeelection         0.06862710         0.3774527           0.3266463
```

```
## agreeforbidgroups             0.09407891         0.4704393           0.5060220
## agreecellphonedata            0.05783722         0.2184788           0.2368420
## agreecurfew                   0.06494628         0.3236996           0.3504118
## agreepublictransportstop      0.03709962         0.4025458           0.3996466
##                          agreecloseactivities agreepostponeelection
## agreequarantine                     0.47424102            0.31006518
## agreeinfectedquarantine             0.37363511            0.31114066
## agreesystematictesting              0.38679865            0.31543846
## agreewearingmask                    0.37881424            0.33891830
## agreehealthcheck                    0.34598039            0.27708656
## serioushealthcons                   0.24304863            0.16342636
## healthmeasures                      0.11686354            0.01638239
## trustscientists                     0.09824382            0.06862710
## agreeschoolclosed                   0.52839740            0.37745267
## agreebusinessclosed                 0.60247509            0.32664631
## agreecloseactivities                1.00000000            0.35396344
## agreepostponeelection               0.35396344            1.00000000
## agreeforbidgroups                   0.49175985            0.35336080
## agreecellphonedata                  0.27542581            0.25385646
## agreecurfew                         0.39724580            0.30840413
## agreepublictransportstop            0.39732932            0.30139718
##                          agreeforbidgroups agreecellphonedata agreecurfew
## agreequarantine                0.49600979        0.334059675  0.46137750
## agreeinfectedquarantine        0.35334151        0.243416324  0.32852848
## agreesystematictesting         0.39404512        0.226919073  0.28579768
## agreewearingmask               0.36071543        0.253995345  0.36519444
## agreehealthcheck               0.36741670        0.154649514  0.24794193
## serioushealthcons              0.23780755        0.125348990  0.17949010
## healthmeasures                 0.08002450       -0.002893724  0.06454901
## trustscientists                0.09407891        0.057837223  0.06494628
## agreeschoolclosed              0.47043930        0.218478820  0.32369962
## agreebusinessclosed            0.50602199        0.236841979  0.35041185
## agreecloseactivities           0.49175985        0.275425812  0.39724580
## agreepostponeelection          0.35336080        0.253856455  0.30840413
## agreeforbidgroups              1.00000000        0.307908117  0.43090549
## agreecellphonedata             0.30790812        1.000000000  0.36805377
## agreecurfew                    0.43090549        0.368053774  1.00000000
## agreepublictransportstop       0.40861689        0.250739202  0.37349322
##                          agreepublictransportstop
## agreequarantine                        0.40476502
## agreeinfectedquarantine                0.32592988
## agreesystematictesting                 0.28754963
## agreewearingmask                       0.30308848
## agreehealthcheck                       0.27243600
## serioushealthcons                      0.20615846
## healthmeasures                         0.06815806
## trustscientists                        0.03709962
## agreeschoolclosed                      0.40254581
## agreebusinessclosed                    0.39964660
## agreecloseactivities                   0.39732932
## agreepostponeelection                  0.30139718
## agreeforbidgroups                      0.40861689
## agreecellphonedata                     0.25073920
## agreecurfew                            0.37349322
```

```
## agreepublictransportstop                1.00000000
```

```
dataset_attitude <- CC_data %>%
  select(
    id,
    country,
    female,
    agreequarantine,
    agreeinfectedquarantine,
    agreesystematictesting,
    agreewearingmask,
    agreehealthcheck,
    serioushealthcons,
    healthmeasures,
    trustscientists,
    agreeschoolclosed,
    agreebusinessclosed,
    agreecloseactivities,
    agreepostponeelection,
    agreeforbidgroups,
    agreecellphonedata,
    agreecurfew,
    agreepublictransportstop,
    overall_agree,
    overall_compliance,
    contactcovid,
    covid
  ) %>%
  filter(country %in% c("USA", "NZ", "Italy")) %>%
  mutate(
    health_attitudes = healthmeasures + agreehealthcheck + agreesystematictesting + trustscientists,
    restriction_attitudes = agreequarantine + agreecurfew + agreecellphonedata + agreewearingmask,
    industry_attitudes = agreeschoolclosed + agreebusinessclosed + agreecloseactivities + agreeforbidgr
    national_attitudes = agreeinfectedquarantine + serioushealthcons + agreepublictransportstop + agree
    ) %>%
  filter(!is.na(health_attitudes)) %>%
  filter(!is.na(restriction_attitudes)) %>%
  filter(!is.na(industry_attitudes)) %>%
  filter(!is.na(national_attitudes)) %>%
  mutate(
        female = ifelse(female == 1, "female",
              ifelse(female == 0, "male",  99))
        ) %>%
  rename(sex = female)
```

Creation of the Behavior Dataset:

We followed a very similar procedure to obtain our dataset with the variables related to COVID-19 behavior. Compared to the attitude datset, these variables are related to whether the individual follows certain behaviors that have been emphasized by the pandemic. Each item in this survey was on a continuous scale from 0 (Never) to 1 (Always) on how often the individual follows these behaviors. Next we followed the same steps as the Attitude Dataset. We extracted the variables that we wanted to analyze (leaving out country- or region-specific questions), then created a preliminary dataset (dataset_correl_behavior) to see the correlation of variables in order to create broader latent variables for behavior.

After we ran the correlation, we decided to create 3 latent variables; Sanitation Behavior represented behaviors

that promote sanitary well-being such as *washhands* and *nophysicalgreet*, Social Behavior represented behaviors about social distancing and leaving the home for essential activities such as *noseefriends* and *nocrowded*, and General Health Behavior represents the variables *wearmask*, *weargloves*, *serioushealth_notreatment*, and *serioushealth_nbdeaths*. Now we created a new dataset called dataset_behavior which included all the original variables, the new latent variables, and the correlation values between the items. Finally, we filtered out any "NA" items in this dataset in order to perform data analysis later on.

```
dataset_correl_behavior <- CC_data %>%
  select(
    country,
    washhands,
    coughsneezeelbow,
    nophysicalgreet,
    distance,
    lessgoout,
    nocrowded,
    noseefriends,
    wearmask,
    weargloves,
    noleavehome,
    serioushealth_notreatment,
    serioushealth_nbdeaths) %>%
  filter(country %in% c("USA", "NZ", "Italy")) %>%
  select(-(country))

cor(dataset_correl_behavior, use = "complete.obs")
```

```
##                            washhands coughsneezeelbow nophysicalgreet
## washhands                 1.00000000       0.36895720      0.45073206
## coughsneezeelbow          0.36895720       1.00000000      0.33128691
## nophysicalgreet           0.45073206       0.33128691      1.00000000
## distance                  0.47739140       0.32961716      0.53575002
## lessgoout                 0.40544414       0.28358624      0.43793533
## nocrowded                 0.42309766       0.28960155      0.53433201
## noseefriends              0.35653419       0.24420704      0.45532256
## wearmask                  0.29438186       0.14100992      0.20769863
## weargloves                0.23112441       0.10841764      0.11915095
## noleavehome               0.24755603       0.19239027      0.28135450
## serioushealth_notreatment 0.09509714       0.03715165      0.01978112
## serioushealth_nbdeaths    0.08405817       0.07060045      0.01629025
##                             distance  lessgoout  nocrowded noseefriends
## washhands                 0.47739140 0.40544414 0.42309766   0.35653419
## coughsneezeelbow          0.32961716 0.28358624 0.28960155   0.24420704
## nophysicalgreet           0.53575002 0.43793533 0.53433201   0.45532256
## distance                  1.00000000 0.46629900 0.56731328   0.43512220
## lessgoout                 0.46629900 1.00000000 0.50983706   0.50704632
## nocrowded                 0.56731328 0.50983706 1.00000000   0.47774381
## noseefriends              0.43512220 0.50704632 0.47774381   1.00000000
## wearmask                  0.29391064 0.28816415 0.25204070   0.21959530
## weargloves                0.19286279 0.19797905 0.17240437   0.17081523
## noleavehome               0.32300961 0.45977070 0.34510923   0.34611921
## serioushealth_notreatment 0.01460671 0.05955542 0.05036551   0.04586694
## serioushealth_nbdeaths    0.07611192 0.10498233 0.06863831   0.08124430
##                            wearmask weargloves noleavehome
## washhands                 0.2943819  0.2311244  0.24755603
```

```
## coughsneezeelbow          0.1410099  0.1084176  0.19239027
## nophysicalgreet           0.2076986  0.1191510  0.28135450
## distance                  0.2939106  0.1928628  0.32300961
## lessgoout                 0.2881642  0.1979790  0.45977070
## nocrowded                 0.2520407  0.1724044  0.34510923
## noseefriends              0.2195953  0.1708152  0.34611921
## wearmask                  1.0000000  0.6221639  0.25102883
## weargloves                0.6221639  1.0000000  0.19349712
## noleavehome               0.2510288  0.1934971  1.00000000
## serioushealth_notreatment 0.3244055  0.2875356  0.09360372
## serioushealth_nbdeaths    0.3151079  0.2839643  0.11818610
##                           serioushealth_notreatment serioushealth_nbdeaths
## washhands                                0.09509714             0.08405817
## coughsneezeelbow                         0.03715165             0.07060045
## nophysicalgreet                          0.01978112             0.01629025
## distance                                 0.01460671             0.07611192
## lessgoout                                0.05955542             0.10498233
## nocrowded                                0.05036551             0.06863831
## noseefriends                             0.04586694             0.08124430
## wearmask                                 0.32440555             0.31510786
## weargloves                               0.28753565             0.28396427
## noleavehome                              0.09360372             0.11818610
## serioushealth_notreatment                1.00000000             0.38089032
## serioushealth_nbdeaths                   0.38089032             1.00000000
```

```r
dataset_behavior <- CC_data %>%
  select(
    id,
    country,
    female,
    washhands,
    coughsneezeelbow,
    nophysicalgreet,
    distance,
    lessgoout,
    nocrowded,
    noseefriends,
    wearmask,
    weargloves,
    noleavehome,
    serioushealth_notreatment,
    serioushealth_nbdeaths,
    overall_compliance,
    contactcovid,
    covid
  ) %>%
  filter(country %in% c("USA", "NZ", "Italy")) %>%
  mutate(
    sanitation_behavior = washhands + coughsneezeelbow + distance + nophysicalgreet,
    social_behavior = lessgoout + nocrowded + noseefriends + noleavehome,
    generalhealth_behavior = wearmask + weargloves + serioushealth_notreatment + serioushealth_nbdeaths
  filter(!is.na(sanitation_behavior)) %>%
  filter(!is.na(social_behavior)) %>%
  filter(!is.na(generalhealth_behavior)) %>%
```

```
  mutate(
        female = ifelse(female == 1, "female",
              ifelse(female == 0, "male",  99))
        ) %>%
  rename(sex = female)
```

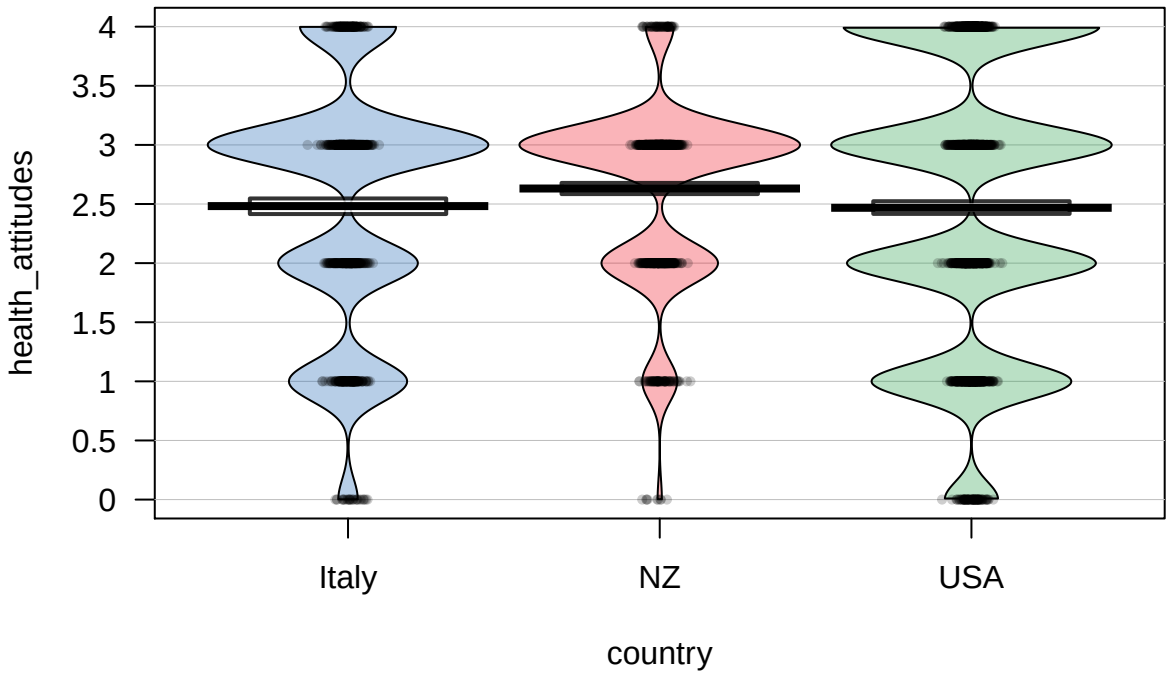
Pirate Plots for the Data Analyst: We can begin answering our research questions by creating pirate plots from the data sets we created, before moving into more technical analyses. These plots are more for the trained data analyst than for the layperson. We can find trends between attitude and behavior with country and gender in order to see if there are any differences within each group.

Attitude Pirate Plots

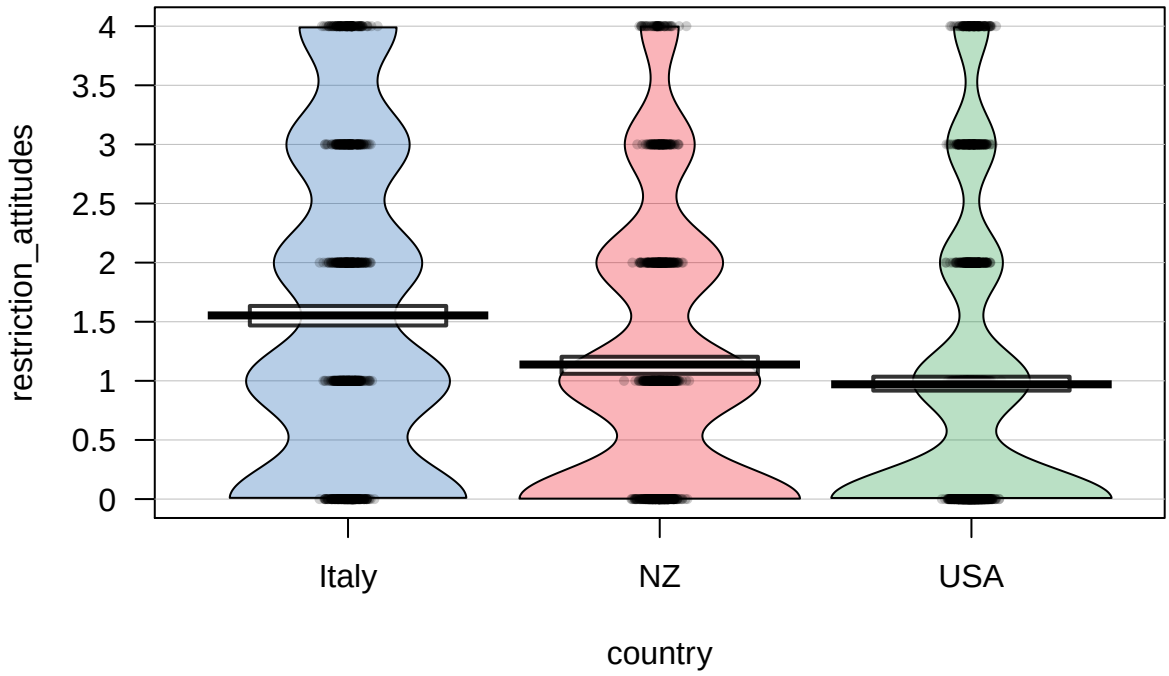
When looking at the attitude dataset by country and sex, a number of trends regarding the four attitude categories can be observed just by viewing the pirate plot. Across country, there seems to be substantial differences between COVID attitudes in Italy, New Zealand, and the US. In terms of *health_attitudes*, the three countries appear to have similar mean agreement scores, yet the United States has a higher concentration on both the high and low end of possible responses, perhaps a product of the political division in the country. For *restriction_attitudes*, in general there is less agreement for all three countries, with the mean being the lowest in the United States. Yet, there appears to be a higher concentration of lower scores for New Zealand, which is interesting to consider when thinking about their pandemic response. For *industry_attitudes*, New Zealand and Italy appear to be fairly similar in attitudes, with a higher concentration of high and low responses and narrow middle responses (akin to an hourglass shape). This indicates that closing down certain economic sectors is an ambivalent response in those two countries. For the US, it maintains a similar shape to the other countries, except there is a large distribution on the low end between 0 and 1, indicating that the shutdowns associated with COVID were generally not favored in the US. And lastly, for *national_attitudes*, the countries do not vary much in mean or distribution, yet there is a larger percentage of people on the lower end in the US.

Across sex, some differences in attitudes can be observed. For *health_attitudes*, the mean and distribution for males and females is fairly similar, with a slightly larger concentration of males on the lower end. For *restriction_attitudes*, there is no difference between the males and females. For *industry_attitudes*, the pirate plots appear to be inverses of each other, where there are more females on the higher end and more males on the lower end, indicating a discrepancy in attitudes regarding economic shutdown. And for *national_attitudes*, the mean for males is lower as well as the general distribution of scores.

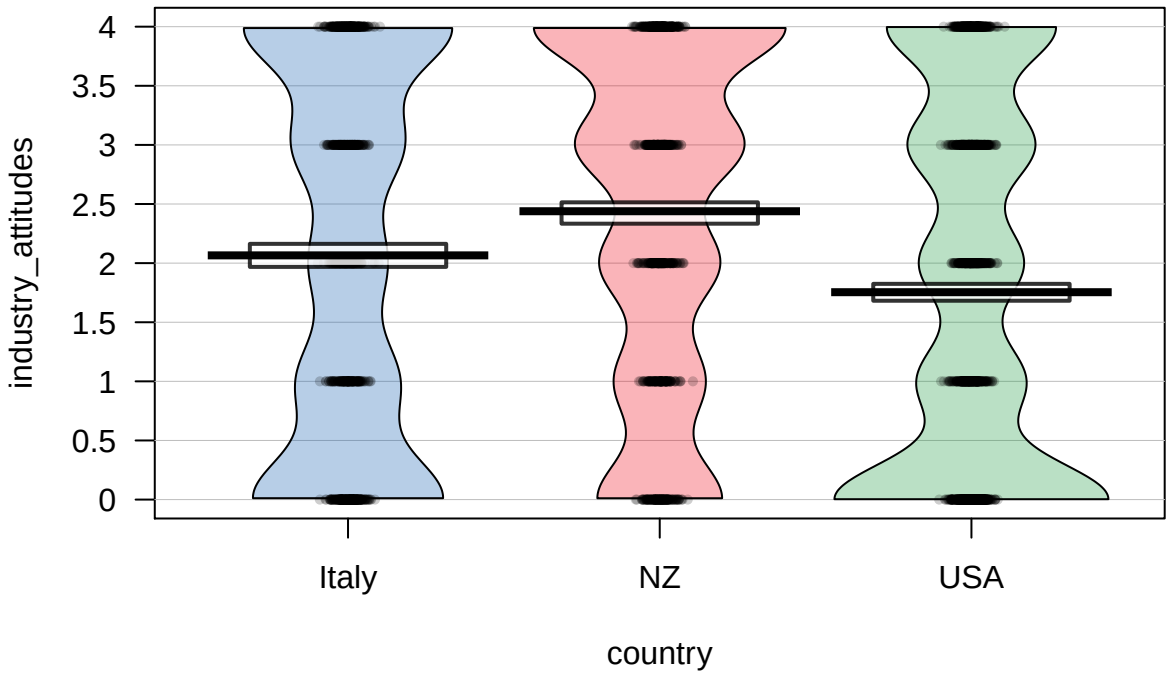
```
pirateplot(health_attitudes ~ country, data = dataset_attitude)
```



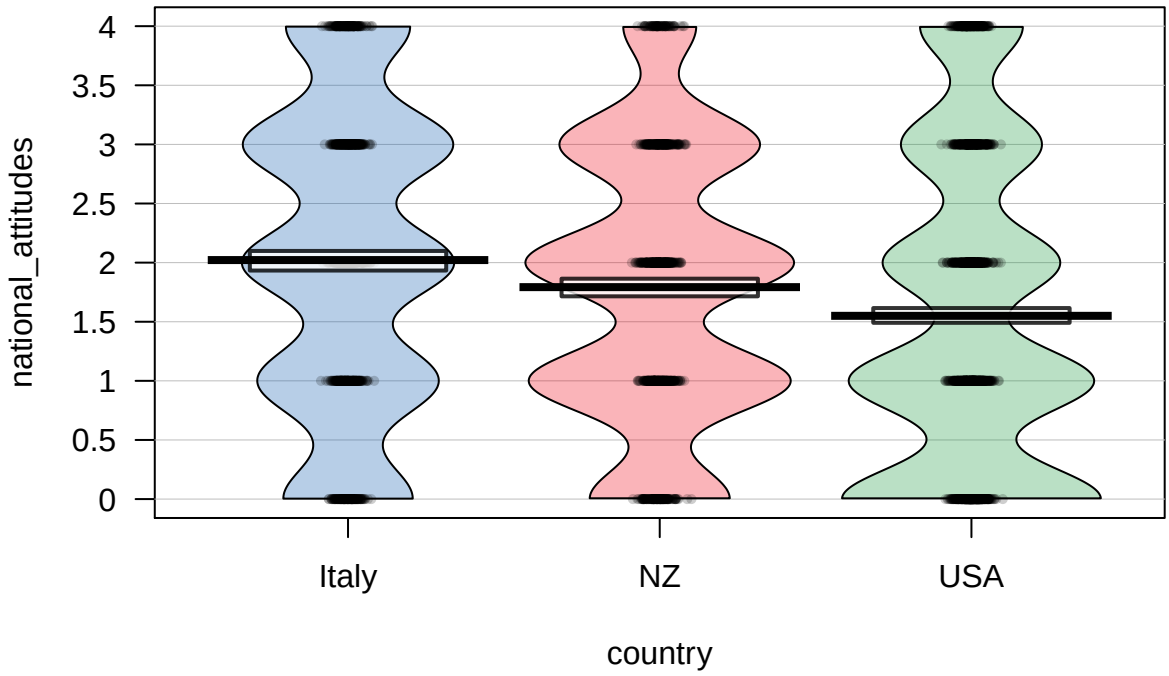

```
pirateplot(restriction_attitudes ~ country, data = dataset_attitude)
```



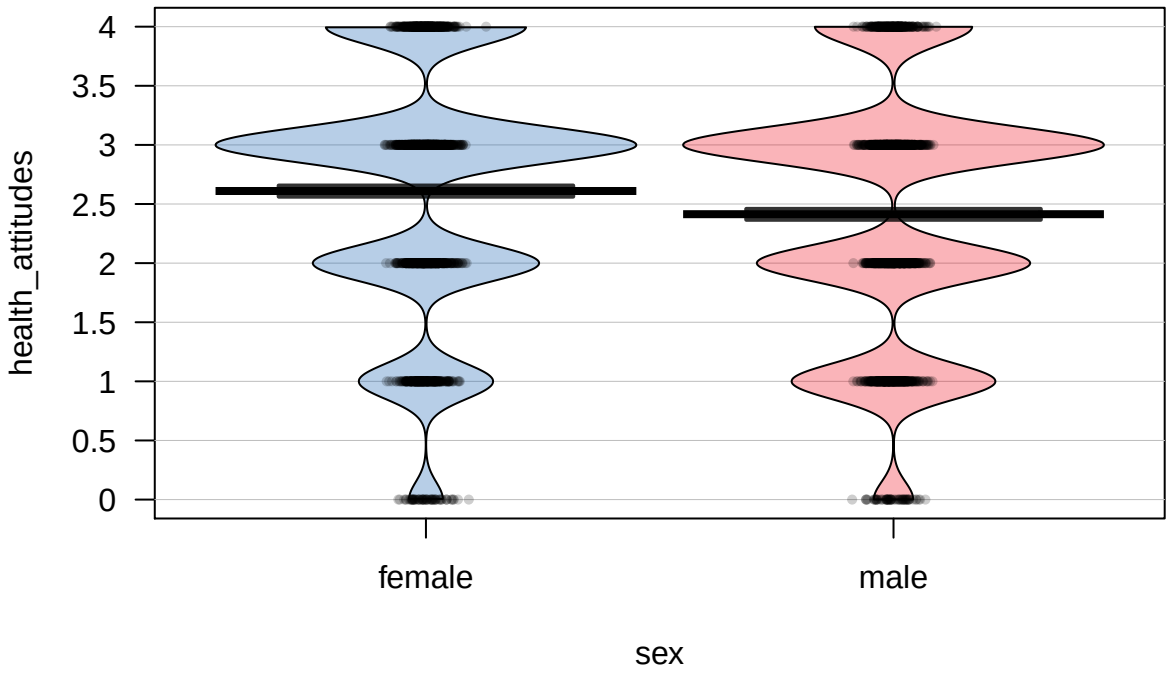

```
pirateplot(industry_attitudes ~ country, data = dataset_attitude)
```



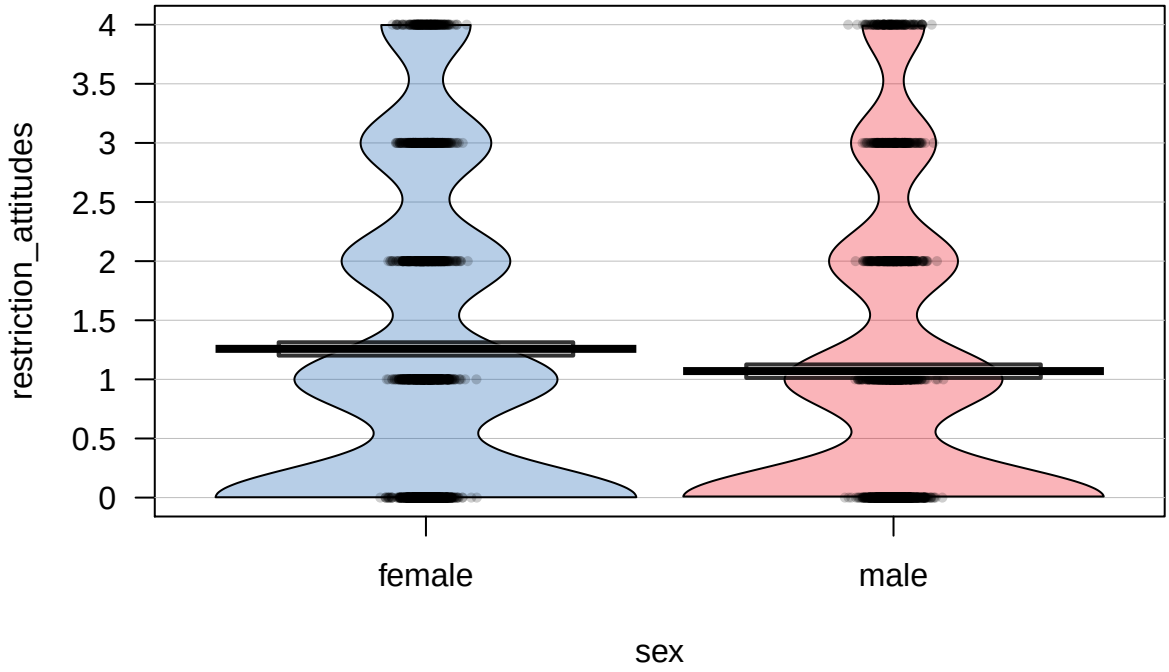

```
pirateplot(national_attitudes ~ country, data = dataset_attitude)
```



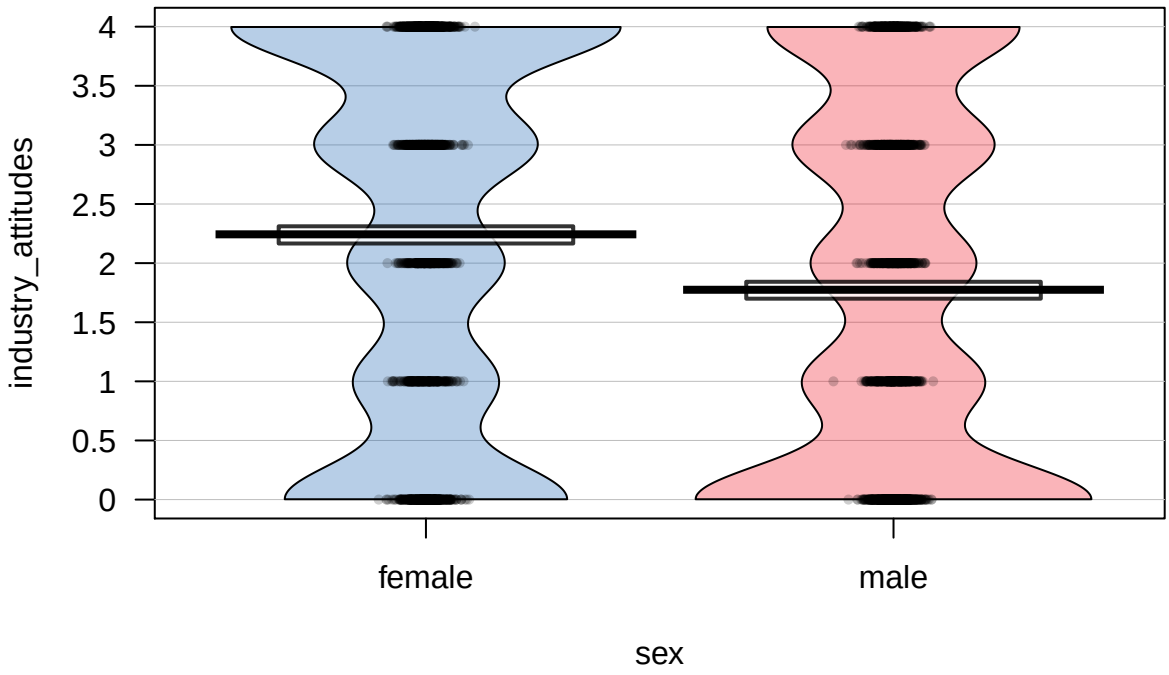

```
pirateplot(health_attitudes ~ sex, data = dataset_attitude)
```



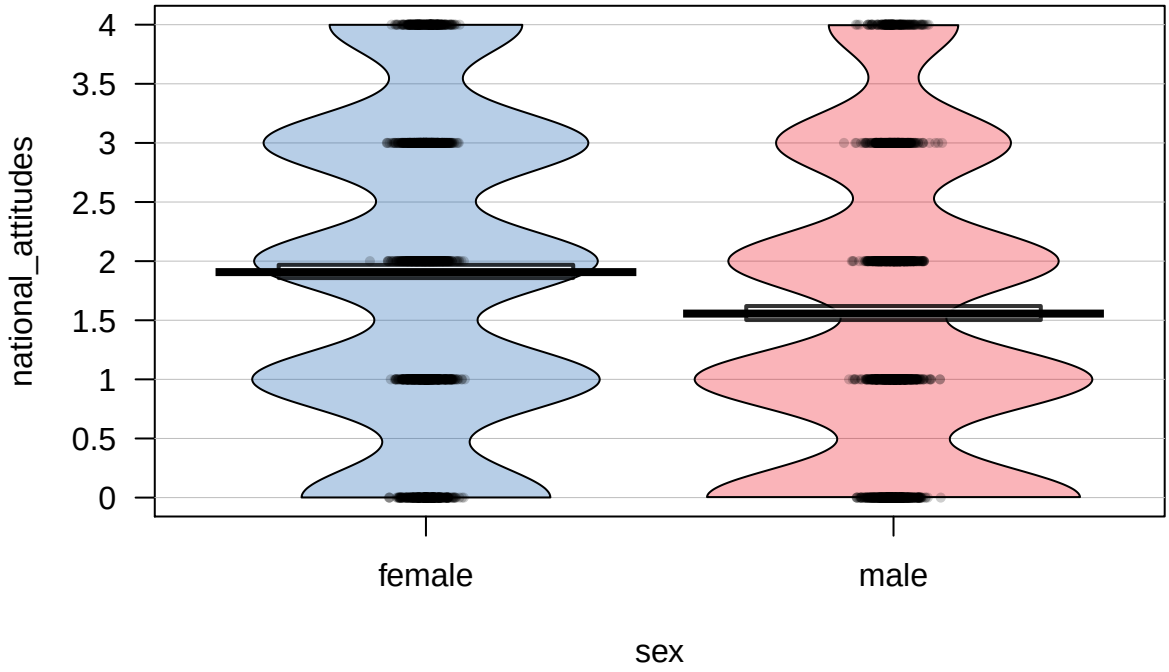

```
pirateplot(restriction_attitudes ~ sex, data = dataset_attitude)
```




```
pirateplot(industry_attitudes ~ sex, data = dataset_attitude)
```




```
pirateplot(national_attitudes ~ sex, data = dataset_attitude)
```



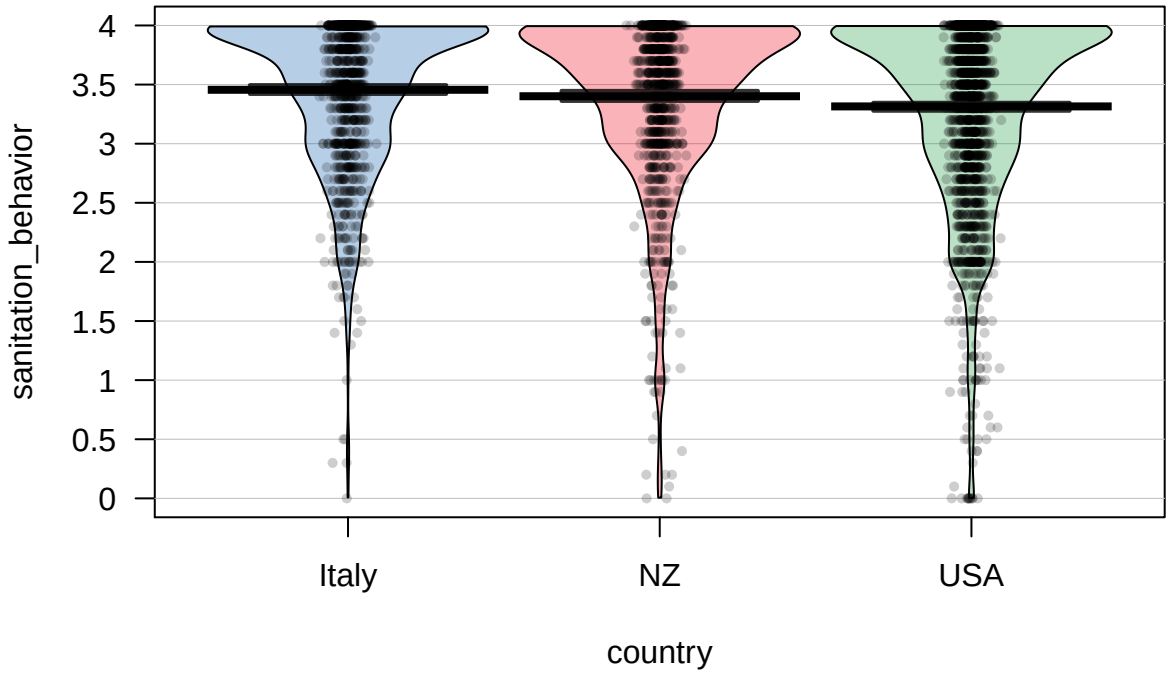
Behavior Pirate Plots

In terms of behavior, differences across sex and country can be observed, albeit in a different manner than for attitude. In general, it appears that there was more compliance for behaviors than there was agreement for attitudes, further reinforcing the notion that attitudes and behavior often don't line up. For *sanitation_behavior*, the means for the three countries are all very high and similar, yet there is a slightly larger proportion of people in the US in the middle portion of the pirate plot, indicating that some behavior for personal health is not followed. For *social_behavior* there are a number of discrepancies. First, Most responses in Italy are concentrated toward the top end of the pirate plot, indicating that a strict lockdown must have taken place that prevented people from engaging in social activity. New Zealand and the United

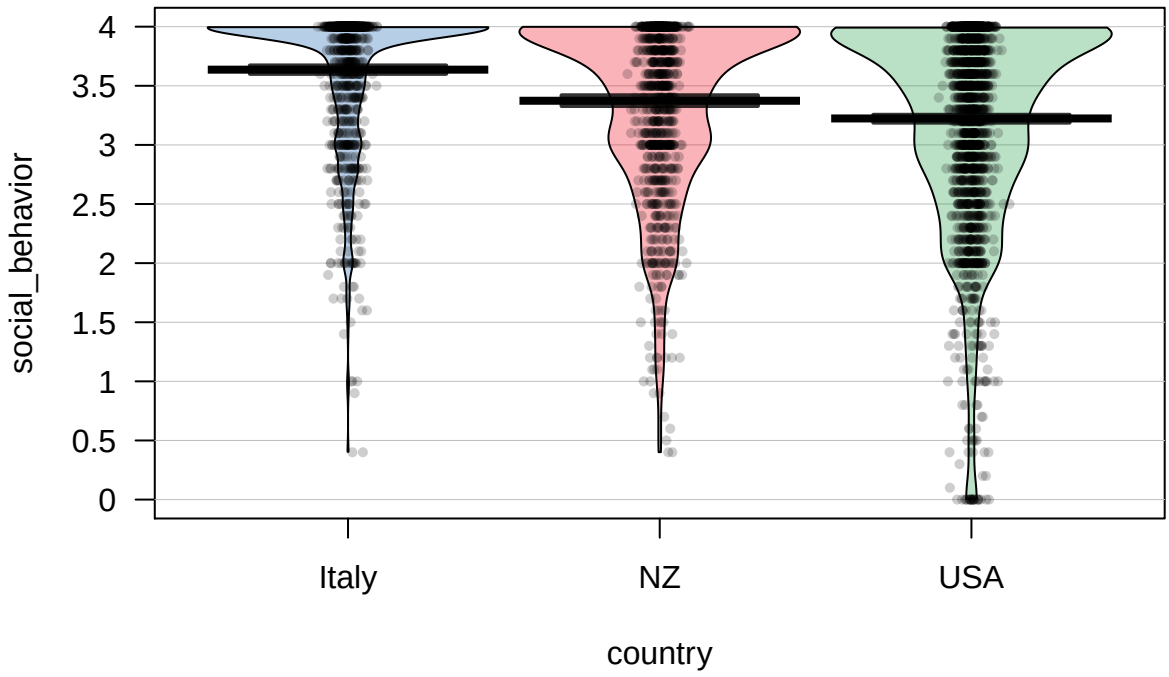
States have a larger concentration of responses toward the middle, indicating that despite what rules may be in place, some people are still engaging in social activity. For *generalhealth_Behavior*, there appears to be a greater amount of variability across the three countries. The mean for New Zealand is drastically lower than that of the United States or Italy, and there is a higher concentration toward the bottom end of repsonses. For the US, there is a greater concentration toward the middle, and for Italy toward the top. In general, this variable had the weakest correlation between the items that loaded with it, so it is not surprising to see such stark variability.

Across sex, more differences can be observed. For *sanitation_behavior*, there is a higher concentration toward the top end for both males and females, yet males also have a large concentration toward the middle, indicating that males are less likely to engage in personal sanitation during the pandemic. Same trend holds for *social_behavior*, as the graphs look almost identical to the one before. There is a greater concentration toward the top for both, yet more male responses toward the middle. For *generalhealth_behavior*, the same issue arises when looking across country, there is too great of variability to really draw a conclusion about either sex.

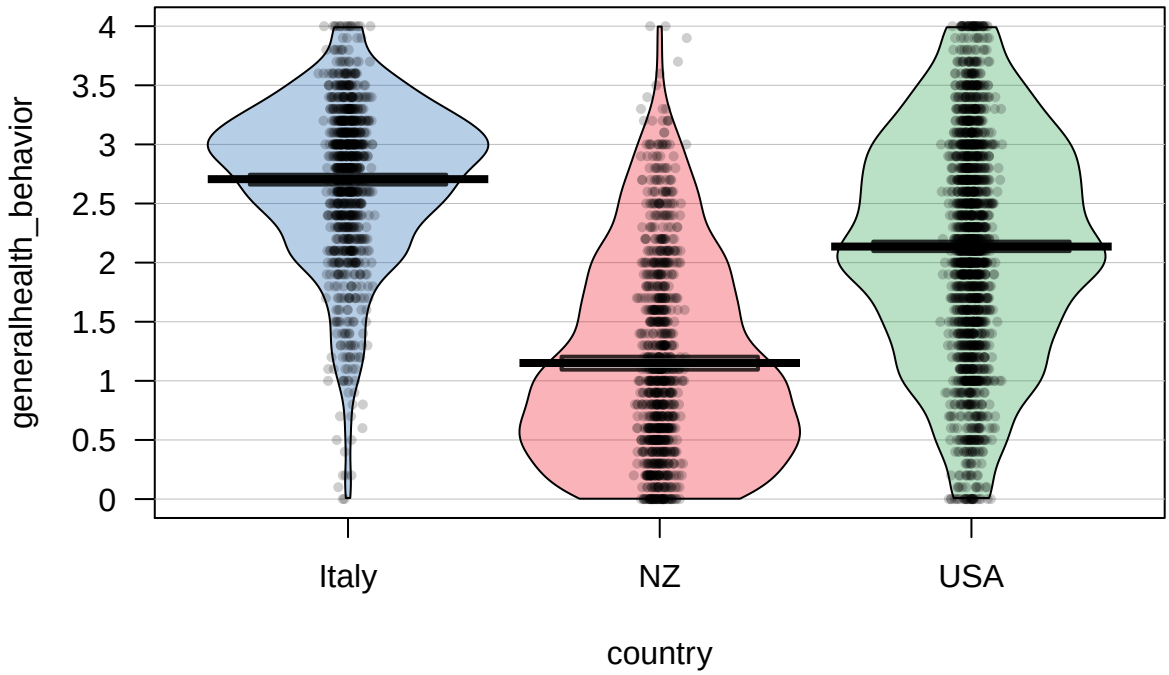
```
pirateplot(sanitation_behavior ~ country, data = dataset_behavior)
```



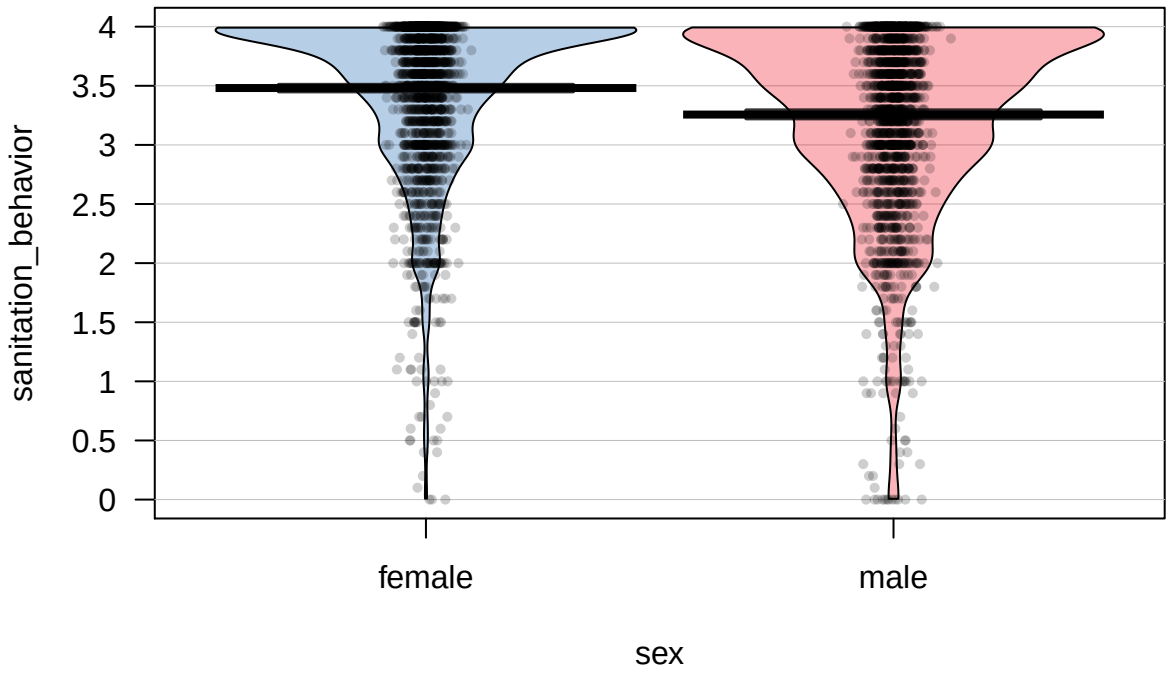

```
pirateplot(social_behavior ~ country, data = dataset_behavior)
```



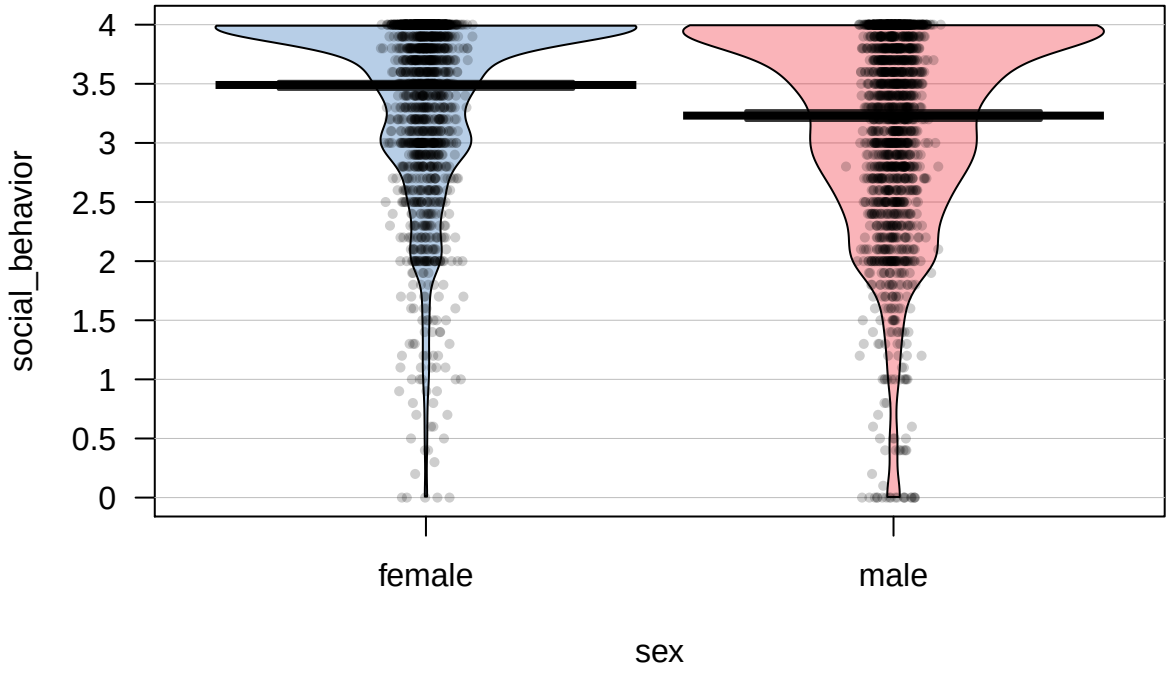

```
pirateplot(generalhealth_behavior ~ country, data = dataset_behavior)
```



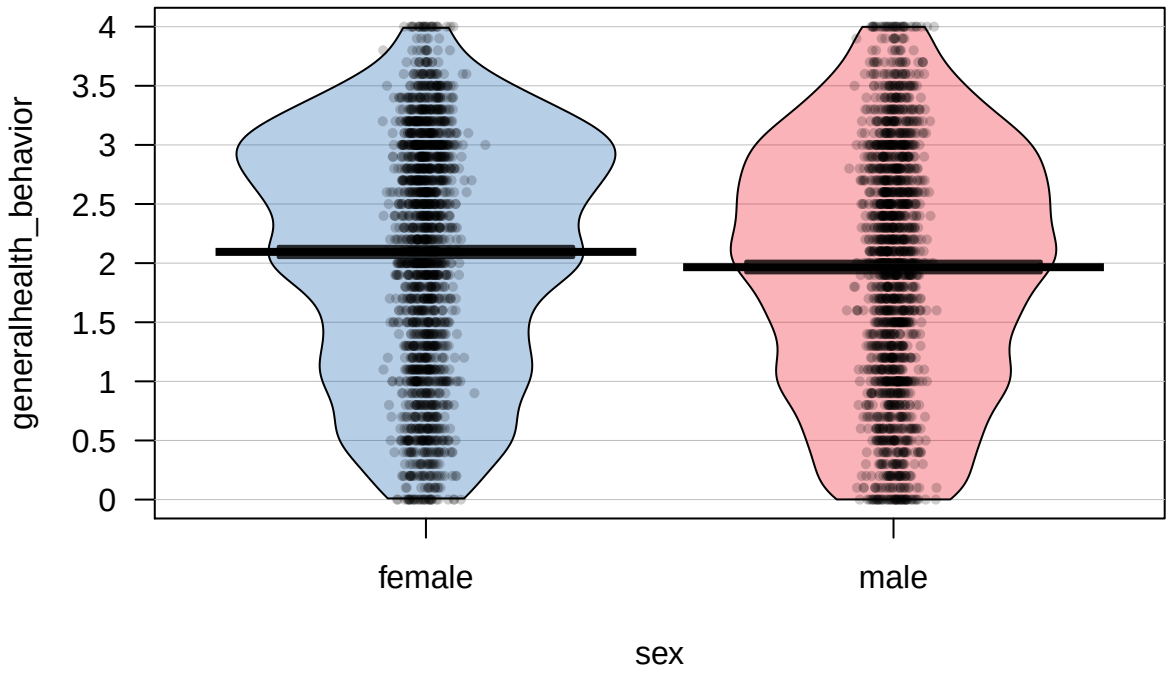

```
pirateplot(sanitation_behavior ~ sex, data = dataset_behavior)
```




```
pirateplot(social_behavior ~ sex, data = dataset_behavior)
```




```
pirateplot(generalhealth_behavior ~ sex, data = dataset_behavior)
```



Finding Correlations in the Data: Our next step is to create a pairs panels for each dataset in order to find the correlation between the latent variables. For the attitude data set, we will also be finding the correlations between the latent variables and the variable *overall_agree* from the original data set. This variable represents the individual's overall agreeableness of the attitudes regarding COVID-19. Similarly, within the behavior dataset, we will find the correlation between the latent variables and the variable *overall_compliance*, which represents the individual's overall compliance with the behaviors that developed during the COVID-19 pandemic. For the attitude and behavior datasets, we created smaller data sets that contained only the variables we are finding correlations for (latent variables and either *overall_agree* or *overall_compliance*) called "attitude_corr" and "behavior_corr".

When we run the pairs panels for the attitude dataset, we see that most of the relationships between the latent variables and *overall_agree* are quite high. The lowest correlation value is 0.41 between *health_attitudes* and *restriction_attitudes*, which indicates that these latent variables have the weakest relationship. The highest correlation value is 0.89 between *industry_attitudes* and *overall_agree*, so these variables have the strongest relationship. The *restriction_attitudes* and *national_attitudes* also have very strong correlation of 0.80 with overall_agree. *Health_attitudes* and *overall_agree* have a correlation value of 0.64, which is still quite high, but means that health attitude has the weakest correlation with *overall_agree*. Thus, we can hypothesize that individuals value *restriction_attitudes*, *industry_attitudes*, and *national_attitudes* have a greater impact on an individual's overall agreeableness with COVID-19 attitudes. Between the latent variables, the highest correlation values are between *industry_attitudes* and *national_attitudes* (0.64) and *restriction_attitudes* and *industry_attitudes* (0.63). Now we can see that the latent variables have generally higher correlation with the overall_agree variable than with other latent variables.

Now we can run a pairs panels on the behavior dataset. There are a couple key differences between this pairs panels, and the one we did previously with attitude. First, we can see that there are much lower correlation values present. *Generalhealth_behavior* has a correlation value of 0.24 with *sanitation_behavior*, and a correlation value of 0.29 with social behavior. These are significantly lower correlation values than any other one present on the pairs panels. The second lowest correlation value is 0.61 between *generalhealth_behavior* and *overall_compliance*. We can see that there is a very large increase in correlation values. In addition, all of the lower correlation values are with *generalhealth_behavior*. Thus, we can conclude that this latent variable has the least correlation with all of the other variables.

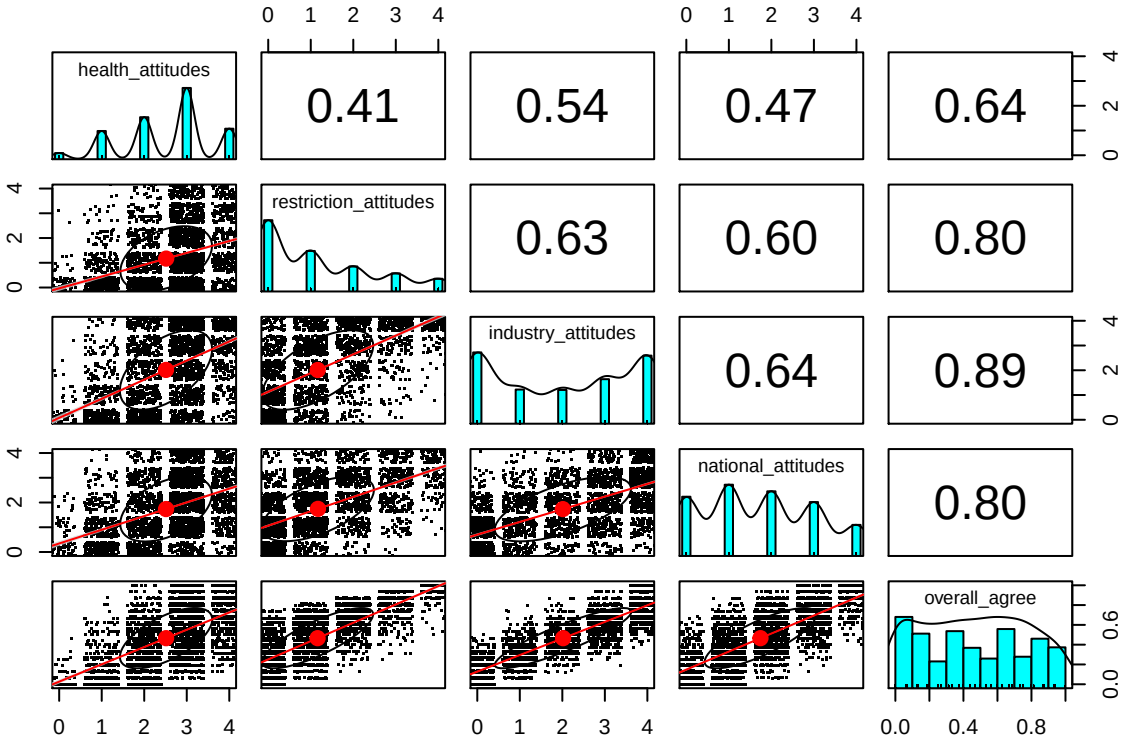
Upon running the correlations, a final dataset was made to gather the information from the attitude_scores

dataset and the behavior_scores dataset, called covidgender_final. This dataset will be used in the future for further analyses.

```
attitude_scores <- dataset_attitude %>%
  select(
    id,
    country,
    sex,
    health_attitudes,
    restriction_attitudes,
    industry_attitudes,
    national_attitudes,
    overall_agree)

attitude_corr <- attitude_scores %>%
  select(-(id), - (sex), -(country))

pairs.panels(attitude_corr,
             jiggle = TRUE,
             ellipses = TRUE,
             lm = TRUE,
             ci = TRUE,
             pch = ".",
             scale = FALSE)
```

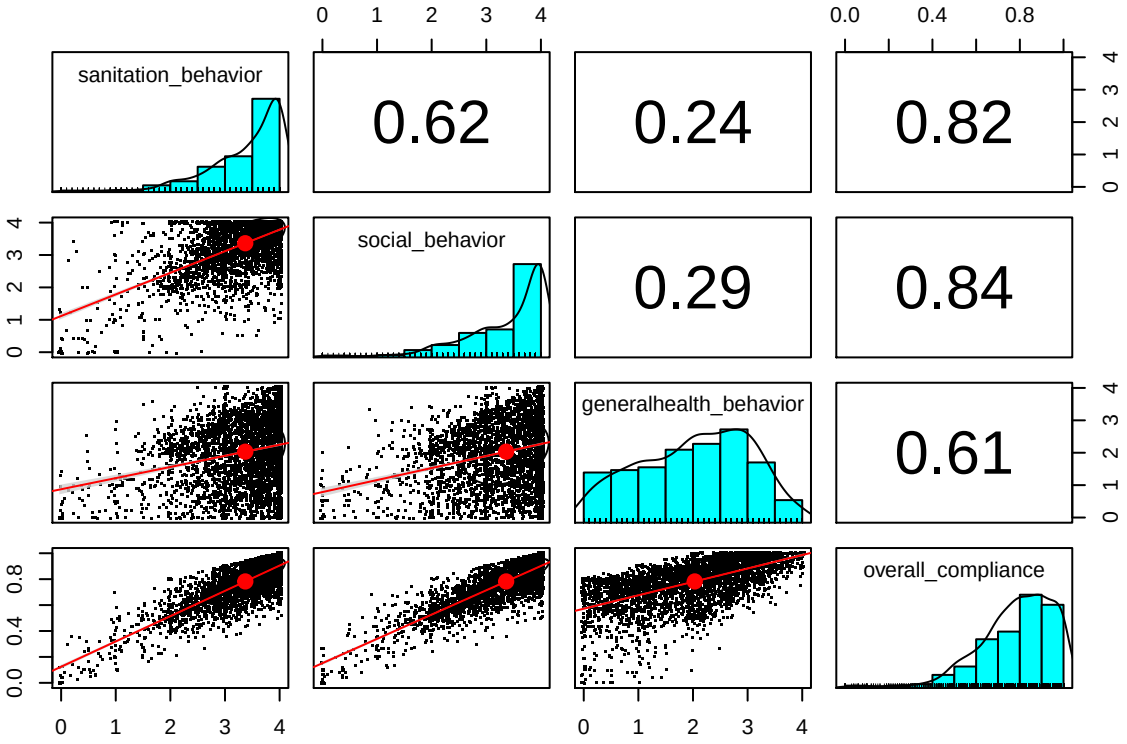



```
behavior_scores <- dataset_behavior %>%
  select(
    id,
    country,
    sex,
    sanitation_behavior,
```

```
    social_behavior,
    generalhealth_behavior,
    overall_compliance)

behavior_corr <- behavior_scores %>%
  select(-(id), - (sex), -(country))

pairs.panels(behavior_corr,
             jiggle = TRUE,
             ellipses = TRUE,
             lm = TRUE,
             ci = TRUE,
             pch = ".",
             scale = FALSE)
```




```
covidgender_final <- full_join(attitude_scores, behavior_scores, by = "id") %>%
  select(-(country.y), -(sex.y)) %>%
  rename(
    country = country.x,
    sex = sex.x
  )
```

Preliminary Regression Analyses: To run the regressions, it is necessary to have the *lm.beta* package installed from the library.

Regressions for Attitude

Once that was ran, we conducted a multiple regression for Attitudes to see which of the four latent variables predicts *overall_agree* the most. After running the analysis, it appears that *industry_attitudes* has the largest standardized beta of the four variables at 0.46. What this means is that when holding the other variables constant, for every 1 unit increase in *industry_attitudes*, *overall_agree* goes up by 0.46 units. The

next strongest predictor was *restriction_attitudes* (0.31), followed by *national_attitudes* (0.25), and then *health_attitudes* (0.14).

In addition to running a multiple regression with all of the latent variables, bivariate regressions were ran to see if shared variance exists with the outcome variable. For *industry_attitudes*, the standardized beta is 0.89. For *restriction_attitudes*, the standardized beta is 0.80. For *national_attitudes*, the standardized beta is 0.80 as well. And lastly, for *health_attitudes*, the standardized beta is 0.64. These standardized betas are far larger than the betas from the multiple regression, indicating that there is a lot of shared variance between the variables and *overall_agree*.

```
library(lm.beta)

attitude_multireg <- lm.beta(lm(overall_agree ~ health_attitudes + restriction_attitudes + industry_att
summary(attitude_multireg)
```

```
##
## Call:
## lm(formula = overall_agree ~ health_attitudes + restriction_attitudes +
##     industry_attitudes + national_attitudes, data = attitude_scores)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.226942 -0.040445  0.002567  0.051052  0.223275
##
## Coefficients:
##                          Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)            -0.004003     0.000000   0.002915  -1.373     0.17
## health_attitudes        0.041712     0.144740   0.001283  32.507   <2e-16 ***
## restriction_attitudes   0.072303     0.305947   0.001184  61.052   <2e-16 ***
## industry_attitudes      0.088997     0.464501   0.001054  84.420   <2e-16 ***
## national_attitudes      0.058100     0.246363   0.001216  47.769   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06837 on 3726 degrees of freedom
## Multiple R-squared:  0.9497, Adjusted R-squared:  0.9496
## F-statistic: 1.757e+04 on 4 and 3726 DF,  p-value: < 2.2e-16
```

```
reg_healt <- lm.beta(lm(overall_agree ~ health_attitudes, data = attitude_scores))
reg_restr <- lm.beta(lm(overall_agree ~ restriction_attitudes, data = attitude_scores))
reg_indus <- lm.beta(lm(overall_agree ~ industry_attitudes, data = attitude_scores))
reg_natl <- lm.beta(lm(overall_agree ~ national_attitudes, data = attitude_scores))

summary(reg_healt)
```

```
##
## Call:
## lm(formula = overall_agree ~ health_attitudes, data = attitude_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.61256 -0.18385 -0.00513  0.17888  0.68676
##
## Coefficients:
##                  Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)      0.005135     0.000000   0.009941   0.517    0.606
```

```
## health_attitudes 0.183106     0.635371   0.003644  50.245   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2352 on 3729 degrees of freedom
## Multiple R-squared:  0.4037, Adjusted R-squared:  0.4035
## F-statistic:  2525 on 1 and 3729 DF,  p-value: < 2.2e-16
```

```
summary(reg_restr)
```

```
##
## Call:
## lm(formula = overall_agree ~ restriction_attitudes, data = attitude_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.56429 -0.12951 -0.00451  0.12592  0.50635
##
## Coefficients:
##                       Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)           0.243645     0.000000   0.003993   61.03   <2e-16 ***
## restriction_attitudes 0.190215     0.804888   0.002297   82.83   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1808 on 3729 degrees of freedom
## Multiple R-squared:  0.6478, Adjusted R-squared:  0.6478
## F-statistic:  6860 on 1 and 3729 DF,  p-value: < 2.2e-16
```

```
summary(reg_indus)
```

```
##
## Call:
## lm(formula = overall_agree ~ industry_attitudes, data = attitude_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.44659 -0.11781 -0.00531  0.09963  0.50835
##
## Coefficients:
##                     Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)         0.120429     0.000000   0.003615   33.32   <2e-16 ***
## industry_attitudes 0.171220     0.893647   0.001408  121.60   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1367 on 3729 degrees of freedom
## Multiple R-squared:  0.7986, Adjusted R-squared:  0.7986
## F-statistic: 1.479e+04 on 1 and 3729 DF,  p-value: < 2.2e-16
```

```
summary(reg_natl)
```

```
##
## Call:
## lm(formula = overall_agree ~ national_attitudes, data = attitude_scores)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.57798 -0.13916 -0.01416  0.11040  0.54834
##
## Coefficients:
##                    Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)        0.139156     0.000000   0.005049   27.56   <2e-16 ***
## national_attitudes 0.187941     0.796939   0.002333   80.56   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.184 on 3729 degrees of freedom
## Multiple R-squared:  0.6351, Adjusted R-squared:  0.635
## F-statistic:  6491 on 1 and 3729 DF,  p-value: < 2.2e-16
```

Regressions for Behavior

Next, a multiple regression was ran to see which latent variable was the strongest predictor of *overall_compliance*. After running the multiple regression, it appears that *social_behavior* is the strongest predictor, with a standardized beta of 0.46. What this means is that when holding the other variables constant, for every 1 unit increase in *social_behavior*, *overall_compliance* increased by 0.46. Following behind that would be *sanitation_behavior* (0.44), and *generalhealth_behavior* (0.37).

Additionally, bivariate regressions were ran to observe shared variance. The standardized beta is 0.82 for *sanitation_behavior*, 0.84 for *social_behavior*, and 0.61 for *generalhealth_behavior*. Similar to the situation with Attitudes above, it is safe to assume there is a lot of shared variance between the latent Behavior variables and *overall_compliance*.

```
behavior_multireg <- lm.beta(lm(overall_compliance ~ sanitation_behavior + social_behavior + generalheal
summary(behavior_multireg)
```

```
##
## Call:
## lm(formula = overall_compliance ~ sanitation_behavior + social_behavior +
##     generalhealth_behavior, data = behavior_scores)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.107530 -0.020527  0.000945  0.020308  0.097948
##
## Coefficients:
##                           Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)            -0.0467915    0.0000000  0.0024882  -18.81   <2e-16 ***
## sanitation_behavior     0.1049891    0.4381546  0.0008579  122.38   <2e-16 ***
## social_behavior         0.1033344    0.4627728  0.0008090  127.74   <2e-16 ***
## generalhealth_behavior  0.0627641    0.3671248  0.0005001  125.49   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03074 on 3998 degrees of freedom
## Multiple R-squared:  0.9688, Adjusted R-squared:  0.9688
## F-statistic: 4.141e+04 on 3 and 3998 DF,  p-value: < 2.2e-16
```

```
reg_sanit <- lm.beta(lm(overall_compliance ~ sanitation_behavior, data = behavior_scores))
reg_socia <- lm.beta(lm(overall_compliance ~ social_behavior, data = behavior_scores))
reg_genhe <- lm.beta(lm(overall_compliance ~ generalhealth_behavior, data = behavior_scores))
```

```r
summary(reg_sanit)
```

```
##
## Call:
## lm(formula = overall_compliance ~ sanitation_behavior, data = behavior_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.40514 -0.06697  0.00939  0.08394  0.38119
##
## Coefficients:
##                     Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)         0.123364     0.000000   0.007560   16.32   <2e-16 ***
## sanitation_behavior 0.195445     0.815658   0.002192   89.17   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1007 on 4000 degrees of freedom
## Multiple R-squared:  0.6653, Adjusted R-squared:  0.6652
## F-statistic:  7951 on 1 and 4000 DF,  p-value: < 2.2e-16
```

```r
summary(reg_socia)
```

```
##
## Call:
## lm(formula = overall_compliance ~ social_behavior, data = behavior_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.42914 -0.05863  0.00582  0.07706  0.35989
##
## Coefficients:
##                 Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)     0.151259     0.000000   0.006611   22.88   <2e-16 ***
## social_behavior 0.187612     0.840200   0.001915   97.99   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09438 on 4000 degrees of freedom
## Multiple R-squared:  0.7059, Adjusted R-squared:  0.7059
## F-statistic:  9602 on 1 and 4000 DF,  p-value: < 2.2e-16
```

```r
summary(reg_genhe)
```

```
##
## Call:
## lm(formula = overall_compliance ~ generalhealth_behavior, data = behavior_scores)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.67903 -0.07004  0.03097  0.09691  0.22830
##
## Coefficients:
##                       Estimate Standardized Std. Error t value Pr(>|t|)
## (Intercept)           0.571696     0.000000   0.004885  117.02   <2e-16 ***
```

```
## generalhealth_behavior 0.103668     0.606384   0.002149   48.23   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1384 on 4000 degrees of freedom
## Multiple R-squared:  0.3677, Adjusted R-squared:  0.3675
## F-statistic:  2326 on 1 and 4000 DF,  p-value: < 2.2e-16
```

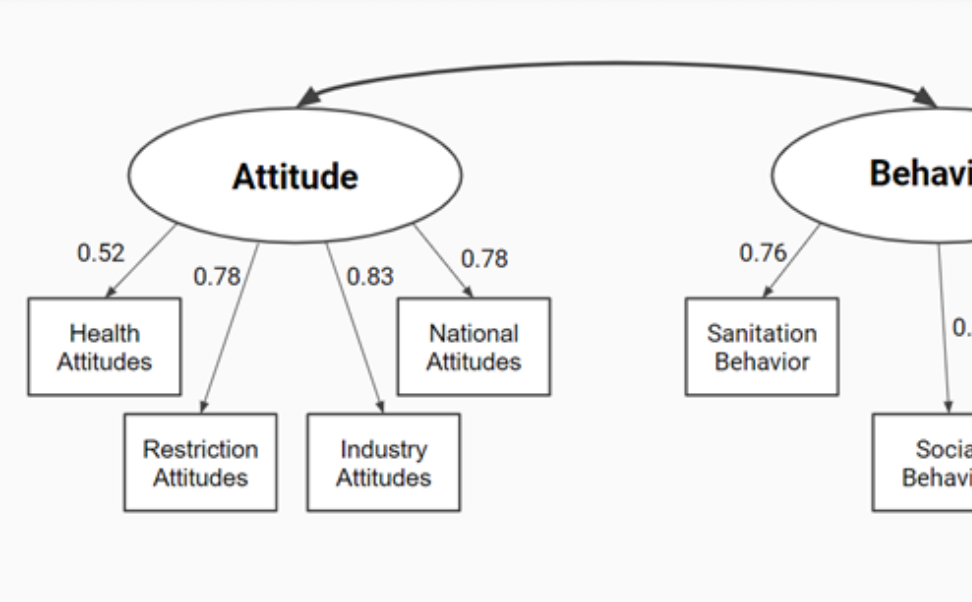
Checking Reliability - Testing for Chronbach's Alpha: To first test reliability, we created a dataset that took out all of the character variables so that the test could be properly ran (dubbed covidgender_reliabilitydata). After running the test with that dataset, we found that there is a very strong internal consistency among the latent variables, with a Cronbach's Alpha of 0.88.

```
covidgender_reliabilitydata <- covidgender_final %>%
  select(-(id), -(country), -(sex))

alpha(covidgender_reliabilitydata)
```

```
##
## Reliability analysis
## Call: alpha(x = covidgender_reliabilitydata)
##
##   raw_alpha std.alpha G6(smc) average_r S/N    ase mean   sd median_r
##       0.82      0.88    0.96      0.44 7.1 0.0036    2 0.65     0.37
##
##  lower alpha upper     95% confidence boundaries
## 0.81 0.82 0.82
##
##  Reliability if an item is dropped:
##                         raw_alpha std.alpha G6(smc) average_r S/N alpha se var.r
## health_attitudes             0.79      0.87    0.96      0.46 6.7   0.0041 0.049
## restriction_attitudes        0.77      0.86    0.95      0.44 6.2   0.0046 0.048
## industry_attitudes           0.78      0.86    0.95      0.43 6.0   0.0047 0.042
## national_attitudes           0.77      0.86    0.95      0.43 6.1   0.0047 0.048
## overall_agree                0.80      0.85    0.92      0.41 5.5   0.0041 0.035
## sanitation_behavior          0.80      0.87    0.94      0.45 6.6   0.0038 0.046
## social_behavior              0.80      0.87    0.94      0.45 6.4   0.0038 0.047
## generalhealth_behavior       0.82      0.89    0.95      0.49 7.7   0.0033 0.040
## overall_compliance           0.82      0.85    0.90      0.42 5.8   0.0038 0.044
##                         med.r
## health_attitudes         0.37
## restriction_attitudes    0.35
## industry_attitudes       0.37
## national_attitudes       0.35
## overall_agree            0.35
## sanitation_behavior      0.38
## social_behavior          0.38
## generalhealth_behavior   0.40
## overall_compliance       0.34
##
##  Item statistics
##                            n raw.r std.r r.cor r.drop mean   sd
## health_attitudes        3731  0.67  0.64  0.57   0.54 2.51 1.06
## restriction_attitudes   3731  0.79  0.74  0.72   0.67 1.17 1.29
```

```
## industry_attitudes     3731  0.82  0.76  0.75   0.69 2.02 1.59
## national_attitudes     3731  0.80  0.75  0.72   0.70 1.74 1.29
## overall_agree          3731  0.91  0.85  0.86   0.90 0.47 0.30
## sanitation_behavior    4002  0.57  0.66  0.66   0.47 3.37 0.73
## social_behavior        4002  0.60  0.69  0.69   0.50 3.36 0.78
## generalhealth_behavior 4002  0.47  0.49  0.48   0.31 2.03 1.02
## overall_compliance     4002  0.70  0.80  0.81   0.68 0.78 0.17
```



Checking Validity- EFA and CFA:

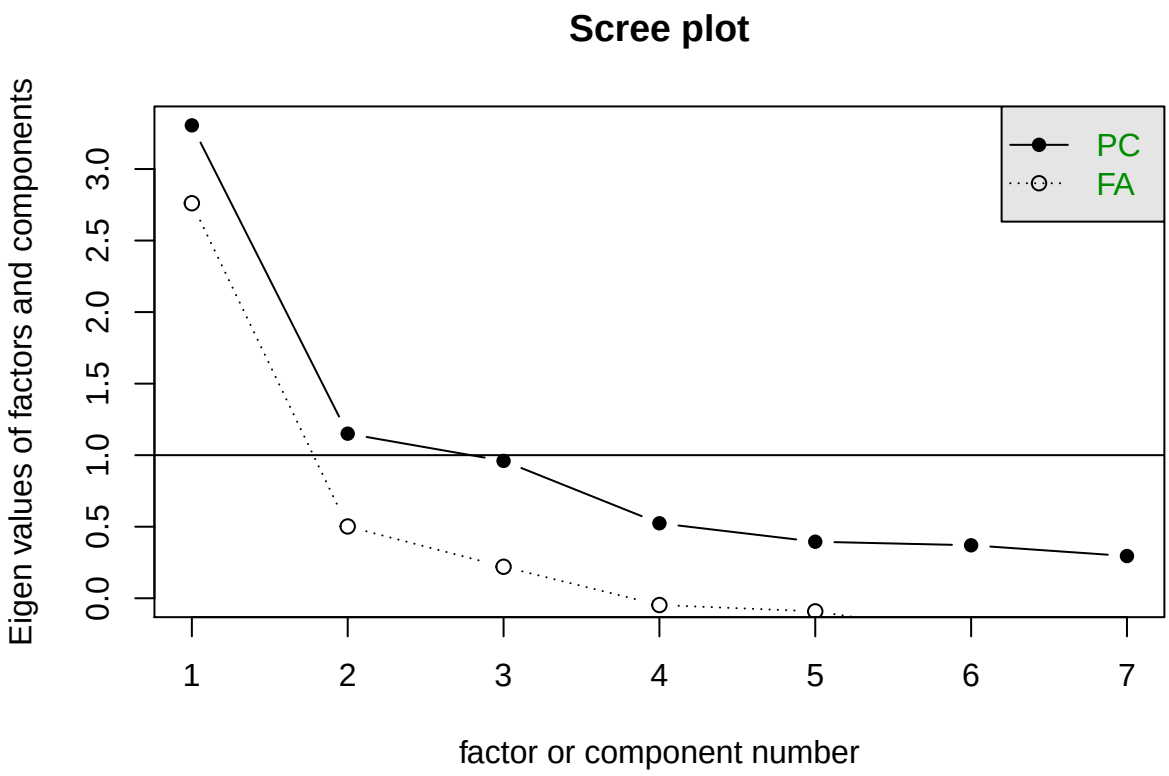
The final model for our dataset is listed the above image, with the standardized loadings. In the next few steps, we will outline how we got there.

EFA:

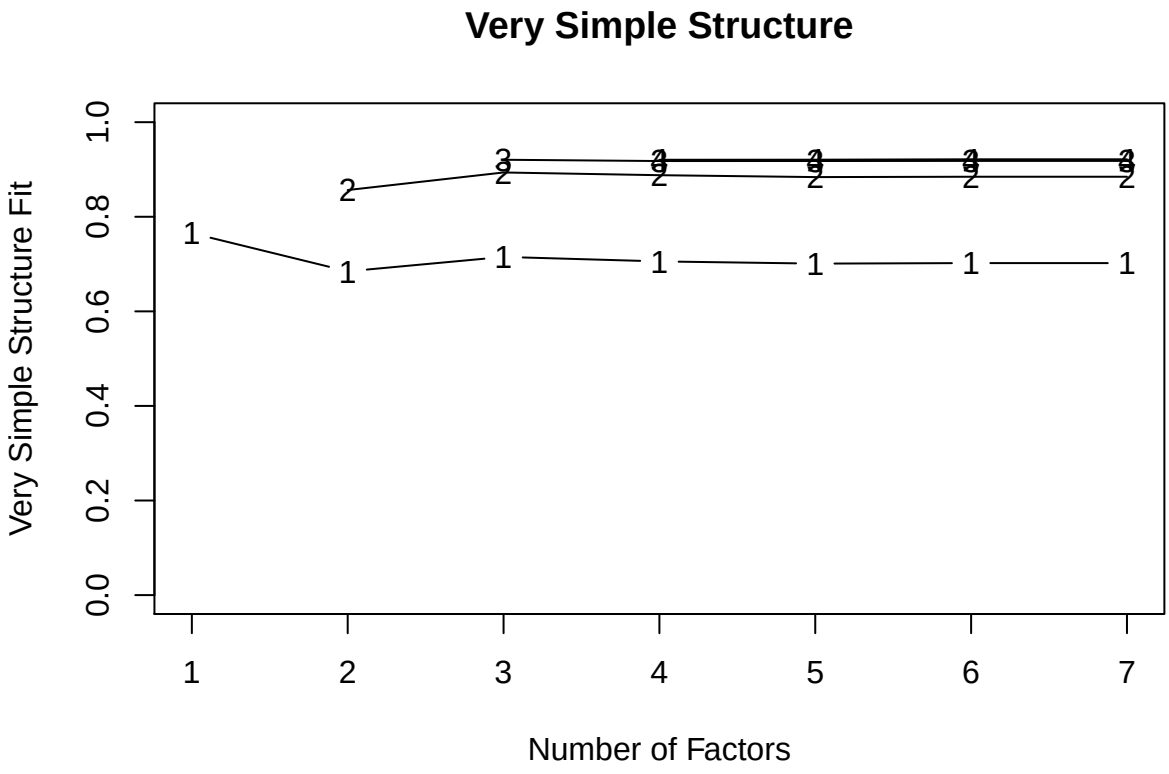
In order to run an EFA and CFA, we created a dataset that took away all of the character variables, as well as the overall_agree and overall_compliance variables (covidgender_validitydata). After creating the dataset, we ran a scree plot to look at the number of eigenvalues the data has in order to determine the possible number of factors, as well as a very simple structure (VSS) plot to look at inflection points. Based off what the plots tell us, it is safe to assume that there are about 2-3 dimensions in this model. Under the oblique factorial analysis ran below, we can see that the standardized loadings for each item match well with one of the possible dimensions. All of the Attitude items fall under MR1, whereas all of the Behavior Items fall under MR2 (or MR3 in the 3 factor model). Next, a CFA will need to be ran in order to understand whether 2 or 3 possible factors is the correct fit for a model.

```
covidgender_validitydata <- covidgender_final %>%
  select(-(id), -(country), -(sex), -(overall_agree), -(overall_compliance))

scree(covidgender_validitydata)
```




```
vss(covidgender_validitydata)
```




```
##
## Very Simple Structure
## Call: vss(x = covidgender_validitydata)
```

```
## VSS complexity 1 achieves a maximimum of 0.77  with  1  factors
## VSS complexity 2 achieves a maximimum of 0.89  with  3  factors
##
## The Velicer MAP achieves a minimum of NA  with  1  factors
## BIC achieves a minimum of  NA  with  3  factors
## Sample Size adjusted BIC achieves a minimum of  NA  with  3  factors
##
## Statistics by number of factors
##   vss1 vss2   map dof   chisq     prob sqresid  fit RMSEA  BIC  SABIC complex
## 1 0.77 0.00 0.071  14 2.2e+03  0.0e+00     3.2 0.77  0.20 2105 2149.7     1.0
## 2 0.68 0.86 0.083   8 6.2e+02 1.3e-128     2.0 0.86  0.14  553  578.9     1.3
## 3 0.72 0.89 0.139   3 1.4e+01  3.6e-03     1.1 0.92  0.03  -11   -1.8     1.3
## 4 0.71 0.89 0.265  -1 6.4e-05       NA     1.1 0.92    NA   NA     NA     1.4
## 5 0.70 0.88 0.432  -4 1.2e-07       NA     1.1 0.92    NA   NA     NA     1.4
## 6 0.70 0.88 1.000  -6 0.0e+00       NA     1.1 0.92    NA   NA     NA     1.4
## 7 0.70 0.88    NA  -7 0.0e+00       NA     1.1 0.92    NA   NA     NA     1.4
##    eChisq    SRMR eCRMS eBIC
## 1 1.9e+03 1.1e-01 0.131 1820
## 2 4.3e+02 5.1e-02 0.082  365
## 3 4.7e+00 5.3e-03 0.014  -20
## 4 2.0e-05 1.1e-05    NA   NA
## 5 3.8e-08 4.8e-07    NA   NA
## 6 7.0e-13 2.0e-09    NA   NA
## 7 7.0e-13 2.0e-09    NA   NA
```

```
covid_fa_orth <- fa(covidgender_validitydata, nfactors = 2, fm = "minres", rotate = "varimax")
covid_fa_orth
```

```
## Factor Analysis using method =  minres
## Call: fa(r = covidgender_validitydata, nfactors = 2, rotate = "varimax",
##     fm = "minres")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                          MR1  MR2   h2   u2 com
## health_attitudes        0.53 0.27 0.36 0.64 1.5
## restriction_attitudes   0.74 0.18 0.58 0.42 1.1
## industry_attitudes      0.80 0.22 0.69 0.31 1.2
## national_attitudes      0.75 0.24 0.62 0.38 1.2
## sanitation_behavior     0.19 0.73 0.57 0.43 1.1
## social_behavior         0.21 0.80 0.69 0.31 1.1
## generalhealth_behavior 0.21 0.27 0.12 0.88 1.9
##
##                        MR1  MR2
## SS loadings           2.17 1.47
## Proportion Var        0.31 0.21
## Cumulative Var        0.31 0.52
## Proportion Explained  0.60 0.40
## Cumulative Proportion 0.60 1.00
##
## Mean item complexity =  1.3
## Test of the hypothesis that 2 factors are sufficient.
##
## The degrees of freedom for the null model are  21  and the objective function was  2.49 with Chi Squa
## The degrees of freedom for the model are 8  and the objective function was  0.16
##
## The root mean square of the residuals (RMSR) is  0.05
```

```
## The df corrected root mean square of the residuals is  0.08
##
## The harmonic number of observations is  3778 with the empirical chi square  402.4  with prob <  5.7e
## The total number of observations was  4002  with Likelihood Chi Square =  619.82  with prob <  1.3e-
##
## Tucker Lewis Index of factoring reliability =  0.839
## RMSEA index =  0.138  and the 90 % confidence intervals are  0.129 0.148
## BIC =  553.46
## Fit based upon off diagonal values = 0.98
## Measures of factor score adequacy
##                                                  MR1  MR2
## Correlation of (regression) scores with factors   0.90 0.86
## Multiple R square of scores with factors          0.81 0.75
## Minimum correlation of possible factor scores     0.62 0.49
```

```
covid_fa_oblique <- fa(covidgender_validitydata, nfactors = 2, fm = "minres", rotate = "oblimin")
covid_fa_oblique
```

```
## Factor Analysis using method =  minres
## Call: fa(r = covidgender_validitydata, nfactors = 2, rotate = "oblimin",
##     fm = "minres")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                          MR1   MR2   h2   u2 com
## health_attitudes        0.52  0.13 0.36 0.64 1.1
## restriction_attitudes   0.78 -0.04 0.58 0.42 1.0
## industry_attitudes      0.83 -0.01 0.69 0.31 1.0
## national_attitudes      0.78  0.02 0.62 0.38 1.0
## sanitation_behavior     0.00  0.76 0.57 0.43 1.0
## social_behavior         0.00  0.83 0.69 0.31 1.0
## generalhealth_behavior 0.16  0.24 0.12 0.88 1.8
##
##                        MR1  MR2
## SS loadings           2.26 1.38
## Proportion Var        0.32 0.20
## Cumulative Var        0.32 0.52
## Proportion Explained  0.62 0.38
## Cumulative Proportion 0.62 1.00
##
##  With factor correlations of
##      MR1  MR2
## MR1 1.00 0.51
## MR2 0.51 1.00
##
## Mean item complexity =  1.1
## Test of the hypothesis that 2 factors are sufficient.
##
## The degrees of freedom for the null model are  21  and the objective function was  2.49 with Chi Squa
## The degrees of freedom for the model are 8  and the objective function was  0.16
##
## The root mean square of the residuals (RMSR) is  0.05
## The df corrected root mean square of the residuals is  0.08
##
## The harmonic number of observations is  3778 with the empirical chi square  402.4  with prob <  5.7e
## The total number of observations was  4002  with Likelihood Chi Square =  619.82  with prob <  1.3e-
##
```

```
## Tucker Lewis Index of factoring reliability =  0.839
## RMSEA index =  0.138  and the 90 % confidence intervals are  0.129 0.148
## BIC =  553.46
## Fit based upon off diagonal values = 0.98
## Measures of factor score adequacy
##                                                  MR1  MR2
## Correlation of (regression) scores with factors   0.93 0.89
## Multiple R square of scores with factors          0.86 0.80
## Minimum correlation of possible factor scores     0.72 0.60
```

```
covid_fa_orth <- fa(covidgender_validitydata, nfactors = 3, fm = "minres", rotate = "varimax")
covid_fa_orth
```

```
## Factor Analysis using method =  minres
## Call: fa(r = covidgender_validitydata, nfactors = 3, rotate = "varimax",
##     fm = "minres")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                          MR1  MR2   MR3   h2   u2 com
## health_attitudes        0.57 0.29 -0.05 0.41 0.59 1.5
## restriction_attitudes   0.72 0.09  0.33 0.63 0.37 1.4
## industry_attitudes      0.84 0.22  0.00 0.75 0.25 1.1
## national_attitudes      0.72 0.20  0.19 0.60 0.40 1.3
## sanitation_behavior     0.19 0.80  0.11 0.69 0.31 1.1
## social_behavior         0.24 0.70  0.17 0.57 0.43 1.4
## generalhealth_behavior 0.11 0.18  0.79 0.67 0.33 1.1
##
##                        MR1  MR2  MR3
## SS loadings           2.17 1.34 0.81
## Proportion Var        0.31 0.19 0.12
## Cumulative Var        0.31 0.50 0.62
## Proportion Explained  0.50 0.31 0.19
## Cumulative Proportion 0.50 0.81 1.00
##
## Mean item complexity =  1.3
## Test of the hypothesis that 3 factors are sufficient.
##
## The degrees of freedom for the null model are  21  and the objective function was  2.49 with Chi Squa
## The degrees of freedom for the model are 3  and the objective function was  0
##
## The root mean square of the residuals (RMSR) is  0.01
## The df corrected root mean square of the residuals is  0.01
##
## The harmonic number of observations is  3778 with the empirical chi square  4.41  with prob <  0.22
## The total number of observations was  4002  with Likelihood Chi Square =  13.55  with prob <  0.0036
##
## Tucker Lewis Index of factoring reliability =  0.993
## RMSEA index =  0.03  and the 90 % confidence intervals are  0.015 0.046
## BIC =  -11.33
## Fit based upon off diagonal values = 1
## Measures of factor score adequacy
##                                                  MR1  MR2  MR3
## Correlation of (regression) scores with factors   0.91 0.86 0.82
## Multiple R square of scores with factors          0.83 0.74 0.67
## Minimum correlation of possible factor scores     0.66 0.47 0.33
```

```
covid_fa_oblique <- fa(covidgender_validitydata, nfactors = 3, fm = "minres", rotate = "oblimin")
covid_fa_oblique
```

```
## Factor Analysis using method =  minres
## Call: fa(r = covidgender_validitydata, nfactors = 3, rotate = "oblimin",
##     fm = "minres")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                          MR1   MR2   MR3   h2   u2 com
## health_attitudes        0.55  0.20 -0.15 0.41 0.59 1.4
## restriction_attitudes   0.75 -0.10  0.24 0.63 0.37 1.2
## industry_attitudes      0.87  0.05 -0.13 0.75 0.25 1.1
## national_attitudes      0.73  0.03  0.09 0.60 0.40 1.0
## sanitation_behavior    -0.02  0.84  0.01 0.69 0.31 1.0
## social_behavior         0.06  0.70  0.08 0.57 0.43 1.0
## generalhealth_behavior  0.02  0.09  0.78 0.67 0.33 1.0
##
##                        MR1  MR2  MR3
## SS loadings           2.23 1.33 0.76
## Proportion Var        0.32 0.19 0.11
## Cumulative Var        0.32 0.51 0.62
## Proportion Explained  0.52 0.31 0.18
## Cumulative Proportion 0.52 0.82 1.00
##
##  With factor correlations of
##      MR1  MR2  MR3
## MR1 1.00 0.46 0.25
## MR2 0.46 1.00 0.24
## MR3 0.25 0.24 1.00
##
## Mean item complexity =  1.1
## Test of the hypothesis that 3 factors are sufficient.
##
## The degrees of freedom for the null model are  21  and the objective function was  2.49 with Chi Squa
## The degrees of freedom for the model are 3  and the objective function was  0
##
## The root mean square of the residuals (RMSR) is  0.01
## The df corrected root mean square of the residuals is  0.01
##
## The harmonic number of observations is  3778 with the empirical chi square  4.41  with prob <  0.22
## The total number of observations was  4002  with Likelihood Chi Square =  13.55  with prob <  0.0036
##
## Tucker Lewis Index of factoring reliability =  0.993
## RMSEA index =  0.03  and the 90 % confidence intervals are  0.015 0.046
## BIC =  -11.33
## Fit based upon off diagonal values = 1
## Measures of factor score adequacy
##                                                  MR1  MR2  MR3
## Correlation of (regression) scores with factors   0.93 0.89 0.83
## Multiple R square of scores with factors          0.87 0.79 0.69
## Minimum correlation of possible factor scores     0.74 0.59 0.38
```

CFA:

Two models were tested to see which is the better fit, a 2-factor model and a 3-factor model. For the 2-factor model, the factors were named "Attitude" and "Behavior", because the attitude variables and behavior

variables loaded onto different factors. The standardized loadings were high for each latent variable except for generalhealth_behavior, which had a loading in the 0.2 range. Other than that, the fit indices looked like the model was a good fit (CFI = 0.93, RSMEA = 0.116, SRMR = 0.05). When testing the 3-factor model, it appeared that there may be better fit than the 2-factor model, but we will explain why we went with the 2-factor model instead. For the 3-factor model, the loadings remained mostly the same, yet the only large change was that generalhealth_behavior went from MR2 to MR3, and the value of the loading went up to 0.78. In addition to solid fit indices (CFI = 0.932, RSMEA = 0.118, SRMR = 0.048) and the AIC/BIC decreasing from the 2-factor to the 3-factor, it looks at first like the 3-factor may be the best choice. Yet, doing so would leave 4 latent variables in MR1, 2 latent variables in MR2, and 1 in MR3; which MR2 and MR3 do not have enough loadings to be considered a standalone factor. Thus, despite some drawbacks of the loadings, we determined that the 2-factor model is the best fit.

```
covid.model_2 <-
'
attitude =~ health_attitudes + restriction_attitudes + industry_attitudes + national_attitudes
behavior =~ sanitation_behavior + social_behavior + generalhealth_behavior

'

fitCOVID <- cfa(covid.model_2, data= covidgender_validitydata)
summary(fitCOVID, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 28 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         15
##
##                                                   Used       Total
##   Number of observations                          3731        4002
##
## Model Test User Model:
##
##   Test statistic                               671.168
##   Degrees of freedom                                13
##   P-value (Chi-square)                           0.000
##
## Model Test Baseline Model:
##
##   Test statistic                              9155.401
##   Degrees of freedom                                21
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.928
##   Tucker-Lewis Index (TLI)                       0.884
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34433.123
##   Loglikelihood unrestricted model (H1)     -34097.539
##
##   Akaike (AIC)                               68896.245
##   Bayesian (BIC)                             68989.612
```

```
##   Sample-size adjusted Bayesian (BIC)        68941.949
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.116
##   90 Percent confidence interval - lower         0.109
##   90 Percent confidence interval - upper         0.124
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.054
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
##     restrctn_tttds    1.464    0.042   35.209    0.000
##     industry_tttds    2.045    0.054   37.714    0.000
##     national_tttds    1.545    0.042   36.388    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    1.188    0.040   29.844    0.000
##     genrlhlth_bhvr    0.690    0.037   18.521    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.185    0.009   19.783    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.691    0.018   38.690    0.000
##    .restrctn_tttds    0.749    0.022   34.022    0.000
##    .industry_tttds    0.747    0.030   25.233    0.000
##    .national_tttds    0.652    0.021   31.244    0.000
##    .sanitatin_bhvr    0.230    0.010   23.902    0.000
##    .social_behavir    0.197    0.012   16.252    0.000
##    .genrlhlth_bhvr    0.920    0.022   41.459    0.000
##     attitude          0.425    0.022   19.509    0.000
##     behavior          0.271    0.013   20.732    0.000
```

```
lavInspect(fitCOVID, what = "std")
```

```
## $lambda
##                       attitd behavr
## health_attitudes       0.617  0.000
## restriction_attitudes  0.741  0.000
## industry_attitudes     0.839  0.000
```

```
## national_attitudes      0.780  0.000
## sanitation_behavior     0.000  0.735
## social_behavior         0.000  0.812
## generalhealth_behavior  0.000  0.351
##
## $theta
##                        hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.619
## restriction_attitudes  0.000  0.451
## industry_attitudes     0.000  0.000  0.296
## national_attitudes     0.000  0.000  0.000  0.391
## sanitation_behavior    0.000  0.000  0.000  0.000  0.460
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.340
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.877
##
## $psi
##          attitd behavr
## attitude 1.000
## behavior 0.546  1.000
```

```
covid.model_3 <-
'
attitude =~ health_attitudes + restriction_attitudes + industry_attitudes + national_attitudes
covid_behavior =~ sanitation_behavior + social_behavior
standard_behavior =~ generalhealth_behavior

'

fitCOVID <- cfa(covid.model_3, data= covidgender_validitydata)
summary(fitCOVID, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 29 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         16
##
##                                                   Used       Total
##   Number of observations                          3731        4002
##
## Model Test User Model:
##
##   Test statistic                               634.982
##   Degrees of freedom                                12
##   P-value (Chi-square)                           0.000
##
## Model Test Baseline Model:
##
##   Test statistic                              9155.401
##   Degrees of freedom                                21
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.932
```

```
##   Tucker-Lewis Index (TLI)                       0.881
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34415.030
##   Loglikelihood unrestricted model (H1)     -34097.539
##
##   Akaike (AIC)                               68862.060
##   Bayesian (BIC)                             68961.651
##   Sample-size adjusted Bayesian (BIC)        68910.810
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.118
##   90 Percent confidence interval - lower         0.110
##   90 Percent confidence interval - upper         0.126
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.048
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                      Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds        1.000
##     restrctn_tttds        1.488    0.042   35.159    0.000
##     industry_tttds        2.041    0.055   37.272    0.000
##     national_tttds        1.564    0.043   36.214    0.000
##   covid_behavior =~
##     sanitatin_bhvr        1.000
##     social_behavir        1.202    0.042   28.311    0.000
##   standard_behavior =~
##     genrlhlth_bhvr        1.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     covid_behavior     0.179    0.009   19.185    0.000
##     standard_behvr     0.182    0.013   14.209    0.000
##   covid_behavior ~~
##     standard_behvr     0.178    0.011   15.948    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.697    0.018   38.774    0.000
##    .restrctn_tttds    0.732    0.022   33.599    0.000
##    .industry_tttds    0.778    0.030   26.157    0.000
```

```
##    .national_tttds    0.641    0.021   30.900    0.000
##    .sanitatin_bhvr    0.231    0.010   22.940    0.000
##    .social_behavir    0.190    0.013   14.490    0.000
##    .genrlhlth_bhvr    0.000
##     attitude          0.420    0.022   19.341    0.000
##     covid_behavior    0.270    0.013   20.190    0.000
##     standard_behvr    1.049    0.024   43.191    0.000
```

```
lavInspect(fitCOVID, what = "std")
```

```
## $lambda
##                         attitd cvd_bh stndr_
## health_attitudes         0.613  0.000      0
## restriction_attitudes    0.748  0.000      0
## industry_attitudes       0.832  0.000      0
## national_attitudes       0.785  0.000      0
## sanitation_behavior      0.000  0.734      0
## social_behavior          0.000  0.820      0
## generalhealth_behavior   0.000  0.000      1
##
## $theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.624
## restriction_attitudes   0.000  0.441
## industry_attitudes      0.000  0.000  0.308
## national_attitudes      0.000  0.000  0.000  0.384
## sanitation_behavior     0.000  0.000  0.000  0.000  0.461
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.327
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.000
##
## $psi
##                    attitd cvd_bh stndr_
## attitude           1.000
## covid_behavior     0.533  1.000
## standard_behavior 0.274  0.334  1.000
```

Measurement Invariance

Our next step is to determine the fairness of our survey data. We can determine if there are any biases present by looking at measurement invariance. In order to answer our two research questions, we analyzed the measurement invariance by both sex and country.

We created four different models for each group comparison: a configural model, a weak invariance model, a strong invariance model, and a strict invariance model. Between each model, different values are standardized in order to see if the factor carries the same weight and direction on both models. For example, the weak invariance models hold factor loadings equivalent, the strong invariance model holds factor loadings and intercepts equivalent, and the strict invariance model holds the factor loadings, intercepts, and residuals equivalent.

After we created these models, we must perform model comparisons in order to see which type of invariance exists in the data. To do this, we compare the CFI, RMSEA, and SRMR values between each level of strictness. If there is a jump in value between models that is GREATER than the 90% confidence interval, we can determine that the models can no longer be compared at a higher level of strictness.

Measuring Invariance by Sex:

When we performed these group comparisons by sex, we were able to determine that the model followed the strict invariance model. The CFI and SRMR values stayed very consistent across all four models, and the RMSEA value did not change by a value of more than 0.015, which was the 90% confidence interval. Thus, we can conclude with strong evidence that the survey was not biased against males or females.

```
covidgender_long <- covidgender_final %>%
  pivot_longer(4:12, names_to = "variable", values_to = "value") %>%
  filter(!is.na(value)) %>%
  filter(!is.na(country))

covidgender_meas_inv <- covidgender_long %>%
  pivot_wider(names_from = "variable", values_from = "value")

fit_config <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "sex")

summary(fit_config, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 42 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         44
##
##   Number of observations per group:
##     female                                        1921
##     male                                          1810
##
## Model Test User Model:
##
##   Test statistic                               704.975
##   Degrees of freedom                               26
##   P-value (Chi-square)                          0.000
##   Test statistic for each group:
##     female                                     309.569
##     male                                       395.407
##
## Model Test Baseline Model:
##
##   Test statistic                              8923.366
##   Degrees of freedom                               42
##   P-value                                       0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.924
##   Tucker-Lewis Index (TLI)                       0.877
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34300.018
##   Loglikelihood unrestricted model (H1)     -33947.530
##
##   Akaike (AIC)                               68688.036
```

```
##   Bayesian (BIC)                                68961.911
##   Sample-size adjusted Bayesian (BIC)           68822.100
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                            0.118
##   90 Percent confidence interval - lower           0.111
##   90 Percent confidence interval - upper           0.126
##   P-value RMSEA <= 0.05                            0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                             0.050
##
## Parameter Estimates:
##
##   Standard errors                               Standard
##   Information                                   Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [female]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
##     restrctn_tttds    1.488    0.059   25.269    0.000
##     industry_tttds    1.996    0.074   26.837    0.000
##     national_tttds    1.537    0.059   26.056    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    1.204    0.063   19.000    0.000
##     genrlhlth_bhvr    0.762    0.062   12.231    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.161    0.012   13.746    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.610    0.024  109.233    0.000
##    .restrctn_tttds    1.258    0.030   42.050    0.000
##    .industry_tttds    2.244    0.036   62.197    0.000
##    .national_tttds    1.907    0.029   64.796    0.000
##    .sanitatin_bhvr    3.495    0.015  238.197    0.000
##    .social_behavir    3.507    0.016  223.594    0.000
##    .genrlhlth_bhvr    2.092    0.023   90.876    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##    .health_attitds    0.672    0.024   27.491    0.000
##    .restrctn_tttds    0.779    0.032   24.121    0.000
##    .industry_tttds    0.806    0.042   19.015    0.000
##    .national_tttds    0.661    0.030   22.238    0.000
##    .sanitatin_bhvr    0.215    0.012   18.395    0.000
##    .social_behavir    0.185    0.015   12.527    0.000
##    .genrlhlth_bhvr    0.903    0.030   29.616    0.000
##     attitude          0.425    0.030   14.087    0.000
##     behavior          0.198    0.015   13.427    0.000
##
##
## Group 2 [male]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
##     restrctn_tttds    1.472    0.061   24.056    0.000
##     industry_tttds    2.083    0.081   25.663    0.000
##     national_tttds    1.540    0.063   24.589    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    1.180    0.056   21.220    0.000
##     genrlhlth_bhvr    0.650    0.049   13.257    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.187    0.014   13.431    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.414    0.025   97.136    0.000
##    .restrctn_tttds    1.070    0.030   36.232    0.000
##    .industry_tttds    1.775    0.037   48.324    0.000
##    .national_tttds    1.556    0.030   52.232    0.000
##    .sanitatin_bhvr    3.267    0.018  184.537    0.000
##    .social_behavir    3.248    0.019  170.322    0.000
##    .genrlhlth_bhvr    1.950    0.024   80.145    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.713    0.026   27.220    0.000
##    .restrctn_tttds    0.701    0.030   23.515    0.000
##    .industry_tttds    0.684    0.041   16.742    0.000
##    .national_tttds    0.647    0.029   22.177    0.000
##    .sanitatin_bhvr    0.246    0.016   15.687    0.000
##    .social_behavir    0.211    0.020   10.637    0.000
##    .genrlhlth_bhvr    0.937    0.032   28.923    0.000
##     attitude          0.405    0.031   13.187    0.000
##     behavior          0.321    0.022   14.834    0.000
```

```r
lavInspect(fit_config, what = "std")
```

```
## $female
## $female$lambda
##                         attitd behavr
## health_attitudes         0.622  0.000
## restriction_attitudes    0.740  0.000
## industry_attitudes       0.823  0.000
## national_attitudes       0.777  0.000
## sanitation_behavior      0.000  0.693
## social_behavior          0.000  0.780
## generalhealth_behavior   0.000  0.336
##
## $female$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.613
## restriction_attitudes   0.000  0.453
## industry_attitudes      0.000  0.000  0.323
## national_attitudes      0.000  0.000  0.000  0.397
## sanitation_behavior     0.000  0.000  0.000  0.000  0.520
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.391
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.887
##
## $female$psi
##           attitd behavr
## attitude 1.000
## behavior 0.553  1.000
##
## $female$nu
##                         intrcp
## health_attitudes         2.492
## restriction_attitudes    0.959
## industry_attitudes       1.419
## national_attitudes       1.478
## sanitation_behavior      5.435
## social_behavior          5.101
## generalhealth_behavior   2.073
##
## $female$alpha
##           intrcp
## attitude       0
## behavior       0
##
##
## $male
## $male$lambda
##                         attitd behavr
## health_attitudes         0.602  0.000
## restriction_attitudes    0.746  0.000
## industry_attitudes       0.848  0.000
## national_attitudes       0.773  0.000
## sanitation_behavior      0.000  0.752
## social_behavior          0.000  0.824
## generalhealth_behavior   0.000  0.356
```

```
##
## $male$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.638
## restriction_attitudes   0.000  0.444
## industry_attitudes      0.000  0.000  0.280
## national_attitudes      0.000  0.000  0.000  0.402
## sanitation_behavior     0.000  0.000  0.000  0.000  0.434
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.321
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.874
##
## $male$psi
##           attitd behavr
## attitude 1.000
## behavior 0.519  1.000
##
## $male$nu
##                         intrcp
## health_attitudes         2.283
## restriction_attitudes    0.852
## industry_attitudes       1.136
## national_attitudes       1.228
## sanitation_behavior      4.338
## social_behavior          4.003
## generalhealth_behavior   1.884
##
## $male$alpha
##           intrcp
## attitude       0
## behavior       0
```

```
fit_weak <- cfa(covid.model_2,
                data = covidgender_meas_inv,
                group = "sex",
                group.equal = c("loadings")
                )

summary(fit_weak, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 36 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         44
##   Number of equality constraints                     5
##
##   Number of observations per group:
##     female                                        1921
##     male                                          1810
##
## Model Test User Model:
##
##   Test statistic                               708.729
##   Degrees of freedom                                31
##   P-value (Chi-square)                           0.000
```

```
##   Test statistic for each group:
##     female                                   311.659
##     male                                     397.069
##
## Model Test Baseline Model:
##
##   Test statistic                            8923.366
##   Degrees of freedom                              42
##   P-value                                      0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                  0.924
##   Tucker-Lewis Index (TLI)                     0.897
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)            -34301.894
##   Loglikelihood unrestricted model (H1)    -33947.530
##
##   Akaike (AIC)                              68681.789
##   Bayesian (BIC)                            68924.542
##   Sample-size adjusted Bayesian (BIC)       68800.619
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                        0.108
##   90 Percent confidence interval - lower       0.101
##   90 Percent confidence interval - upper       0.115
##   P-value RMSEA <= 0.05                        0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                         0.051
##
## Parameter Estimates:
##
##   Standard errors                           Standard
##   Information                               Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [female]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.479    0.042   34.880    0.000
##     indstr_ (.p3.)    2.039    0.055   37.155    0.000
##     ntnl_tt (.p4.)    1.539    0.043   35.825    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.191    0.042   28.520    0.000
```

```
##     gnrlhl_ (.p7.)    0.694    0.039   18.003    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.161    0.011   15.293    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.610    0.024  109.501    0.000
##    .restrctn_tttds    1.258    0.030   42.260    0.000
##    .industry_tttds    2.244    0.036   61.813    0.000
##    .national_tttds    1.907    0.029   64.922    0.000
##    .sanitatin_bhvr    3.495    0.015  237.546    0.000
##    .social_behavir    3.507    0.016  223.500    0.000
##    .genrlhlth_bhvr    2.092    0.023   91.399    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.672    0.024   27.804    0.000
##    .restrctn_tttds    0.786    0.032   24.914    0.000
##    .industry_tttds    0.789    0.041   19.382    0.000
##    .national_tttds    0.666    0.029   23.110    0.000
##    .sanitatin_bhvr    0.213    0.011   20.241    0.000
##    .social_behavir    0.185    0.013   14.617    0.000
##    .genrlhlth_bhvr    0.909    0.030   30.023    0.000
##     attitude          0.419    0.024   17.210    0.000
##     behavior          0.203    0.012   16.603    0.000
##
##
## Group 2 [male]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.479    0.042   34.880    0.000
##     indstr_ (.p3.)    2.039    0.055   37.155    0.000
##     ntnl_tt (.p4.)    1.539    0.043   35.825    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.191    0.042   28.520    0.000
##     gnrlhl_ (.p7.)    0.694    0.039   18.003    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.187    0.013   14.754    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.414    0.025   96.874    0.000
```

```
##    .restrctn_tttds    1.070    0.030   36.049    0.000
##    .industry_tttds    1.775    0.037   48.617    0.000
##    .national_tttds    1.556    0.030   52.125    0.000
##    .sanitatin_bhvr    3.267    0.018  184.996    0.000
##    .social_behavir    3.248    0.019  170.384    0.000
##    .genrlhlth_bhvr    1.950    0.024   79.676    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.713    0.026   27.387    0.000
##    .restrctn_tttds    0.695    0.029   23.801    0.000
##    .industry_tttds    0.702    0.038   18.244    0.000
##    .national_tttds    0.640    0.028   22.637    0.000
##    .sanitatin_bhvr    0.249    0.014   17.896    0.000
##    .social_behavir    0.210    0.017   12.228    0.000
##    .genrlhlth_bhvr    0.933    0.032   28.887    0.000
##     attitude          0.411    0.024   16.895    0.000
##     behavior          0.316    0.018   17.136    0.000
```

```
lavInspect(fit_weak, what = "std")
```

```
## $female
## $female$lambda
##                          attitd behavr
## health_attitudes          0.620  0.000
## restriction_attitudes     0.734  0.000
## industry_attitudes        0.830  0.000
## national_attitudes        0.773  0.000
## sanitation_behavior       0.000  0.699
## social_behavior           0.000  0.780
## generalhealth_behavior    0.000  0.312
##
## $female$theta
##                          hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes          0.616
## restriction_attitudes     0.000  0.461
## industry_attitudes        0.000  0.000  0.312
## national_attitudes        0.000  0.000  0.000  0.402
## sanitation_behavior       0.000  0.000  0.000  0.000  0.512
## social_behavior           0.000  0.000  0.000  0.000  0.000  0.391
## generalhealth_behavior    0.000  0.000  0.000  0.000  0.000  0.000  0.903
##
## $female$psi
##           attitd behavr
## attitude  1.000
## behavior  0.551  1.000
##
## $female$nu
##                          intrcp
## health_attitudes          2.498
## restriction_attitudes     0.964
## industry_attitudes        1.410
## national_attitudes        1.481
```

```
## sanitation_behavior     5.420
## social_behavior         5.099
## generalhealth_behavior  2.085
##
## $female$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $male
## $male$lambda
##                         attitd behavr
## health_attitudes         0.605  0.000
## restriction_attitudes    0.751  0.000
## industry_attitudes       0.842  0.000
## national_attitudes       0.777  0.000
## sanitation_behavior      0.000  0.748
## social_behavior          0.000  0.825
## generalhealth_behavior   0.000  0.374
##
## $male$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.634
## restriction_attitudes   0.000  0.436
## industry_attitudes      0.000  0.000  0.291
## national_attitudes      0.000  0.000  0.000  0.397
## sanitation_behavior     0.000  0.000  0.000  0.000  0.441
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.320
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.860
##
## $male$psi
##          attitd behavr
## attitude 1.00
## behavior 0.52   1.00
##
## $male$nu
##                         intrcp
## health_attitudes         2.277
## restriction_attitudes    0.847
## industry_attitudes       1.143
## national_attitudes       1.225
## sanitation_behavior      4.348
## social_behavior          4.005
## generalhealth_behavior   1.873
##
## $male$alpha
##          intrcp
## attitude      0
## behavior      0
```

```
fit_strong <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "sex",
```

```
                group.equal = c("loadings", "intercepts")
                )

summary(fit_strong, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 43 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         46
##   Number of equality constraints                    12
##
##   Number of observations per group:
##     female                                        1921
##     male                                          1810
##
## Model Test User Model:
##
##   Test statistic                               730.165
##   Degrees of freedom                                36
##   P-value (Chi-square)                           0.000
##   Test statistic for each group:
##     female                                       323.632
##     male                                         406.533
##
## Model Test Baseline Model:
##
##   Test statistic                              8923.366
##   Degrees of freedom                                42
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.922
##   Tucker-Lewis Index (TLI)                       0.909
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34312.613
##   Loglikelihood unrestricted model (H1)     -33947.530
##
##   Akaike (AIC)                               68693.225
##   Bayesian (BIC)                             68904.856
##   Sample-size adjusted Bayesian (BIC)        68796.820
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.102
##   90 Percent confidence interval - lower         0.095
##   90 Percent confidence interval - upper         0.108
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
```

```
##   SRMR                                           0.052
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [female]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
##     rstrct_ (.p2.)   1.461    0.041   35.219    0.000
##     indstr_ (.p3.)   2.048    0.054   37.784    0.000
##     ntnl_tt (.p4.)   1.544    0.042   36.415    0.000
##   behavior =~
##     snttn_b          1.000
##     scl_bhv (.p6.)   1.184    0.039   30.617    0.000
##     gnrlhl_ (.p7.)   0.688    0.037   18.514    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior         0.161    0.010   15.441    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)   2.614    0.021  126.788    0.000
##    .rstrct_ (.19.)   1.315    0.027   49.145    0.000
##    .indstr_ (.20.)   2.217    0.035   63.876    0.000
##    .ntnl_tt (.21.)   1.890    0.027   69.239    0.000
##    .snttn_b (.22.)   3.492    0.014  253.709    0.000
##    .scl_bhv (.23.)   3.508    0.015  231.122    0.000
##    .gnrlhl_ (.24.)   2.097    0.018  117.240    0.000
##     attitud          0.000
##     behavir          0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds   0.672    0.024   27.808    0.000
##    .restrctn_tttds   0.796    0.032   25.165    0.000
##    .industry_tttds   0.785    0.041   19.241    0.000
##    .national_tttds   0.666    0.029   23.060    0.000
##    .sanitatin_bhvr   0.212    0.010   20.415    0.000
##    .social_behavir   0.186    0.012   15.039    0.000
##    .genrlhlth_bhvr   0.909    0.030   30.040    0.000
##     attitude         0.419    0.024   17.358    0.000
##     behavior         0.204    0.012   17.073    0.000
##
##
## Group 2 [male]:
```

```
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
##     rstrct_ (.p2.)   1.461    0.041   35.219    0.000
##     indstr_ (.p3.)   2.048    0.054   37.784    0.000
##     ntnl_tt (.p4.)   1.544    0.042   36.415    0.000
##   behavior =~
##     snttn_b          1.000
##     scl_bhv (.p6.)   1.184    0.039   30.617    0.000
##     gnrlhl_ (.p7.)   0.688    0.037   18.514    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior         0.188    0.013   14.895    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)   2.614    0.021  126.788    0.000
##    .rstrct_ (.19.)   1.315    0.027   49.145    0.000
##    .indstr_ (.20.)   2.217    0.035   63.876    0.000
##    .ntnl_tt (.21.)   1.890    0.027   69.239    0.000
##    .snttn_b (.22.)   3.492    0.014  253.709    0.000
##    .scl_bhv (.23.)   3.508    0.015  231.122    0.000
##    .gnrlhl_ (.24.)   2.097    0.018  117.240    0.000
##     attitud         -0.204    0.023   -8.752    0.000
##     behavir         -0.221    0.020  -11.182    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds   0.712    0.026   27.389    0.000
##    .restrctn_tttds   0.704    0.029   24.059    0.000
##    .industry_tttds   0.698    0.039   18.089    0.000
##    .national_tttds   0.640    0.028   22.589    0.000
##    .sanitatin_bhvr   0.248    0.014   18.114    0.000
##    .social_behavir   0.212    0.017   12.681    0.000
##    .genrlhlth_bhvr   0.933    0.032   28.909    0.000
##     attitude         0.411    0.024   17.041    0.000
##     behavior         0.318    0.018   17.664    0.000
```

```
lavInspect(fit_strong, what = "std")
```

```
## $female
## $female$lambda
##                        attitd behavr
## health_attitudes        0.620  0.000
## restriction_attitudes   0.727  0.000
## industry_attitudes      0.831  0.000
## national_attitudes      0.774  0.000
## sanitation_behavior     0.000  0.701
## social_behavior         0.000  0.779
## generalhealth_behavior  0.000  0.310
##
```

```
## $female$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.616
## restriction_attitudes  0.000  0.471
## industry_attitudes     0.000  0.000  0.309
## national_attitudes     0.000  0.000  0.000  0.400
## sanitation_behavior    0.000  0.000  0.000  0.000  0.509
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.394
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.904
##
## $female$psi
##          attitd behavr
## attitude 1.000
## behavior 0.551  1.000
##
## $female$nu
##                         intrcp
## health_attitudes        2.503
## restriction_attitudes   1.012
## industry_attitudes      1.391
## national_attitudes      1.465
## sanitation_behavior     5.412
## social_behavior         5.104
## generalhealth_behavior  2.091
##
## $female$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $male
## $male$lambda
##                         attitd behavr
## health_attitudes        0.605  0.000
## restriction_attitudes   0.745  0.000
## industry_attitudes      0.844  0.000
## national_attitudes      0.778  0.000
## sanitation_behavior     0.000  0.750
## social_behavior         0.000  0.823
## generalhealth_behavior  0.000  0.372
##
## $male$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.634
## restriction_attitudes  0.000  0.445
## industry_attitudes     0.000  0.000  0.288
## national_attitudes     0.000  0.000  0.000  0.395
## sanitation_behavior    0.000  0.000  0.000  0.000  0.438
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.322
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.861
##
## $male$psi
##          attitd behavr
```

```
## attitude 1.000
## behavior 0.521  1.000
##
## $male$nu
##                         intrcp
## health_attitudes         2.467
## restriction_attitudes    1.046
## industry_attitudes       1.425
## national_attitudes       1.485
## sanitation_behavior      4.644
## social_behavior          4.328
## generalhealth_behavior   2.015
##
## $male$alpha
##          intrcp
## attitude -0.318
## behavior -0.393
```

```
fit_strict <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "sex",
                  group.equal = c("loadings", "intercepts", "residuals")
                  )

summary(fit_strict, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 42 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         46
##   Number of equality constraints                    19
##
##   Number of observations per group:
##     female                                        1921
##     male                                          1810
##
## Model Test User Model:
##
##   Test statistic                               750.321
##   Degrees of freedom                                43
##   P-value (Chi-square)                           0.000
##   Test statistic for each group:
##     female                                     332.310
##     male                                       418.011
##
## Model Test Baseline Model:
##
##   Test statistic                              8923.366
##   Degrees of freedom                                42
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.920
```

```
##   Tucker-Lewis Index (TLI)                       0.922
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34322.691
##   Loglikelihood unrestricted model (H1)     -33947.530
##
##   Akaike (AIC)                               68699.382
##   Bayesian (BIC)                             68867.441
##   Sample-size adjusted Bayesian (BIC)        68781.648
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.094
##   90 Percent confidence interval - lower         0.088
##   90 Percent confidence interval - upper         0.100
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.052
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [female]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.462    0.042   35.196    0.000
##     indstr_ (.p3.)    2.047    0.054   37.751    0.000
##     ntnl_tt (.p4.)    1.545    0.042   36.405    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.181    0.037   31.943    0.000
##     gnrlhl_ (.p7.)    0.685    0.037   18.575    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.161    0.010   15.472    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.614    0.021  126.347    0.000
##    .rstrct_ (.19.)    1.312    0.027   49.058    0.000
##    .indstr_ (.20.)    2.219    0.035   64.026    0.000
##    .ntnl_tt (.21.)    1.890    0.027   69.152    0.000
```

```
##    .snttn_b (.22.)    3.492    0.014  252.895    0.000
##    .scl_bhv (.23.)    3.508    0.015  231.139    0.000
##    .gnrlhl_ (.24.)    2.097    0.018  117.419    0.000
##     attitud           0.000
##     behavir           0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.p8.)    0.691    0.018   38.704    0.000
##    .rstrct_ (.p9.)    0.752    0.022   34.104    0.000
##    .indstr_ (.10.)    0.744    0.030   25.186    0.000
##    .ntnl_tt (.11.)    0.652    0.021   31.285    0.000
##    .snttn_b (.12.)    0.229    0.009   25.126    0.000
##    .scl_bhv (.13.)    0.199    0.011   17.747    0.000
##    .gnrlhl_ (.14.)    0.921    0.022   41.532    0.000
##     attitud           0.422    0.024   17.343    0.000
##     behavir           0.200    0.011   17.373    0.000
##
##
## Group 2 [male]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.462    0.042   35.196    0.000
##     indstr_ (.p3.)    2.047    0.054   37.751    0.000
##     ntnl_tt (.p4.)    1.545    0.042   36.405    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.181    0.037   31.943    0.000
##     gnrlhl_ (.p7.)    0.685    0.037   18.575    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.189    0.013   14.996    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.614    0.021  126.347    0.000
##    .rstrct_ (.19.)    1.312    0.027   49.058    0.000
##    .indstr_ (.20.)    2.219    0.035   64.026    0.000
##    .ntnl_tt (.21.)    1.890    0.027   69.152    0.000
##    .snttn_b (.22.)    3.492    0.014  252.895    0.000
##    .scl_bhv (.23.)    3.508    0.015  231.139    0.000
##    .gnrlhl_ (.24.)    2.097    0.018  117.419    0.000
##     attitud          -0.204    0.023   -8.752    0.000
##     behavir          -0.222    0.020  -11.206    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.p8.)    0.691    0.018   38.704    0.000
##    .rstrct_ (.p9.)    0.752    0.022   34.104    0.000
```

```
##    .indstr_ (.10.)    0.744    0.030   25.186    0.000
##    .ntnl_tt (.11.)    0.652    0.021   31.285    0.000
##    .snttn_b (.12.)    0.229    0.009   25.126    0.000
##    .scl_bhv (.13.)    0.199    0.011   17.747    0.000
##    .gnrlhl_ (.14.)    0.921    0.022   41.532    0.000
##     attitud           0.408    0.024   17.080    0.000
##     behavir           0.325    0.018   18.165    0.000
```

```
lavInspect(fit_strict, what = "std")
```

```
## $female
## $female$lambda
##                         attitd behavr
## health_attitudes         0.615  0.000
## restriction_attitudes    0.738  0.000
## industry_attitudes       0.839  0.000
## national_attitudes       0.779  0.000
## sanitation_behavior      0.000  0.683
## social_behavior          0.000  0.764
## generalhealth_behavior   0.000  0.304
##
## $female$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.621
## restriction_attitudes   0.000  0.455
## industry_attitudes      0.000  0.000  0.296
## national_attitudes      0.000  0.000  0.000  0.393
## sanitation_behavior     0.000  0.000  0.000  0.000  0.534
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.417
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.908
##
## $female$psi
##           attitd behavr
## attitude 1.000
## behavior 0.556  1.000
##
## $female$nu
##                         intrcp
## health_attitudes         2.478
## restriction_attitudes    1.020
## industry_attitudes       1.400
## national_attitudes       1.468
## sanitation_behavior      5.337
## social_behavior          5.077
## generalhealth_behavior   2.082
##
## $female$alpha
##           intrcp
## attitude       0
## behavior       0
##
##
## $male
## $male$lambda
##                         attitd behavr
```

```
## health_attitudes        0.609  0.000
## restriction_attitudes   0.733  0.000
## industry_attitudes      0.835  0.000
## national_attitudes      0.774  0.000
## sanitation_behavior     0.000  0.766
## social_behavior         0.000  0.833
## generalhealth_behavior  0.000  0.377
##
## $male$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.629
## restriction_attitudes   0.000  0.463
## industry_attitudes      0.000  0.000  0.303
## national_attitudes      0.000  0.000  0.000  0.401
## sanitation_behavior     0.000  0.000  0.000  0.000  0.413
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.305
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.858
##
## $male$psi
##           attitd behavr
## attitude 1.000
## behavior 0.519  1.000
##
## $male$nu
##                         intrcp
## health_attitudes         2.493
## restriction_attitudes    1.030
## industry_attitudes       1.417
## national_attitudes       1.482
## sanitation_behavior      4.695
## social_behavior          4.345
## generalhealth_behavior   2.024
##
## $male$alpha
##           intrcp
## attitude -0.320
## behavior -0.389
```

Measuring Invariance by Country:

When we performed these group comparisons by country, we determined that the model followed a weak invariance model. Unlike the gender model, we witnessed a very large increase in RMSEA value from the weak model to the strong model (0.106 vs. 0.175, a 0.069 difference). This difference was much larger than our 90% confidence interval of 0.015. Additionally, we saw that CFI decreased from 0.927 to 0.758 (0.169 difference), and SRMR increased from 0.066 to 0.161 (0.095 difference) between the weak and strong model. Thus, we could not continue comparing the groups at the strict model. While the structure of test is similar, it functions differently in how each item loads onto each factor and their starting points differ slightly. Therefore, we can conclude that there is evidence that the survey is biased against countries.

```
fit_config <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "country")

summary(fit_config, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 65 iterations
```

```
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         66
##
##   Number of observations per group:
##     Italy                                          974
##     NZ                                             984
##     USA                                           1773
##
## Model Test User Model:
##
##   Test statistic                               632.262
##   Degrees of freedom                               39
##   P-value (Chi-square)                          0.000
##   Test statistic for each group:
##     Italy                                       82.478
##     NZ                                         155.999
##     USA                                        393.785
##
## Model Test Baseline Model:
##
##   Test statistic                              9410.101
##   Degrees of freedom                                63
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.937
##   Tucker-Lewis Index (TLI)                       0.897
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -33005.323
##   Loglikelihood unrestricted model (H1)     -32689.192
##
##   Akaike (AIC)                               66142.645
##   Bayesian (BIC)                             66553.458
##   Sample-size adjusted Bayesian (BIC)        66343.741
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.111
##   90 Percent confidence interval - lower         0.103
##   90 Percent confidence interval - upper         0.118
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.054
##
## Parameter Estimates:
##
##   Standard errors                             Standard
```

```
##   Information                                    Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [Italy]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
##     restrctn_tttds    1.632    0.077   21.070    0.000
##     industry_tttds    2.084    0.095   22.000    0.000
##     national_tttds    1.524    0.073   20.992    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    0.947    0.062   15.295    0.000
##     genrlhlth_bhvr    0.744    0.057   13.057    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.158    0.016   10.004    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.483    0.033   74.437    0.000
##    .restrctn_tttds    1.553    0.044   35.556    0.000
##    .industry_tttds    2.066    0.052   39.721    0.000
##    .national_tttds    2.022    0.041   49.278    0.000
##    .sanitatin_bhvr    3.451    0.020  169.848    0.000
##    .social_behavir    3.636    0.019  193.086    0.000
##    .genrlhlth_bhvr    2.707    0.021  126.551    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.622    0.031   19.965    0.000
##    .restrctn_tttds    0.631    0.039   16.268    0.000
##    .industry_tttds    0.631    0.050   12.726    0.000
##    .national_tttds    0.567    0.034   16.454    0.000
##    .sanitatin_bhvr    0.186    0.015   12.460    0.000
##    .social_behavir    0.152    0.013   11.702    0.000
##    .genrlhlth_bhvr    0.326    0.017   19.337    0.000
##     attitude          0.461    0.042   10.896    0.000
##     behavior          0.216    0.020   10.633    0.000
##
##
## Group 2 [NZ]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
```

```
##     restrctn_tttds    1.965    0.154   12.797    0.000
##     industry_tttds    2.828    0.211   13.405    0.000
##     national_tttds    1.884    0.148   12.690    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    0.955    0.116    8.271    0.000
##     genrlhlth_bhvr    0.260    0.069    3.750    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.086    0.012    7.475    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.631    0.024  110.487    0.000
##    .restrctn_tttds    1.138    0.038   30.006    0.000
##    .industry_tttds    2.439    0.047   52.194    0.000
##    .national_tttds    1.793    0.037   48.411    0.000
##    .sanitatin_bhvr    3.400    0.022  151.175    0.000
##    .social_behavir    3.370    0.023  145.355    0.000
##    .genrlhlth_bhvr    1.145    0.027   42.931    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.407    0.021   19.491    0.000
##    .restrctn_tttds    0.831    0.049   16.919    0.000
##    .industry_tttds    0.937    0.074   12.669    0.000
##    .national_tttds    0.812    0.047   17.247    0.000
##    .sanitatin_bhvr    0.254    0.031    8.303    0.000
##    .social_behavir    0.307    0.029   10.429    0.000
##    .genrlhlth_bhvr    0.683    0.031   21.897    0.000
##     attitude          0.151    0.020    7.610    0.000
##     behavior          0.244    0.034    7.094    0.000
##
##
## Group 3 [USA]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     health_attitds    1.000
##     restrctn_tttds    1.211    0.047   25.847    0.000
##     industry_tttds    1.825    0.063   28.793    0.000
##     national_tttds    1.395    0.051   27.344    0.000
##   behavior =~
##     sanitatin_bhvr    1.000
##     social_behavir    1.160    0.042   27.665    0.000
##     genrlhlth_bhvr    0.678    0.040   16.864    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##   attitude ~~
##     behavior          0.277    0.018   15.777    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.468    0.028   86.769    0.000
##    .restrctn_tttds    0.971    0.030   32.661    0.000
##    .industry_tttds    1.754    0.038   46.648    0.000
##    .national_tttds    1.550    0.032   48.940    0.000
##    .sanitatin_bhvr    3.339    0.018  189.108    0.000
##    .social_behavir    3.248    0.020  165.557    0.000
##    .genrlhlth_bhvr    2.136    0.022   96.006    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.848    0.031   26.983    0.000
##    .restrctn_tttds    0.706    0.029   24.695    0.000
##    .industry_tttds    0.554    0.036   15.251    0.000
##    .national_tttds    0.637    0.029   22.011    0.000
##    .sanitatin_bhvr    0.194    0.013   15.469    0.000
##    .social_behavir    0.200    0.016   12.597    0.000
##    .genrlhlth_bhvr    0.712    0.025   28.354    0.000
##     attitude          0.587    0.041   14.282    0.000
##     behavior          0.358    0.020   17.552    0.000
```

```
lavInspect(fit_config, what = "std")
```

```
## $Italy
## $Italy$lambda
##                        attitd behavr
## health_attitudes        0.652  0.000
## restriction_attitudes   0.813  0.000
## industry_attitudes      0.872  0.000
## national_attitudes      0.809  0.000
## sanitation_behavior     0.000  0.733
## social_behavior         0.000  0.749
## generalhealth_behavior  0.000  0.518
##
## $Italy$theta
##                        hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.574
## restriction_attitudes  0.000  0.339
## industry_attitudes     0.000  0.000  0.240
## national_attitudes     0.000  0.000  0.000  0.346
## sanitation_behavior    0.000  0.000  0.000  0.000  0.463
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.440
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.731
##
## $Italy$psi
##          attitd behavr
## attitude 1.000
## behavior 0.501  1.000
##
```

```
## $Italy$nu
##                         intrcp
## health_attitudes         2.385
## restriction_attitudes    1.139
## industry_attitudes       1.273
## national_attitudes       1.579
## sanitation_behavior      5.442
## social_behavior          6.187
## generalhealth_behavior   4.055
##
## $Italy$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $NZ
## $NZ$lambda
##                         attitd behavr
## health_attitudes         0.521  0.000
## restriction_attitudes    0.643  0.000
## industry_attitudes       0.751  0.000
## national_attitudes       0.631  0.000
## sanitation_behavior      0.000  0.699
## social_behavior          0.000  0.648
## generalhealth_behavior   0.000  0.153
##
## $NZ$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.729
## restriction_attitudes   0.000  0.587
## industry_attitudes      0.000  0.000  0.436
## national_attitudes      0.000  0.000  0.000  0.602
## sanitation_behavior     0.000  0.000  0.000  0.000  0.511
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.580
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.977
##
## $NZ$psi
##          attitd behavr
## attitude 1.000
## behavior 0.449  1.000
##
## $NZ$nu
##                         intrcp
## health_attitudes         3.522
## restriction_attitudes    0.957
## industry_attitudes       1.664
## national_attitudes       1.543
## sanitation_behavior      4.819
## social_behavior          4.634
## generalhealth_behavior   1.369
##
## $NZ$alpha
##          intrcp
```

```
## attitude      0
## behavior      0
##
##
## $USA
## $USA$lambda
##                         attitd behavr
## health_attitudes         0.639  0.000
## restriction_attitudes    0.741  0.000
## industry_attitudes       0.883  0.000
## national_attitudes       0.801  0.000
## sanitation_behavior      0.000  0.805
## social_behavior          0.000  0.841
## generalhealth_behavior   0.000  0.434
##
## $USA$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.591
## restriction_attitudes   0.000  0.451
## industry_attitudes      0.000  0.000  0.221
## national_attitudes      0.000  0.000  0.000  0.358
## sanitation_behavior     0.000  0.000  0.000  0.000  0.351
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.293
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.812
##
## $USA$psi
##          attitd behavr
## attitude 1.000
## behavior 0.603  1.000
##
## $USA$nu
##                         intrcp
## health_attitudes         2.061
## restriction_attitudes    0.776
## industry_attitudes       1.108
## national_attitudes       1.162
## sanitation_behavior      4.491
## social_behavior          3.932
## generalhealth_behavior   2.280
##
## $USA$alpha
##          intrcp
## attitude      0
## behavior      0
```

```
fit_weak <- cfa(covid.model_2,
                data = covidgender_meas_inv,
                group = "country",
                group.equal = c("loadings")
                )

summary(fit_weak, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 42 iterations
##
```

```
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         66
##   Number of equality constraints                    10
##
##   Number of observations per group:
##     Italy                                          974
##     NZ                                             984
##     USA                                           1773
##
## Model Test User Model:
##
##   Test statistic                               730.347
##   Degrees of freedom                                49
##   P-value (Chi-square)                           0.000
##   Test statistic for each group:
##     Italy                                      107.607
##     NZ                                         203.938
##     USA                                        418.801
##
## Model Test Baseline Model:
##
##   Test statistic                              9410.101
##   Degrees of freedom                                63
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.927
##   Tucker-Lewis Index (TLI)                       0.906
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -33054.365
##   Loglikelihood unrestricted model (H1)     -32689.192
##
##   Akaike (AIC)                               66220.730
##   Bayesian (BIC)                             66569.298
##   Sample-size adjusted Bayesian (BIC)        66391.357
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.106
##   90 Percent confidence interval - lower         0.099
##   90 Percent confidence interval - upper         0.113
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.066
##
## Parameter Estimates:
##
##   Standard errors                             Standard
```

```
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [Italy]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
##     rstrct_ (.p2.)   1.459    0.042   35.036    0.000
##     indstr_ (.p3.)   2.056    0.055   37.690    0.000
##     ntnl_tt (.p4.)   1.536    0.043   36.046    0.000
##   behavior =~
##     snttn_b          1.000
##     scl_bhv (.p6.)   1.105    0.034   32.357    0.000
##     gnrlhl_ (.p7.)   0.648    0.030   21.346    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior         0.151    0.014   11.021    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds   2.483    0.034   73.701    0.000
##    .restrctn_tttds   1.553    0.042   37.054    0.000
##    .industry_tttds   2.066    0.052   39.381    0.000
##    .national_tttds   2.022    0.042   48.396    0.000
##    .sanitatin_bhvr   3.451    0.020  171.624    0.000
##    .social_behavir   3.636    0.019  189.587    0.000
##    .genrlhlth_bhvr   2.707    0.021  129.677    0.000
##     attitude         0.000
##     behavior         0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds   0.618    0.031   19.986    0.000
##    .restrctn_tttds   0.676    0.038   17.918    0.000
##    .industry_tttds   0.621    0.048   13.042    0.000
##    .national_tttds   0.552    0.034   16.301    0.000
##    .sanitatin_bhvr   0.203    0.013   16.014    0.000
##    .social_behavir   0.126    0.012   10.663    0.000
##    .genrlhlth_bhvr   0.344    0.017   20.725    0.000
##     attitude         0.487    0.033   14.752    0.000
##     behavior         0.191    0.014   13.844    0.000
##
##
## Group 2 [NZ]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
```

```
##     rstrct_ (.p2.)    1.459    0.042   35.036    0.000
##     indstr_ (.p3.)    2.056    0.055   37.690    0.000
##     ntnl_tt (.p4.)    1.536    0.043   36.046    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.105    0.034   32.357    0.000
##     gnrlhl_ (.p7.)    0.648    0.030   21.346    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.098    0.011    9.123    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.631    0.025  104.690    0.000
##    .restrctn_tttds    1.138    0.037   30.642    0.000
##    .industry_tttds    2.439    0.046   53.551    0.000
##    .national_tttds    1.793    0.037   48.323    0.000
##    .sanitatin_bhvr    3.400    0.022  153.710    0.000
##    .social_behavir    3.370    0.023  146.176    0.000
##    .genrlhlth_bhvr    1.145    0.028   41.465    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.386    0.021   18.473    0.000
##    .restrctn_tttds    0.857    0.046   18.727    0.000
##    .industry_tttds    1.047    0.063   16.493    0.000
##    .national_tttds    0.800    0.044   18.061    0.000
##    .sanitatin_bhvr    0.296    0.018   16.036    0.000
##    .social_behavir    0.297    0.020   14.552    0.000
##    .genrlhlth_bhvr    0.672    0.032   21.143    0.000
##     attitude          0.235    0.017   13.729    0.000
##     behavior          0.185    0.016   11.575    0.000
##
##
## Group 3 [USA]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.459    0.042   35.036    0.000
##     indstr_ (.p3.)    2.056    0.055   37.690    0.000
##     ntnl_tt (.p4.)    1.536    0.043   36.046    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.105    0.034   32.357    0.000
##     gnrlhl_ (.p7.)    0.648    0.030   21.346    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
```

```
##   attitude ~~
##     behavior          0.251    0.015   16.811    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    2.468    0.027   89.846    0.000
##    .restrctn_tttds    0.971    0.031   31.591    0.000
##    .industry_tttds    1.754    0.038   46.563    0.000
##    .national_tttds    1.550    0.031   49.512    0.000
##    .sanitatin_bhvr    3.339    0.018  187.457    0.000
##    .social_behavir    3.248    0.019  166.729    0.000
##    .genrlhlth_bhvr    2.136    0.022   96.308    0.000
##     attitude          0.000
##     behavior          0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.874    0.031   27.786    0.000
##    .restrctn_tttds    0.686    0.029   24.032    0.000
##    .industry_tttds    0.553    0.035   15.832    0.000
##    .national_tttds    0.643    0.028   22.885    0.000
##    .sanitatin_bhvr    0.185    0.012   15.124    0.000
##    .social_behavir    0.212    0.015   14.419    0.000
##    .genrlhlth_bhvr    0.713    0.025   28.496    0.000
##     attitude          0.464    0.028   16.757    0.000
##     behavior          0.378    0.020   19.075    0.000
```

```
lavInspect(fit_weak, what = "std")
```

```
## $Italy
## $Italy$lambda
##                        attitd behavr
## health_attitudes        0.664  0.000
## restriction_attitudes   0.778  0.000
## industry_attitudes      0.876  0.000
## national_attitudes      0.822  0.000
## sanitation_behavior     0.000  0.696
## social_behavior         0.000  0.806
## generalhealth_behavior  0.000  0.434
##
## $Italy$theta
##                        hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.560
## restriction_attitudes  0.000  0.395
## industry_attitudes     0.000  0.000  0.232
## national_attitudes     0.000  0.000  0.000  0.325
## sanitation_behavior    0.000  0.000  0.000  0.000  0.516
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.351
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.811
##
## $Italy$psi
##          attitd behavr
## attitude 1.000
## behavior 0.495  1.000
##
```

```
## $Italy$nu
##                         intrcp
## health_attitudes         2.362
## restriction_attitudes    1.187
## industry_attitudes       1.262
## national_attitudes       1.551
## sanitation_behavior      5.499
## social_behavior          6.075
## generalhealth_behavior   4.155
##
## $Italy$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $NZ
## $NZ$lambda
##                         attitd behavr
## health_attitudes         0.615  0.000
## restriction_attitudes    0.607  0.000
## industry_attitudes       0.698  0.000
## national_attitudes       0.640  0.000
## sanitation_behavior      0.000  0.620
## social_behavior          0.000  0.658
## generalhealth_behavior   0.000  0.322
##
## $NZ$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.622
## restriction_attitudes   0.000  0.632
## industry_attitudes      0.000  0.000  0.513
## national_attitudes      0.000  0.000  0.000  0.591
## sanitation_behavior     0.000  0.000  0.000  0.000  0.615
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.567
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.896
##
## $NZ$psi
##          attitd behavr
## attitude 1.000
## behavior 0.471  1.000
##
## $NZ$nu
##                         intrcp
## health_attitudes         3.337
## restriction_attitudes    0.977
## industry_attitudes       1.707
## national_attitudes       1.540
## sanitation_behavior      4.900
## social_behavior          4.660
## generalhealth_behavior   1.322
##
## $NZ$alpha
##          intrcp
```

```
## attitude      0
## behavior      0
##
##
## $USA
## $USA$lambda
##                         attitd behavr
## health_attitudes         0.589  0.000
## restriction_attitudes    0.768  0.000
## industry_attitudes       0.883  0.000
## national_attitudes       0.794  0.000
## sanitation_behavior      0.000  0.819
## social_behavior          0.000  0.828
## generalhealth_behavior   0.000  0.427
##
## $USA$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.653
## restriction_attitudes   0.000  0.410
## industry_attitudes      0.000  0.000  0.220
## national_attitudes      0.000  0.000  0.000  0.370
## sanitation_behavior     0.000  0.000  0.000  0.000  0.329
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.315
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.818
##
## $USA$psi
##          attitd behavr
## attitude 1.0
## behavior 0.6    1.0
##
## $USA$nu
##                         intrcp
## health_attitudes         2.134
## restriction_attitudes    0.750
## industry_attitudes       1.106
## national_attitudes       1.176
## sanitation_behavior      4.452
## social_behavior          3.960
## generalhealth_behavior   2.287
##
## $USA$alpha
##          intrcp
## attitude      0
## behavior      0
```

```
fit_strong <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "country",
                  group.equal = c("loadings", "intercepts")
                  )

summary(fit_strong, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 64 iterations
##
```

```
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         70
##   Number of equality constraints                    24
##
##   Number of observations per group:
##     Italy                                          974
##     NZ                                             984
##     USA                                           1773
##
## Model Test User Model:
##
##   Test statistic                              2318.916
##   Degrees of freedom                                59
##   P-value (Chi-square)                           0.000
##   Test statistic for each group:
##     Italy                                      547.588
##     NZ                                        1294.244
##     USA                                        477.084
##
## Model Test Baseline Model:
##
##   Test statistic                              9410.101
##   Degrees of freedom                                63
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.758
##   Tucker-Lewis Index (TLI)                       0.742
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -33848.650
##   Loglikelihood unrestricted model (H1)     -32689.192
##
##   Akaike (AIC)                               67789.300
##   Bayesian (BIC)                             68075.623
##   Sample-size adjusted Bayesian (BIC)        67929.458
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.175
##   90 Percent confidence interval - lower         0.169
##   90 Percent confidence interval - upper         0.182
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.161
##
## Parameter Estimates:
##
##   Standard errors                             Standard
```

```
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [Italy]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
##     rstrct_ (.p2.)   1.485    0.043   34.789    0.000
##     indstr_ (.p3.)   2.072    0.056   37.326    0.000
##     ntnl_tt (.p4.)   1.570    0.044   35.953    0.000
##   behavior =~
##     snttn_b          1.000
##     scl_bhv (.p6.)   1.223    0.036   34.335    0.000
##     gnrlhl_ (.p7.)   0.875    0.035   24.883    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior         0.136    0.012   11.019    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)   2.622    0.027   98.584    0.000
##    .rstrct_ (.19.)   1.343    0.037   36.133    0.000
##    .indstr_ (.20.)   2.225    0.050   44.682    0.000
##    .ntnl_tt (.21.)   1.925    0.038   50.073    0.000
##    .snttn_b (.22.)   3.595    0.017  210.063    0.000
##    .scl_bhv (.23.)   3.636    0.018  197.764    0.000
##    .gnrlhl_ (.24.)   2.427    0.019  128.582    0.000
##     attitud          0.000
##     behavir          0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds   0.638    0.032   20.006    0.000
##    .restrctn_tttds   0.736    0.041   18.058    0.000
##    .industry_tttds   0.683    0.050   13.535    0.000
##    .national_tttds   0.552    0.035   15.916    0.000
##    .sanitatin_bhvr   0.247    0.014   18.087    0.000
##    .social_behavir   0.117    0.012    9.718    0.000
##    .genrlhlth_bhvr   0.425    0.021   20.396    0.000
##     attitude         0.470    0.032   14.621    0.000
##     behavior         0.156    0.012   13.367    0.000
##
##
## Group 2 [NZ]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
```

```
##     rstrct_ (.p2.)    1.485    0.043   34.789    0.000
##     indstr_ (.p3.)    2.072    0.056   37.326    0.000
##     ntnl_tt (.p4.)    1.570    0.044   35.953    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.223    0.036   34.335    0.000
##     gnrlhl_ (.p7.)    0.875    0.035   24.883    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.090    0.010    8.922    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.622    0.027   98.584    0.000
##    .rstrct_ (.19.)    1.343    0.037   36.133    0.000
##    .indstr_ (.20.)    2.225    0.050   44.682    0.000
##    .ntnl_tt (.21.)    1.925    0.038   50.073    0.000
##    .snttn_b (.22.)    3.595    0.017  210.063    0.000
##    .scl_bhv (.23.)    3.636    0.018  197.764    0.000
##    .gnrlhl_ (.24.)    2.427    0.019  128.582    0.000
##     attitud          -0.015    0.029   -0.522    0.602
##     behavir          -0.268    0.023  -11.630    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.384    0.021   18.431    0.000
##    .restrctn_tttds    0.905    0.048   18.784    0.000
##    .industry_tttds    1.150    0.068   16.924    0.000
##    .national_tttds    0.811    0.045   17.919    0.000
##    .sanitatin_bhvr    0.314    0.018   17.022    0.000
##    .social_behavir    0.282    0.021   13.139    0.000
##    .genrlhlth_bhvr    1.827    0.085   21.579    0.000
##     attitude          0.225    0.017   13.537    0.000
##     behavior          0.165    0.015   11.363    0.000
##
##
## Group 3 [USA]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.485    0.043   34.789    0.000
##     indstr_ (.p3.)    2.072    0.056   37.326    0.000
##     ntnl_tt (.p4.)    1.570    0.044   35.953    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.223    0.036   34.335    0.000
##     gnrlhl_ (.p7.)    0.875    0.035   24.883    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##   attitude ~~
##     behavior          0.232    0.014   16.751    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.622    0.027   98.584    0.000
##    .rstrct_ (.19.)    1.343    0.037   36.133    0.000
##    .indstr_ (.20.)    2.225    0.050   44.682    0.000
##    .ntnl_tt (.21.)    1.925    0.038   50.073    0.000
##    .snttn_b (.22.)    3.595    0.017  210.063    0.000
##    .scl_bhv (.23.)    3.636    0.018  197.764    0.000
##    .gnrlhl_ (.24.)    2.427    0.019  128.582    0.000
##     attitud          -0.230    0.029   -7.789    0.000
##     behavir          -0.297    0.022  -13.573    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .health_attitds    0.885    0.032   27.857    0.000
##    .restrctn_tttds    0.683    0.029   23.938    0.000
##    .industry_tttds    0.565    0.035   16.191    0.000
##    .national_tttds    0.636    0.028   22.672    0.000
##    .sanitatin_bhvr    0.211    0.011   18.771    0.000
##    .social_behavir    0.200    0.014   13.787    0.000
##    .genrlhlth_bhvr    0.701    0.025   27.654    0.000
##     attitude          0.452    0.027   16.628    0.000
##     behavior          0.323    0.017   18.644    0.000
```

```
lavInspect(fit_strong, what = "std")
```

```
## $Italy
## $Italy$lambda
##                         attitd behavr
## health_attitudes         0.651  0.000
## restriction_attitudes    0.765  0.000
## industry_attitudes       0.864  0.000
## national_attitudes       0.823  0.000
## sanitation_behavior      0.000  0.621
## social_behavior          0.000  0.816
## generalhealth_behavior   0.000  0.468
##
## $Italy$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.576
## restriction_attitudes   0.000  0.415
## industry_attitudes      0.000  0.000  0.253
## national_attitudes      0.000  0.000  0.000  0.323
## sanitation_behavior     0.000  0.000  0.000  0.000  0.614
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.334
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.781
##
## $Italy$psi
##          attitd behavr
## attitude 1.000
## behavior 0.502  1.000
##
```

```
## $Italy$nu
##                         intrcp
## health_attitudes         2.491
## restriction_attitudes    1.009
## industry_attitudes       1.354
## national_attitudes       1.472
## sanitation_behavior      5.663
## social_behavior          6.150
## generalhealth_behavior   3.291
##
## $Italy$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $NZ
## $NZ$lambda
##                         attitd behavr
## health_attitudes         0.608  0.000
## restriction_attitudes    0.595  0.000
## industry_attitudes       0.675  0.000
## national_attitudes       0.637  0.000
## sanitation_behavior      0.000  0.588
## social_behavior          0.000  0.684
## generalhealth_behavior   0.000  0.255
##
## $NZ$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.631
## restriction_attitudes   0.000  0.646
## industry_attitudes      0.000  0.000  0.544
## national_attitudes      0.000  0.000  0.000  0.594
## sanitation_behavior     0.000  0.000  0.000  0.000  0.655
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.533
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.935
##
## $NZ$psi
##          attitd behavr
## attitude 1.000
## behavior 0.465  1.000
##
## $NZ$nu
##                         intrcp
## health_attitudes         3.362
## restriction_attitudes    1.135
## industry_attitudes       1.530
## national_attitudes       1.647
## sanitation_behavior      5.192
## social_behavior          4.995
## generalhealth_behavior   1.736
##
## $NZ$alpha
##          intrcp
```

```
## attitude -0.032
## behavior -0.659
##
##
## $USA
## $USA$lambda
##                         attitd behavr
## health_attitudes         0.582  0.000
## restriction_attitudes    0.770  0.000
## industry_attitudes       0.880  0.000
## national_attitudes       0.798  0.000
## sanitation_behavior      0.000  0.777
## social_behavior          0.000  0.841
## generalhealth_behavior   0.000  0.510
##
## $USA$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.662
## restriction_attitudes   0.000  0.407
## industry_attitudes      0.000  0.000  0.225
## national_attitudes      0.000  0.000  0.000  0.363
## sanitation_behavior     0.000  0.000  0.000  0.000  0.396
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.293
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.740
##
## $USA$psi
##          attitd behavr
## attitude 1.000
## behavior 0.609  1.000
##
## $USA$nu
##                         intrcp
## health_attitudes         2.268
## restriction_attitudes    1.036
## industry_attitudes       1.405
## national_attitudes       1.455
## sanitation_behavior      4.920
## social_behavior          4.401
## generalhealth_behavior   2.492
##
## $USA$alpha
##          intrcp
## attitude -0.341
## behavior -0.523
```

```
fit_strict <- cfa(covid.model_2,
                  data = covidgender_meas_inv,
                  group = "country",
                  group.equal = c("loadings", "intercepts", "residuals")
                  )

summary(fit_strict, fit.measures=TRUE)
```

```
## lavaan 0.6-7 ended normally after 56 iterations
##
```

```
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of free parameters                         70
##   Number of equality constraints                    38
##
##   Number of observations per group:
##     Italy                                          974
##     NZ                                             984
##     USA                                           1773
##
## Model Test User Model:
##
##   Test statistic                              3055.425
##   Degrees of freedom                                73
##   P-value (Chi-square)                           0.000
##   Test statistic for each group:
##     Italy                                     1022.158
##     NZ                                        1374.098
##     USA                                        659.169
##
## Model Test Baseline Model:
##
##   Test statistic                              9410.101
##   Degrees of freedom                                63
##   P-value                                        0.000
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                    0.681
##   Tucker-Lewis Index (TLI)                       0.725
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -34216.904
##   Loglikelihood unrestricted model (H1)     -32689.192
##
##   Akaike (AIC)                               68497.809
##   Bayesian (BIC)                             68696.990
##   Sample-size adjusted Bayesian (BIC)        68595.310
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.181
##   90 Percent confidence interval - lower         0.176
##   90 Percent confidence interval - upper         0.187
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.175
##
## Parameter Estimates:
##
##   Standard errors                             Standard
```

```
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
##
## Group 1 [Italy]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
##     rstrct_ (.p2.)   1.453    0.041   35.366    0.000
##     indstr_ (.p3.)   2.041    0.054   38.059    0.000
##     ntnl_tt (.p4.)   1.534    0.042   36.585    0.000
##   behavior =~
##     snttn_b          1.000
##     scl_bhv (.p6.)   1.272    0.039   32.512    0.000
##     gnrlhl_ (.p7.)   0.791    0.039   20.375    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior         0.134    0.012   10.833    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)   2.626    0.027   96.513    0.000
##    .rstrct_ (.19.)   1.329    0.037   35.892    0.000
##    .indstr_ (.20.)   2.243    0.050   44.900    0.000
##    .ntnl_tt (.21.)   1.908    0.038   49.643    0.000
##    .snttn_b (.22.)   3.580    0.017  214.798    0.000
##    .scl_bhv (.23.)   3.630    0.019  189.844    0.000
##    .gnrlhl_ (.24.)   2.178    0.020  107.888    0.000
##     attitud          0.000
##     behavir          0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.p8.)   0.688    0.018   38.700    0.000
##    .rstrct_ (.p9.)   0.755    0.022   34.302    0.000
##    .indstr_ (.10.)   0.739    0.029   25.286    0.000
##    .ntnl_tt (.11.)   0.658    0.021   31.622    0.000
##    .snttn_b (.12.)   0.254    0.009   29.051    0.000
##    .scl_bhv (.13.)   0.179    0.011   16.201    0.000
##    .gnrlhl_ (.14.)   0.895    0.022   41.200    0.000
##     attitud          0.481    0.033   14.756    0.000
##     behavir          0.133    0.011   12.693    0.000
##
##
## Group 2 [NZ]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt          1.000
```

```
##     rstrct_ (.p2.)    1.453    0.041   35.366    0.000
##     indstr_ (.p3.)    2.041    0.054   38.059    0.000
##     ntnl_tt (.p4.)    1.534    0.042   36.585    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.272    0.039   32.512    0.000
##     gnrlhl_ (.p7.)    0.791    0.039   20.375    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude ~~
##     behavior          0.088    0.010    8.525    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.626    0.027   96.513    0.000
##    .rstrct_ (.19.)    1.329    0.037   35.892    0.000
##    .indstr_ (.20.)    2.243    0.050   44.900    0.000
##    .ntnl_tt (.21.)    1.908    0.038   49.643    0.000
##    .snttn_b (.22.)    3.580    0.017  214.798    0.000
##    .scl_bhv (.23.)    3.630    0.019  189.844    0.000
##    .gnrlhl_ (.24.)    2.178    0.020  107.888    0.000
##     attitud          -0.006    0.030   -0.211    0.833
##     behavir          -0.254    0.023  -11.253    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.p8.)    0.688    0.018   38.700    0.000
##    .rstrct_ (.p9.)    0.755    0.022   34.302    0.000
##    .indstr_ (.10.)    0.739    0.029   25.286    0.000
##    .ntnl_tt (.11.)    0.658    0.021   31.622    0.000
##    .snttn_b (.12.)    0.254    0.009   29.051    0.000
##    .scl_bhv (.13.)    0.179    0.011   16.201    0.000
##    .gnrlhl_ (.14.)    0.895    0.022   41.200    0.000
##     attitud           0.266    0.019   13.896    0.000
##     behavir           0.190    0.014   13.800    0.000
##
##
## Group 3 [USA]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   attitude =~
##     hlth_tt           1.000
##     rstrct_ (.p2.)    1.453    0.041   35.366    0.000
##     indstr_ (.p3.)    2.041    0.054   38.059    0.000
##     ntnl_tt (.p4.)    1.534    0.042   36.585    0.000
##   behavior =~
##     snttn_b           1.000
##     scl_bhv (.p6.)    1.272    0.039   32.512    0.000
##     gnrlhl_ (.p7.)    0.791    0.039   20.375    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##   attitude ~~
##     behavior          0.232    0.014   16.538    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.18.)    2.626    0.027   96.513    0.000
##    .rstrct_ (.19.)    1.329    0.037   35.892    0.000
##    .indstr_ (.20.)    2.243    0.050   44.900    0.000
##    .ntnl_tt (.21.)    1.908    0.038   49.643    0.000
##    .snttn_b (.22.)    3.580    0.017  214.798    0.000
##    .scl_bhv (.23.)    3.630    0.019  189.844    0.000
##    .gnrlhl_ (.24.)    2.178    0.020  107.888    0.000
##     attitud          -0.230    0.030   -7.687    0.000
##     behavir          -0.271    0.022  -12.592    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .hlth_tt (.p8.)    0.688    0.018   38.700    0.000
##    .rstrct_ (.p9.)    0.755    0.022   34.302    0.000
##    .indstr_ (.10.)    0.739    0.029   25.286    0.000
##    .ntnl_tt (.11.)    0.658    0.021   31.622    0.000
##    .snttn_b (.12.)    0.254    0.009   29.051    0.000
##    .scl_bhv (.13.)    0.179    0.011   16.201    0.000
##    .gnrlhl_ (.14.)    0.895    0.022   41.200    0.000
##     attitud           0.464    0.027   17.216    0.000
##     behavir           0.313    0.018   17.680    0.000
```

```
lavInspect(fit_strict, what = "std")
```

```
## $Italy
## $Italy$lambda
##                        attitd behavr
## health_attitudes        0.642  0.000
## restriction_attitudes   0.757  0.000
## industry_attitudes      0.855  0.000
## national_attitudes      0.795  0.000
## sanitation_behavior     0.000  0.587
## social_behavior         0.000  0.739
## generalhealth_behavior  0.000  0.292
##
## $Italy$theta
##                        hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes       0.588
## restriction_attitudes  0.000  0.426
## industry_attitudes     0.000  0.000  0.269
## national_attitudes     0.000  0.000  0.000  0.367
## sanitation_behavior    0.000  0.000  0.000  0.000  0.656
## social_behavior        0.000  0.000  0.000  0.000  0.000  0.453
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.915
##
## $Italy$psi
##          attitd behavr
## attitude 1.000
## behavior 0.528  1.000
##
```

```
## $Italy$nu
##                         intrcp
## health_attitudes         2.429
## restriction_attitudes    0.998
## industry_attitudes       1.354
## national_attitudes       1.426
## sanitation_behavior      5.753
## social_behavior          5.776
## generalhealth_behavior   2.202
##
## $Italy$alpha
##          intrcp
## attitude      0
## behavior      0
##
##
## $NZ
## $NZ$lambda
##                         attitd behavr
## health_attitudes         0.528  0.000
## restriction_attitudes    0.653  0.000
## industry_attitudes       0.774  0.000
## national_attitudes       0.698  0.000
## sanitation_behavior      0.000  0.654
## social_behavior          0.000  0.795
## generalhealth_behavior   0.000  0.342
##
## $NZ$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.721
## restriction_attitudes   0.000  0.574
## industry_attitudes      0.000  0.000  0.400
## national_attitudes      0.000  0.000  0.000  0.513
## sanitation_behavior     0.000  0.000  0.000  0.000  0.572
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.368
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.883
##
## $NZ$psi
##          attitd behavr
## attitude 1.00
## behavior 0.39   1.00
##
## $NZ$nu
##                         intrcp
## health_attitudes         2.690
## restriction_attitudes    1.158
## industry_attitudes       1.651
## national_attitudes       1.684
## sanitation_behavior      5.373
## social_behavior          5.203
## generalhealth_behavior   2.164
##
## $NZ$alpha
##          intrcp
```

```
## attitude -0.012
## behavior -0.582
##
##
## $USA
## $USA$lambda
##                         attitd behavr
## health_attitudes         0.635  0.000
## restriction_attitudes    0.752  0.000
## industry_attitudes       0.851  0.000
## national_attitudes       0.790  0.000
## sanitation_behavior      0.000  0.743
## social_behavior          0.000  0.860
## generalhealth_behavior   0.000  0.424
##
## $USA$theta
##                         hlth_t rstrc_ indst_ ntnl_t snttn_ scl_bh gnrlh_
## health_attitudes        0.597
## restriction_attitudes   0.000  0.435
## industry_attitudes      0.000  0.000  0.277
## national_attitudes      0.000  0.000  0.000  0.376
## sanitation_behavior     0.000  0.000  0.000  0.000  0.448
## social_behavior         0.000  0.000  0.000  0.000  0.000  0.261
## generalhealth_behavior 0.000  0.000  0.000  0.000  0.000  0.000  0.821
##
## $USA$psi
##          attitd behavr
## attitude 1.00
## behavior 0.61   1.00
##
## $USA$nu
##                         intrcp
## health_attitudes         2.447
## restriction_attitudes    1.009
## industry_attitudes       1.372
## national_attitudes       1.442
## sanitation_behavior      4.755
## social_behavior          4.384
## generalhealth_behavior   2.086
##
## $USA$alpha
##          intrcp
## attitude -0.338
## behavior -0.484
```

Ethical Considerations

We also had to consider many ethical factors when performing this data analysis. We had to address the biases that exist from us, the data analysts, as well as the survey data itself. For example, some of our bias is present by the data that we selected from the survey. The two researchers have demographic differences, gender differences, and represent different fields of study, but both of them are from the United States. Thus, there is some diversity in terms of opinion and background, but both researchers experience some bias by factors such as the media outlets from the United States and how they portray the COVID-19 Pandemic

within the US, as well as in other countries.

Additionally, we were wary of the potential bias of the survey items that measure attitude. All of the survey questions pertaining to attitude began with the phrase "Do you agree with." This could potentially be a leading question for the survey takers, which could lead to dishonesty or other types of issues in the survey results. We also had to remove attitudes that focused on travel restrictions from our analysis because some of the questions were region specific (i.e. US borders, EU border) and could not be compared across countries.

We also had to consider the ethics and rights of the individuals taking the survey and how their information would be used and handled. First, the user data was protected because participants were given unique identification numbers, and they also had the right to remove their data from the analysis. Also, contact information from the team that initially collected the data and the team that is using the data for data analysis is available to address any concerns about the ethical behavior of the data study.

Graphs for Layperson Audience

Finally, we have created bar graphs that are easy to read and interpret for a wide audience. These graphs show data that can be used to answer our two research questions. We needed to create new data sets that calculated the mean values of the latent variables when grouped by country or by sex. The mean value would be an easy score for an audience to interpret and be able to compare across different groups. Thus, we have four new datasets with which we can create effective bar graphs.

```
attitude_country_means <- attitude_scores %>%
  group_by(country) %>%
  summarize(
    HealthAttitudes = mean(health_attitudes),
    RestrictionAttitudes = mean(restriction_attitudes),
    IndustryAttitudes = mean(industry_attitudes),
    NationalAttitudes = mean(national_attitudes)
  ) %>%
  pivot_longer(2:5, names_to = "stat", values_to = "value")

attitude_sex_means <- attitude_scores %>%
  group_by(sex) %>%
  summarize(
    HealthAttitudes = mean(health_attitudes),
    RestrictionAttitudes = mean(restriction_attitudes),
    IndustryAttitudes = mean(industry_attitudes),
    NationalAttitudes = mean(national_attitudes)
  ) %>%
  pivot_longer(2:5, names_to = "stat", values_to = "value")



behavior_country_means <- behavior_scores %>%
  group_by(country) %>%
  summarize(
    SanitationBehavior = mean(sanitation_behavior),
    SocialBehavior = mean(social_behavior),
    GeneralHealthBehavior = mean(generalhealth_behavior),
  ) %>%
  pivot_longer(2:4, names_to = "stat", values_to = "value")

behavior_sex_means <- behavior_scores %>%
```

```
  group_by(sex) %>%
  summarize(
    SanitationBehavior = mean(sanitation_behavior),
    SocialBehavior = mean(social_behavior),
    GeneralHealthBehavior = mean(generalhealth_behavior),
  ) %>%
  pivot_longer(2:4, names_to = "stat", values_to = "value")
```

First we will analyze the results about differences in attitudes and behaviors between countries.

When looking at the bar chart of the agreeableness in attitudes across country, we can see that the USA has the lowest attitude score in all four latent variables compared to Italy and New Zealand. This means that individuals from the US are generally less agreeable towards attitudes developed during the COVID-19 pandemic than individuals from Italy or New Zealand. Italy had higher scores in *NationalAttitudes* and *RestrictionAttitudes*, and New Zealand had higher scores in *HealthAttitudes* and *IndustryAttitudes*. This could correlate with the handling of the virus thus far. The US has had a much higher proportion of the population have COVID-19 compared to the other two countries. In comparison, New Zealand was viewed as a country that handled the pandemic very well, while Italy had a large outbreak at the beginning of the pandemic, but were able to control their cases.

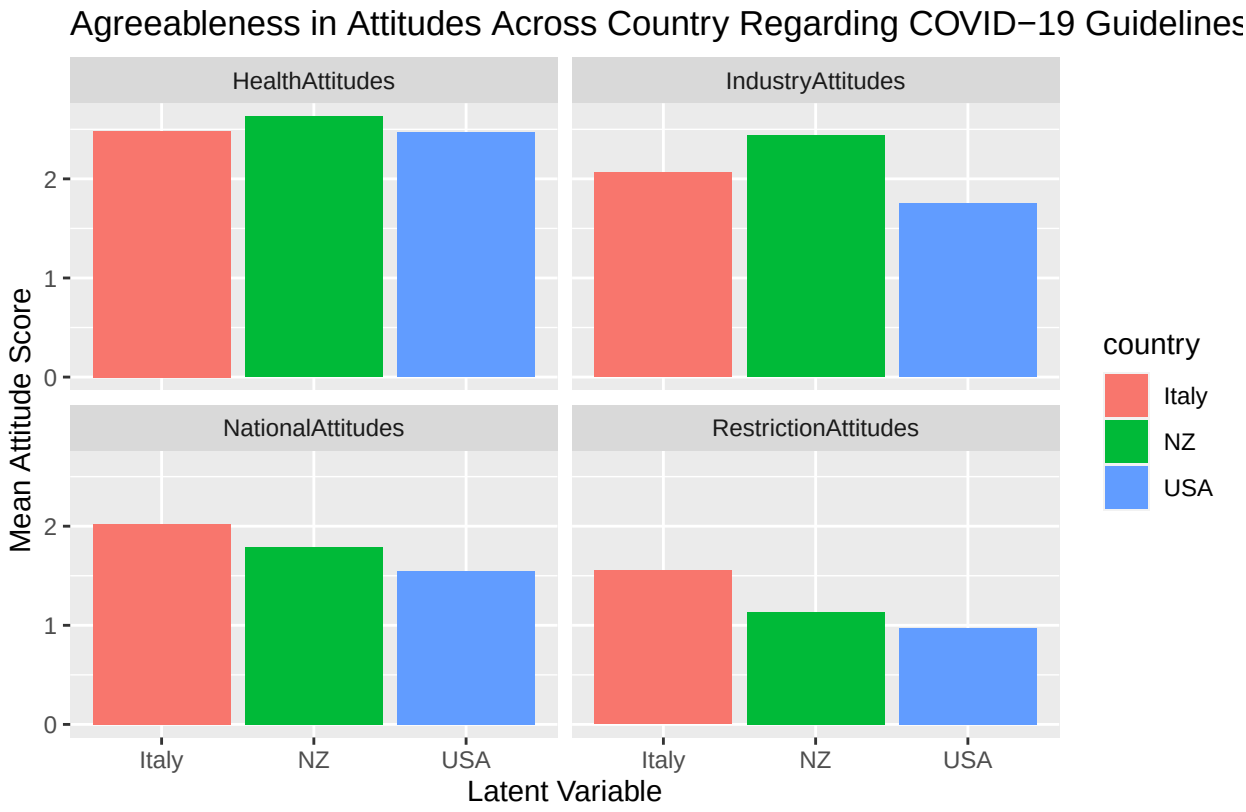
We can also use these graphs to view the general attitude scores during the pandemic. We can see that *RestrictionAttitudes* has the lowest attitude score between each country. Thus, most individuals are less agreeable toward restrictions than the other latent variables. In addition, all three countries have the highest attitude score for *HealthAttitudes*. Therefore, individuals generally are more agreeable toward attitudes regarding health during this pandemic. This also seems to make sense in the context of the data. During a pandemic, attitudes towards health would have higher scores, in order to decrease the spread of COVID-19 and promote attitudes that increase an individual's health and risk of the virus. Regarding restriction attitudes, it would make sense that individuals would be less likely to agree to having their daily lives restricted by certain policies in place.

Next we can analyze our results for behavior scores regarding the COVID-19 pandemic. When analyzing the graphs, it is important to remember that the latent variable *GeneralHealthBehavior* had the least correlation with any of the other latent variables, which could cause some skewed data. For example, this latent variable has the highest range of values when compared by country (New Zealand has the lowest score of 1.15, USA has a score of 2.13, and Italy has the highest score of 2.71), while the other two latent variables have small ranges of 3.32 to 3.46 (*SanitationBehavior*) and 3.22 to 3.63 (*Social Behavior*). This does not seem to follow any trend similar to any of our other latent variables.

When comparing our results by country, we can see once again that the US has the lowest behavior scores in *SanitationBehavior* and *SocialBehavior*. This corresponds with the low agreeableness regarding attitude in the US. Additionally, Italy has the highest compliance in these two latent variables as well, which could be correlated with the country having the highest attitude score in two of the attitude latent variables. Therefore, the US has the lowest levels of agreeableness and compliance among the three countries, and Italy has the highest compliance, and one of the higher score of agreeableness as well.

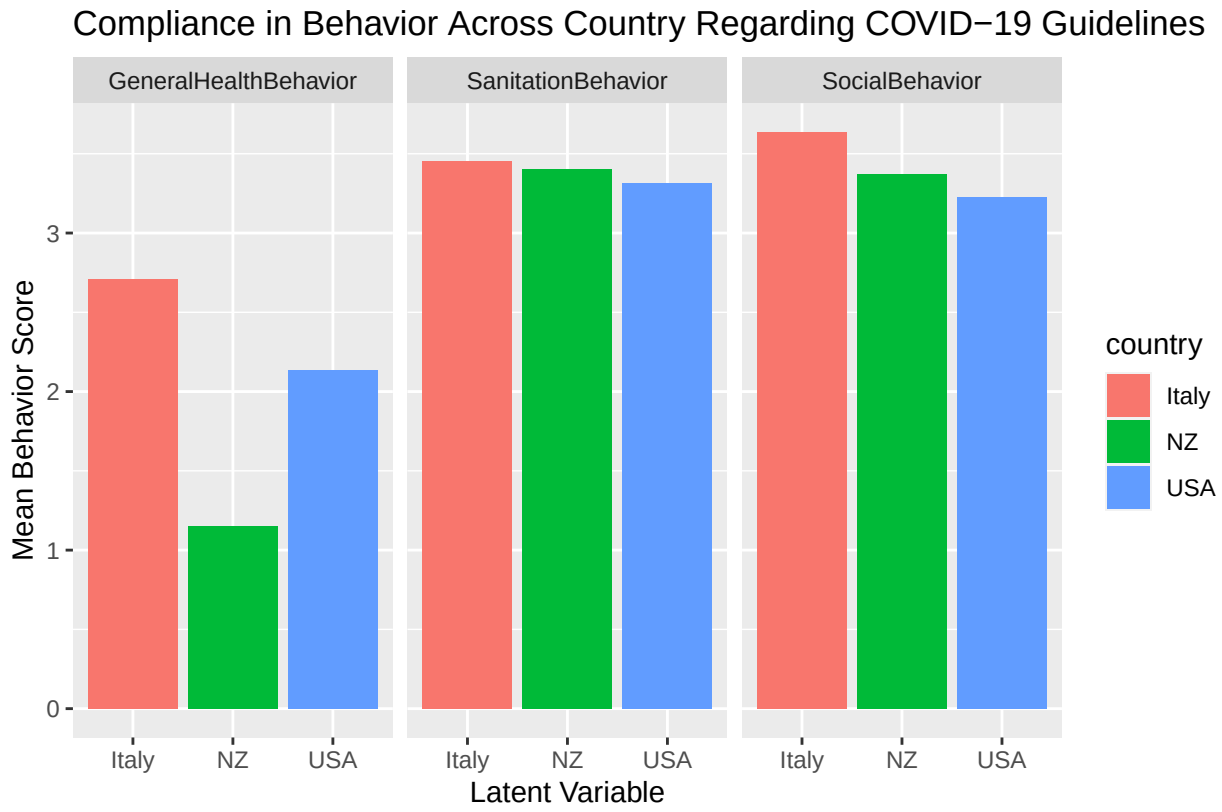
Additionally it seems that the scores for behavior are generally much higher than the score for attitude. The latent variables for behavior range from 3.0 to 4.0, while the latent variables for attitude range from 1.0-3.0. This means that although individuals may not agree with certain COVID-19 guidelines and restrictions, they will still comply with them.

```
ggplot(data = attitude_country_means, aes(x = country, y = value, fill = country)) +
    geom_bar(stat="identity") + facet_wrap(~stat) + labs(x = "Latent Variable", y = "Mean Attitude Score
```



Attitude scores on a scale of 0−4. Higher scores indicate more agreement with that type of attitude.

```
ggplot(data = behavior_country_means, aes(x = country, y = value, fill = country)) +
    geom_bar(stat="identity") + facet_wrap(~stat) + labs(x = "Latent Variable", y = "Mean Behavior Score
```

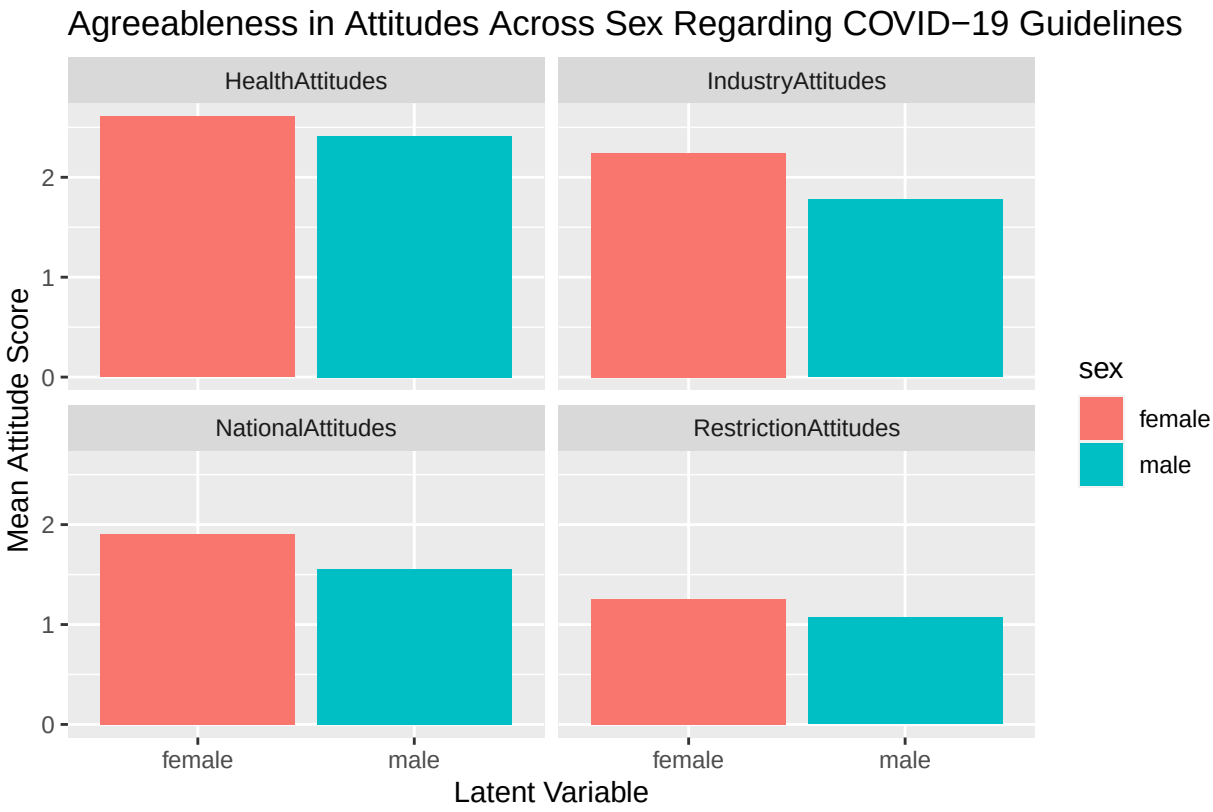


ehavior scores on a scale of 0−4. Higher scores indicate more compliance with that type of behavior.

Now we will compare the attitude and behavior scores between men and women. Looking at our first bar chart depicting agreeableness in attitudes across sex, we see that females have higher scores in all four latent variables. Thus, it is possible that there is a distinct difference in COVID-19 behavior between men and women, where women are generally more agreeable towards guidelines and restrictions than men. Additionally, men and women seem to follow the same general trend in their which attitudes they agree with most. The highest scores for men and women are for *HealthAttitudes*, followed by *IndustryAttitudes*, *NationalAttitudes*, and finally, *RestrictionAttitudes*. This is also the same trend we found in attitude scores when we were comparing by country. Thus, it seems that the priority of restrictions is the same between women and men.

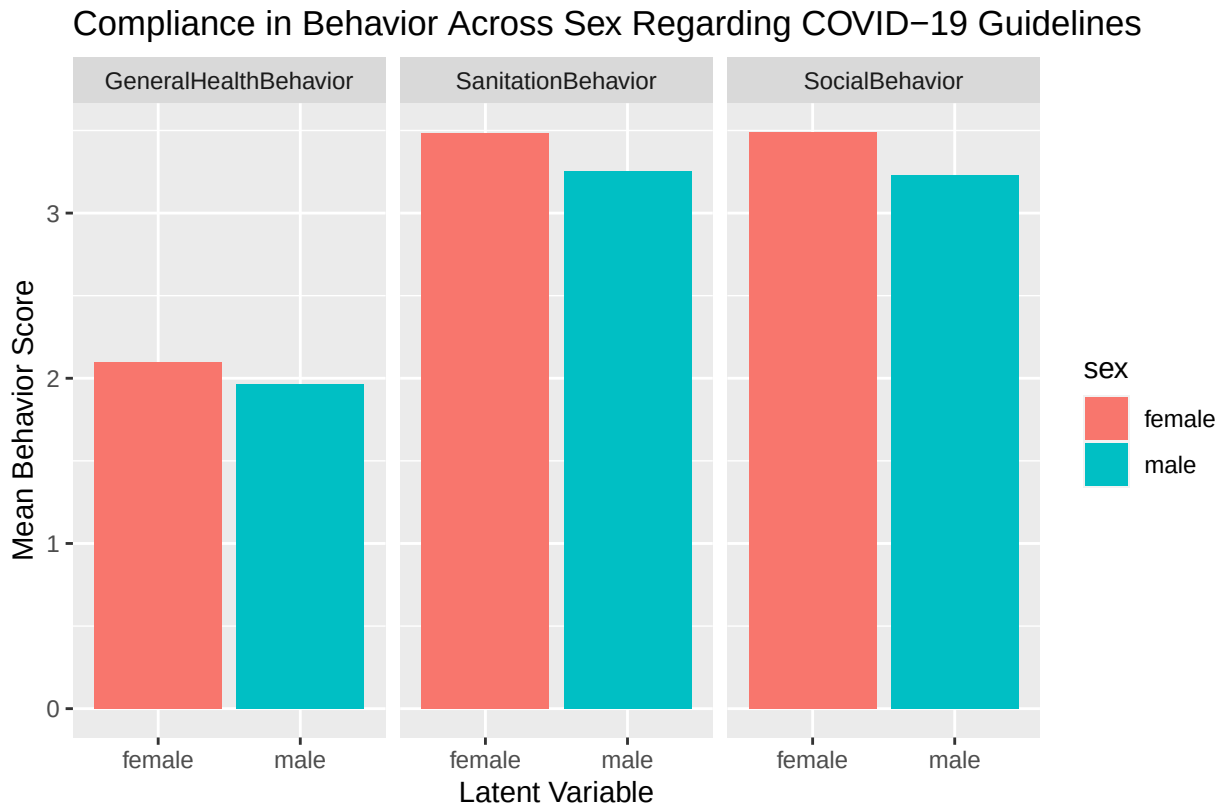
When we observe the differences in behavior scores across sex, we see once again that females have higher scores than males in all three latent variables. This provides more evidence that gender differences are present regarding COVID-19 attitudes and behaviors. Once again, we see that behavior scores among this group are also higher than attitude scores. Regarding the GeneralHealthBehavior variable that was difficult to interpret across countries, we see that when comparing between genders, it follows a similar trend with a similar range of values as the other latent variables. The one difference would be that the scores for both males and females is much lower than the behavior scores of the other latent variables.

```
ggplot(data = attitude_sex_means, aes(x = sex, y = value, fill = sex)) +
    geom_bar(stat="identity") + facet_wrap(~stat) + labs(x = "Latent Variable", y = "Mean Attitude Score
```



Attitude scores on a scale of 0−4. Higher scores indicate more agreement with that type of attitude.

```
ggplot(data = behavior_sex_means, aes(x = sex, y = value, fill = sex)) +
    geom_bar(stat="identity") + facet_wrap(~stat) + labs(x = "Latent Variable", y = "Mean Behavior Score
```



ıavior scores on a scale of 0−4. Higher scores indicate more compliance with that type of behavior.

In conclusion, we can say with confidence that women and men do differ in attitudes and behaviors regarding the changes in daily life caused by COVID-19. Across both attitude and behavior, females had higher score in all categories compared to men. This means that on average, women have higher agreeableness and compliance with COVID-19 guidelines and behaviors.

When looking across countries, the conclusion is not as clear. However, there does seem to be a difference between the US, and Italy and New Zealand. The United States had the lowest scores in all attitude and behavior latent variables except for *GeneralHealthBehavior* which may not be an accurate variable of comparison to begin with. Determining a difference between Italy and New Zealand is slightly more difficult. Italy had higher behavior scores, but when looking at attitude scores, both New Zealand and Italy had the highest scores in two latent variables. Thus, there is evidence that there is a difference in behavior between these two countries. There is also some evidence that there is a difference in attitude, but it is not clear cut.

All of these differences could be due to a multitude of factors including culture, society, government, and more. In future studies, it could be interesting to explore these factors in more detail to get a better idea of the origin of these differences. In addition, the study could be extended to more countries, specifically countries in Asia, Africa, and South America, which were not well represented. This could provide for more interesting contrast between countries as well. Regarding gender, it is important to understand that this study viewed gender on a binary scale, but in future studies, other gender identities should be considered in order to get a more representative sample.