# InterStats

January 5, 2022

[ ]:
```
library(tidyverse)
library(xtable)
library(ggplot2)
library(ggpubr)
library(ggrepel)
library(gridExtra)
library(rstatix)
library(survival)
library(survminer)
library(vcd)
library(finalfit)
```

Read data

[2]:
```
surveys1 <- read_csv("Datasets/effec1.quest.compil.csv", locale = locale("fr"),␣
↪show_col_types = FALSE)
surveys2 <- read_csv("Datasets/effec2.quest.compil.csv", locale = locale("fr"),␣
↪show_col_types = FALSE)
surveys3 <- read_csv("Datasets/effec3.quest.compil.csv", locale = locale("fr"),␣
↪show_col_types = FALSE)
usages1 <- distinct(read_csv("Datasets/usages.effec1.csv", locale =␣
↪locale("fr"), show_col_types = FALSE))
usages2 <- distinct(read_csv("Datasets/usages.effec2.csv", locale =␣
↪locale("fr"), show_col_types = FALSE))
usages3 <- distinct(read_csv("Datasets/usages.effec3.csv", locale =␣
↪locale("fr"), show_col_types = FALSE))
```

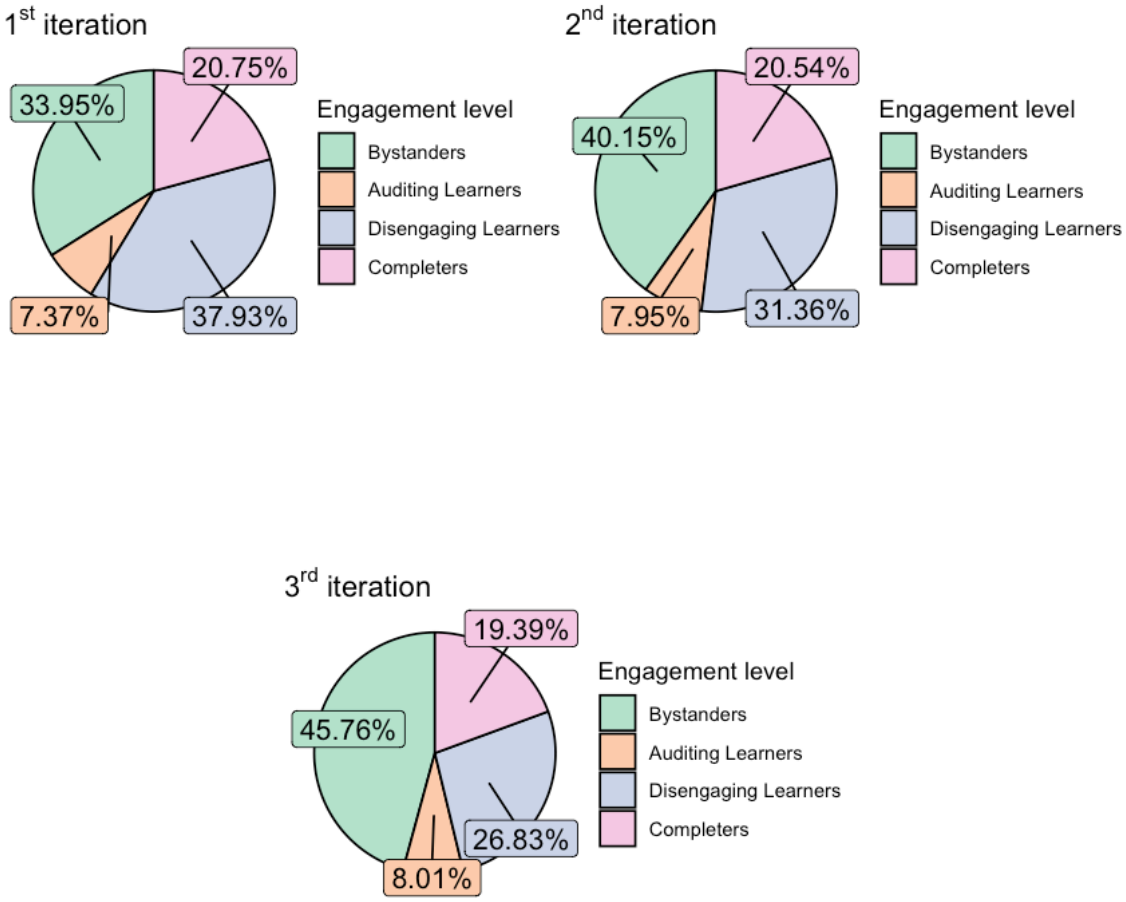
## 1 Observation of learners' engagement

[3]:
```
# Fix Exam.bin on usages1
usages1 <- usages1 %>% mutate(Exam.bin = case_when(last.quizz == 5 & last.video␣
↪> 30 ~ 1,
                                                   TRUE ~ 0))

usages1 <- usages1 %>%
           mutate(EngagementLevel = case_when(Exam.bin == 1 & Assignment.bin ==␣
↪1 ~ 3, # Completers
```

```
                                                last.quizz > 0 | Assignment.bin␣
↪== 1 ~ 2, # Disengaging Learners
                                                last.video / 35 > 0.1 ~ 1, #␣
↪Auditing Learners
                                                TRUE ~ 0)) # Bystanders

usages2 <- usages2 %>%
           mutate(EngagementLevel = case_when(Exam.bin == 1 & Assignment.bin ==␣
↪1 ~ 3, # Completers
                                                last.quizz > 0 | Assignment.bin␣
↪== 1 ~ 2, # Disengaging Learners
                                                last.video / 35 > 0.1 ~ 1, #␣
↪Auditing Learners
                                                TRUE ~ 0)) # Bystanders

usages3 <- usages3 %>%
           mutate(EngagementLevel = case_when(Exam.bin == 1 & Assignment.bin ==␣
↪1 ~ 3, # Completers
                                                last.quizz > 0 | Assignment.bin␣
↪== 1 ~ 2, # Disengaging Learners
                                                last.video / 35 > 0.1 ~ 1, #␣
↪Auditing Learners
                                                TRUE ~ 0)) # Bystanders
```

[24]:
```
df1 <- usages1 %>% group_by(EngagementLevel) %>% tally(name = "value") %>%
          mutate(csum = rev(cumsum(rev(value))),
         pos = if_else(is.na(value/2 + lead(csum, 1)), value/2, value/2 +␣
↪lead(csum, 1)))

plot1 <- ggplot(df1, aes(x = "" , y = value, fill = factor(EngagementLevel))) +
  geom_col(width = 1, color = 1) +
  coord_polar(theta = "y") +
  geom_label_repel(data = df1,
                   aes(y = pos, label = paste0(round(value / sum(value) * 100,
                                               digits = 2), "%")),
                   size = 4.5, nudge_x = 1, show.legend = FALSE) +
  scale_fill_brewer(palette = "Pastel2", name = "Engagement level",
                    labels = c('Bystanders', 'Auditing Learners',
                    'Disengaging Learners', 'Completers')) +

  theme_void() + labs(title = expression('1'^st*' iteration'))

df2 <- usages2 %>% group_by(EngagementLevel) %>% tally(name = "value") %>%
          mutate(csum = rev(cumsum(rev(value))),
         pos = if_else(is.na(value/2 + lead(csum, 1)), value/2, value/2 +␣
↪lead(csum, 1)))
```

```
plot2 <- ggplot(df2, aes(x = "" , y = value, fill = factor(EngagementLevel))) +
  geom_col(width = 1, color = 1) +
  coord_polar(theta = "y") +
  geom_label_repel(data = df2,
                   aes(y = pos, label = paste0(round(value / sum(value) * 100,
                                               digits = 2), "%")),
                   size = 4.5, nudge_x = 1, show.legend = FALSE) +
  scale_fill_brewer(palette = "Pastel2", name = "Engagement level",
                    labels = c('Bystanders', 'Auditing Learners',
                    'Disengaging Learners', 'Completers')) +

  theme_void() + labs(title = expression('2'^nd*' iteration'))

df3 <- usages3 %>% group_by(EngagementLevel) %>% tally(name = "value") %>%
          mutate(csum = rev(cumsum(rev(value))),
         pos = if_else(is.na(value/2 + lead(csum, 1)), value/2, value/2 +␣
 ↪lead(csum, 1)))

plot3 <- ggplot(df3, aes(x = "" , y = value, fill = factor(EngagementLevel))) +
  geom_col(width = 1, color = 1) +
  coord_polar(theta = "y") +
  geom_label_repel(data = df3,
                   aes(y = pos, label = paste0(round(value / sum(value) * 100,
                                               digits = 2), "%")),
                   size = 4.5, nudge_x = 1, show.legend = FALSE) +
  scale_fill_brewer(palette = "Pastel2", name = "Engagement level",
                    labels = c('Bystanders', 'Auditing Learners',
                    'Disengaging Learners', 'Completers')) +

  theme_void() + labs(title = expression('3'^rd*' iteration'))

g <- arrangeGrob(plot1, plot2, plot3, ncol = 2, layout_matrix=rbind(c(1,1,2,2),␣
 ↪c(NA, 3, 3, NA)))
grid.arrange(plot1, plot2, plot3, ncol = 2, layout_matrix=rbind(c(1,1,2,2),␣
 ↪c(NA, 3, 3, NA)))
```




## 2 Inferential Statistics

Prepare data to apply hypothesis tests

[ ]:
```
# Merge data
iter1 <- distinct(left_join(surveys1, usages1, by='Student_ID'))
iter2 <- distinct(left_join(surveys2, usages2, by='Student_ID'))
iter3 <- distinct(left_join(surveys3, usages3, by='Student_ID'))
iter3 <- iter3 %>% mutate_at(c('Curiosity.MOOC', 'Rencontres'), as.numeric)
df <- iter1 %>% full_join(iter2) %>% full_join(iter3)
```

[6]:
```
df <- df %>% mutate(Country_HDI = case_when(Country_HDI == "TH" ~ "Very High",
                                            Country_HDI == "H" | Country_HDI ==␣
 ↪"M" ~ "Intermediate",
                                            Country_HDI == "B" ~ "Low"))
df$Country_HDI <- factor(df$Country_HDI, levels = c("Very High",␣
 ↪"Intermediate", "Low"))

df <- df %>% mutate(Gender = case_when(Gender == "un homme" ~ "Male",
                                       Gender == "une femme" ~"Female"))
df$Gender <- factor(df$Gender, levels = c("Male", "Female"))
df$Exam.bin <- factor(df$Exam.bin)
```

## 2.1 Gender and Viewed videos

[7]:
```
df.t_test <- df %>% drop_na(c(Gender, last.video))
df.t_test %>%
  group_by(Gender) %>%
  get_summary_stats(last.video, type = "mean_sd")
```

A tibble: 2 × 5

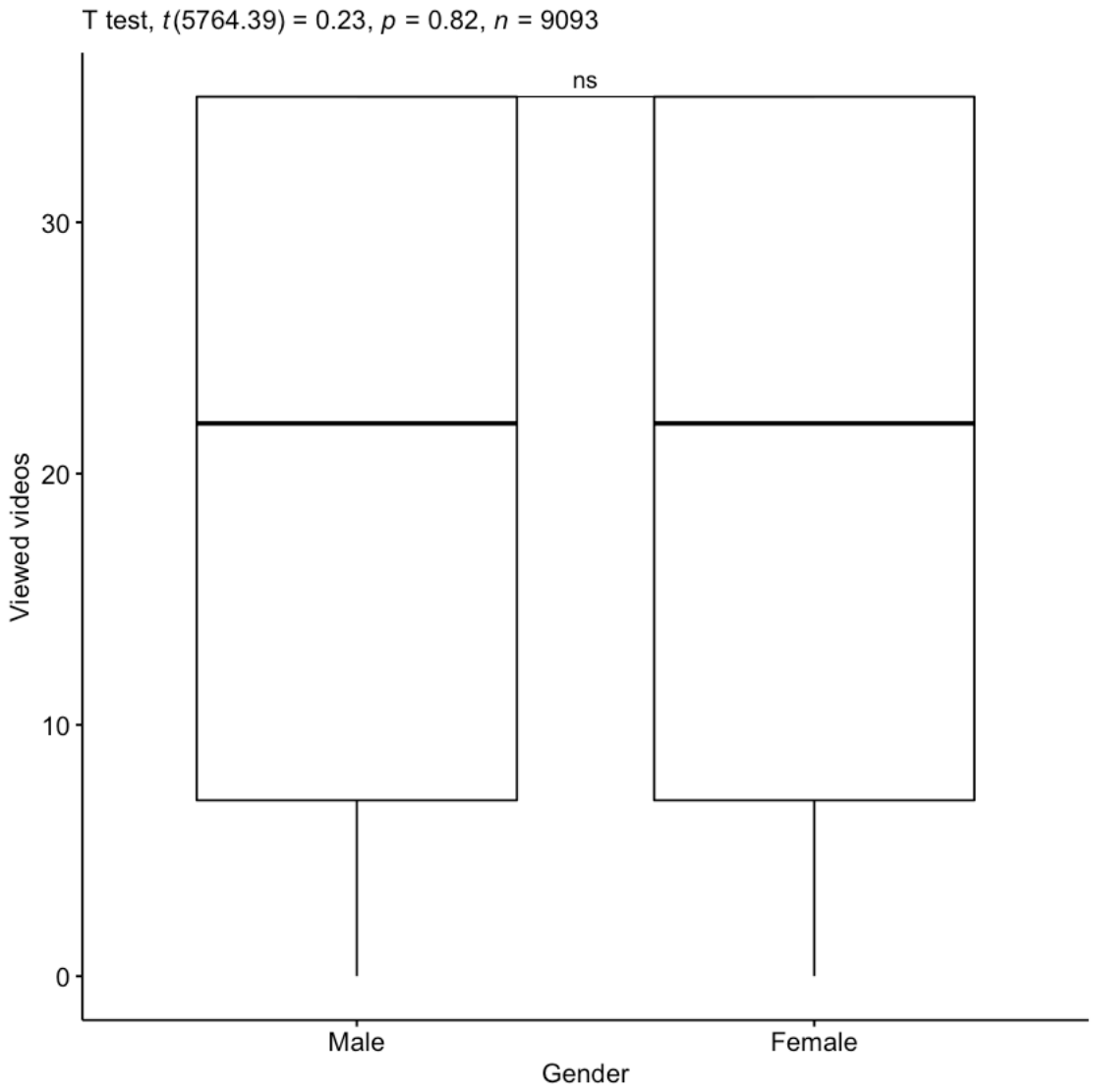
| Gender <fct> | variable <chr> | n <dbl> | mean <dbl> | sd <dbl> |
|---|---|---|---|---|
| Male | last.video | 6103 | 20.843 | 13.458 |
| Female | last.video | 2990 | 20.773 | 13.912 |

[8]:
```
# Independent sample t-test
stat.test <- df.t_test %>%
             t_test(last.video ~ Gender)
stat.test
```

A rstatix_test: 1 × 8

| | .y. <chr> | group1 <chr> | group2 <chr> | n1 <int> | n2 <int> | statistic <dbl> | df <dbl> | p <dbl> |
|---|---|---|---|---|---|---|---|---|
| 1 | last.video | Male | Female | 6103 | 2990 | 0.2292759 | 5764.39 | 0.819 |

[9]:
```
# Create a box-plot
bxp <- ggboxplot(
  df.t_test, x = "Gender", y = "last.video",
  ylab = "Viewed videos", xlab = "Gender")

# Add p-value and significance levels
stat.test <- stat.test %>% add_xy_position(x = "Gender") %>%
             add_significance()
bxp +
  stat_pvalue_manual(stat.test, tip.length = 0) +
  labs(subtitle = get_test_label(stat.test, detailed = TRUE))
```




## 2.2 Country's HDI and Viewed videos

[10]:
```
df.anova <- df %>% drop_na(c(Country_HDI, last.video))
df.anova %>%
  group_by(Country_HDI) %>%
  get_summary_stats(last.video, type = "mean_sd")
```

A tibble: 3 × 5

| Country_HDI <fct> | variable <chr> | n <dbl> | mean <dbl> | sd <dbl> |
|---|---|---|---|---|
| Very High | last.video | 7264 | 21.665 | 13.580 |
| Intermediate | last.video | 667 | 18.099 | 13.846 |
| Low | last.video | 1032 | 16.633 | 12.638 |

[11]:
```
# Levene test
levene <- df.anova %>% levene_test(last.video ~ Country_HDI)
levene
```

A tibble: 1 × 4

| df1 | df2 | statistic | p |
|---|---|---|---|
| <int> | <int> | <dbl> | <dbl> |
| 2 | 8960 | 11.85427 | 7.220328e-06 |

[12]:
```
# Welch One way ANOVA test
res.aov <- df.anova %>% welch_anova_test(last.video ~ Country_HDI)
res.aov
```

A rstatix_test: 1 × 7

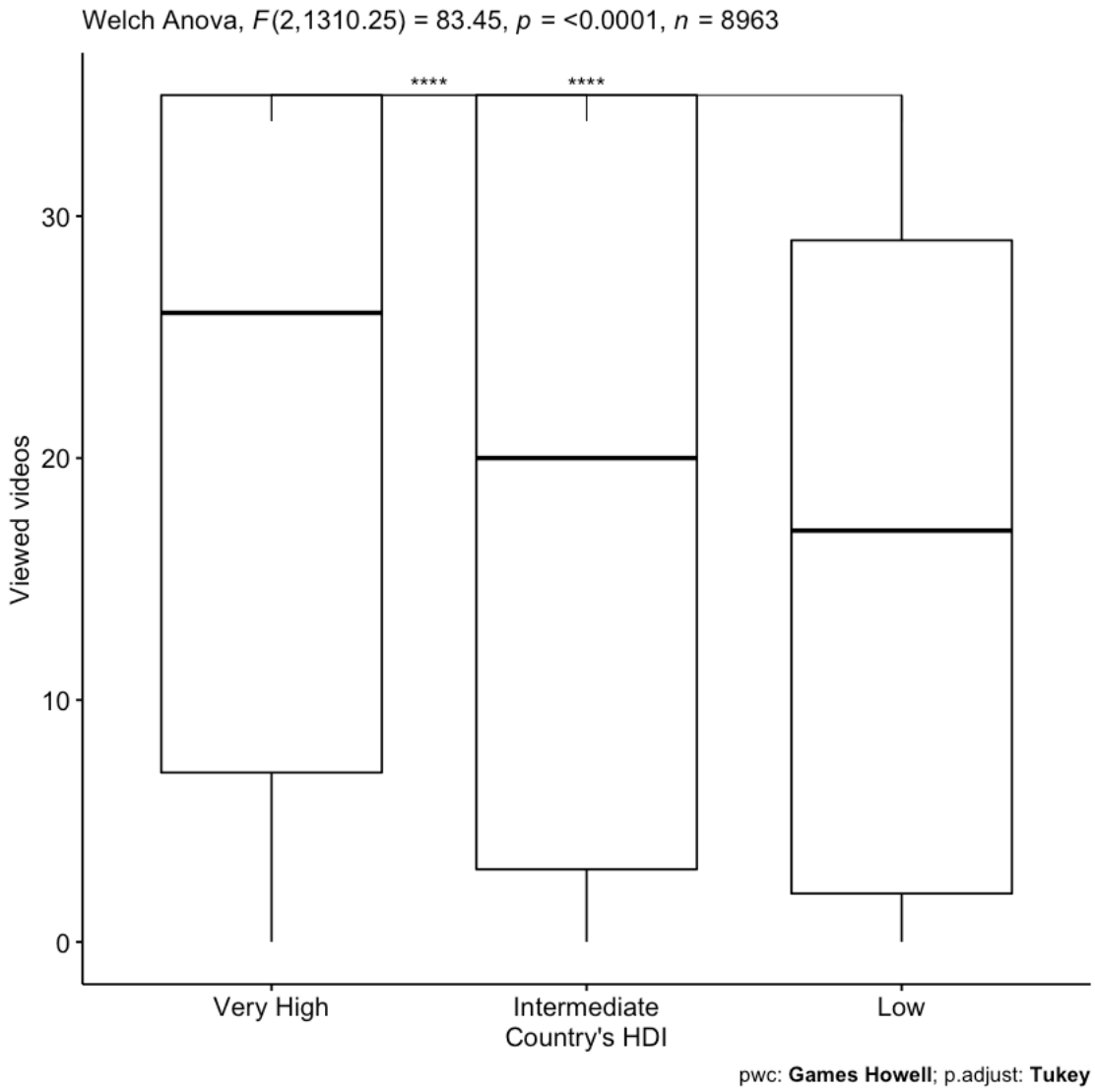
| | .y. | n | statistic | DFn | DFd | p | method |
|---|---|---|---|---|---|---|---|
| | <chr> | <int> | <dbl> | <dbl> | <dbl> | <dbl> | <chr> |
| 1 | last.video | 8963 | 83.45 | 2 | 1310.252 | 7.7e-35 | Welch ANOVA |

[13]:
```
# Pairwise comparisons (Games-Howell)
pwc <- df.anova %>% games_howell_test(last.video ~ Country_HDI)
pwc
```

A rstatix_test: 3 × 8

| | .y. | group1 | group2 | estimate | conf.low | conf.high | p.adj |
|---|---|---|---|---|---|---|---|
| | <chr> | <chr> | <chr> | <dbl> | <dbl> | <dbl> | <dbl> |
| 1 | last.video | Very High | Intermediate | -3.566385 | -4.879709 | -2.25306145 | 0.000 |
| 2 | last.video | Very High | Low | -5.032584 | -6.028394 | -4.03677382 | 0.000 |
| 3 | last.video | Intermediate | Low | -1.466199 | -3.026445 | 0.09404754 | 0.071 |

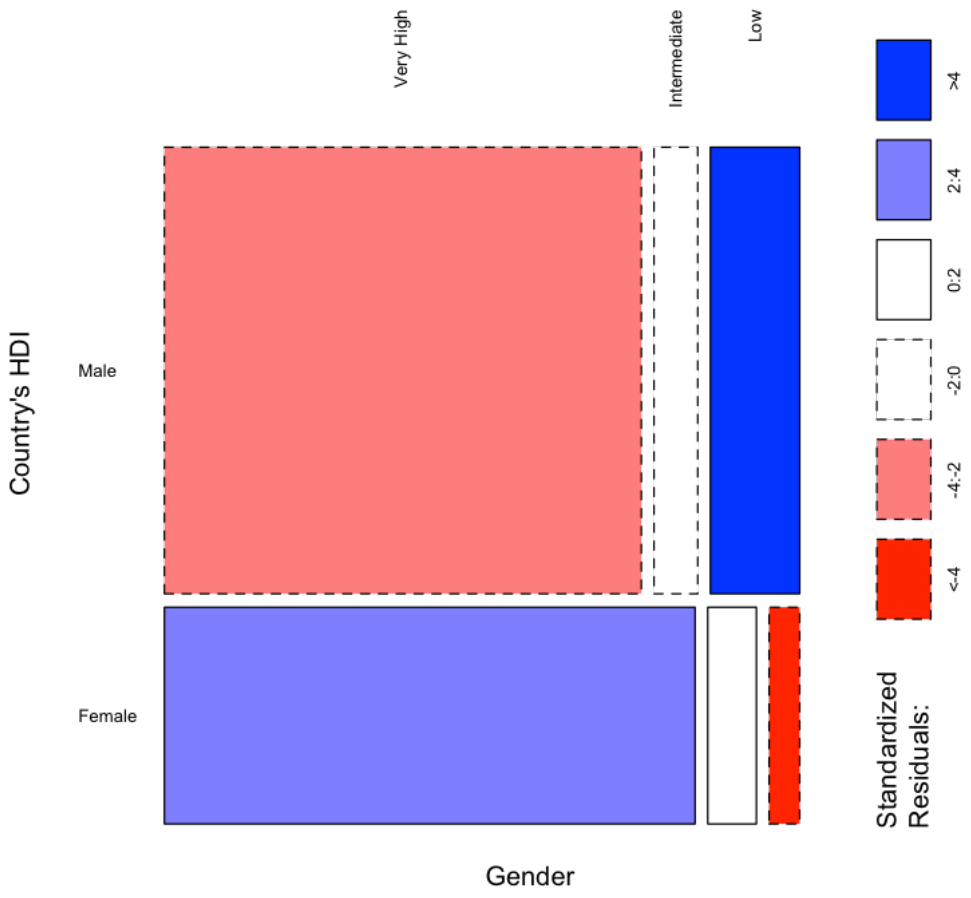
[14]:
```
# Visualization: box plots with p-values
pwc <- pwc %>% add_xy_position(x = "Country_HDI")
ggboxplot(df.anova, x = "Country_HDI", y = "last.video",
          ylab = "Viewed videos", xlab = "Country's HDI") +
  stat_pvalue_manual(pwc, hide.ns = TRUE) +
  labs(
    subtitle = get_test_label(res.aov, detailed = TRUE),
    caption = get_pwc_label(pwc)
    )
```




### 2.3 Genders and Country's HDI groups

[15]:
```
df.chisq <- df %>% drop_na(c(Country_HDI, Gender))
```

[16]:
```
# Mosaic plot
mosaicplot( ~ Gender + Country_HDI, data = df.chisq,
           shade = TRUE, las=2, dir=c("h", "v"),
           main = NULL,
           xlab = "Gender", ylab = "Country's HDI")
```




[17]:
```
# Chi-squared test
chisq <- chisq_test(df.chisq$Gender, df.chisq$Country_HDI)
chisq
```

A rstatix_test: 1 × 6

| | n | statistic | p | df | method | p.signif |
|---|---|---|---|---|---|---|
| | <int> | <dbl> | <dbl> | <int> | <chr> | <chr> |
| 1 | 8957 | 179.0476 | 1.32e-39 | 2 | Chi-square test | **** |

### 2.4 Odds ratios of course accomplishment

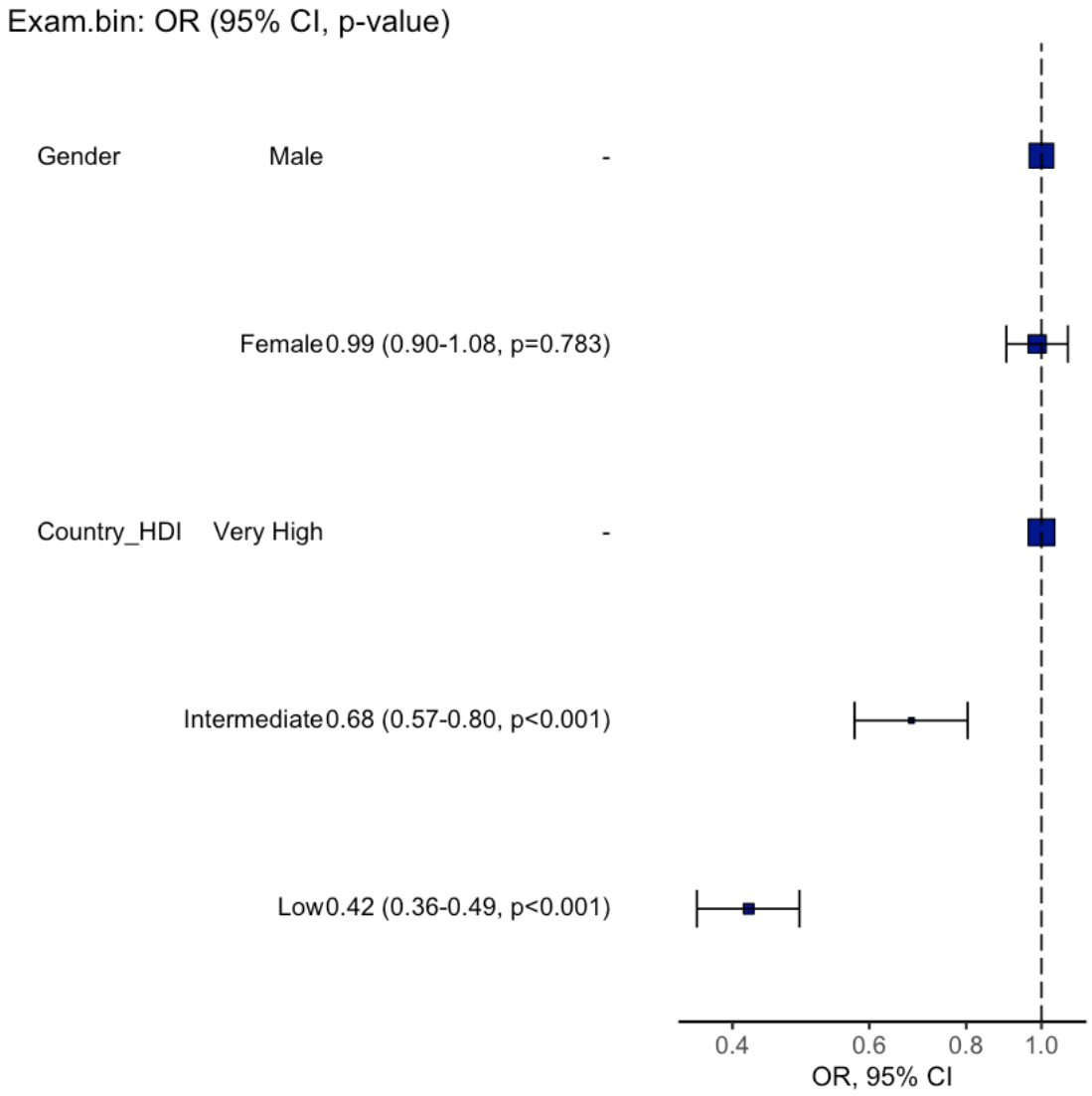
[18]:
```
# Logistic regression
lr <- glm(Exam.bin ~ Country_HDI + Gender, data=df, family = "binomial")
summary(lr)
```

```
Call:
glm(formula = Exam.bin ~ Country_HDI + Gender, family = "binomial",
    data = df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.0553  -1.0553  -0.9008   1.3047   1.6997

Coefficients:
                         Estimate Std. Error z value Pr(>|z|)
(Intercept)              -0.29429    0.02882 -10.213  < 2e-16 ***
Country_HDIIntermediate -0.38536    0.08550  -4.507 6.57e-06 ***
Country_HDILow           -0.86831    0.07755 -11.197  < 2e-16 ***
GenderFemale             -0.01281    0.04662  -0.275    0.783
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 12030  on 8950  degrees of freedom
Residual deviance: 11877  on 8947  degrees of freedom
  (7969 observations deleted due to missingness)
AIC: 11885

Number of Fisher Scoring iterations: 4
```

[19]:
```
# OR plot
df %>%
  or_plot("Exam.bin", c("Gender","Country_HDI"), table_text_size=4,␣
 ↪title_text_size=14,
    plot_opts=list(xlab("OR, 95% CI"), theme(axis.title =␣
 ↪element_text(size=12))))
```

```
Note: dependent includes missing data. These are dropped.

Waiting for profiling to be done…

Waiting for profiling to be done…

Waiting for profiling to be done…
```

```
Warning message:
"Removed 2 rows containing missing values (geom_errorbarh)."
```




[20]:
```
# Poisson Regression
pr <- glm(last.video ~ Country_HDI + Gender, data=df, family = "poisson")
pr
```

```
Call:  glm(formula = last.video ~ Country_HDI + Gender, family = "poisson",
    data = df)

Coefficients:
            (Intercept)  Country_HDIIntermediate           Country_HDILow
                3.08560                  -0.18080                  -0.26909
```

```
            GenderFemale
                -0.02596

Degrees of Freedom: 8950 Total (i.e. Null);  8947 Residual
  (7969 observations deleted due to missingness)
Null Deviance:            104100
Residual Deviance: 102600         AIC: 141100
```

# 3 Survival Analysis

Prepare data to apply linear models

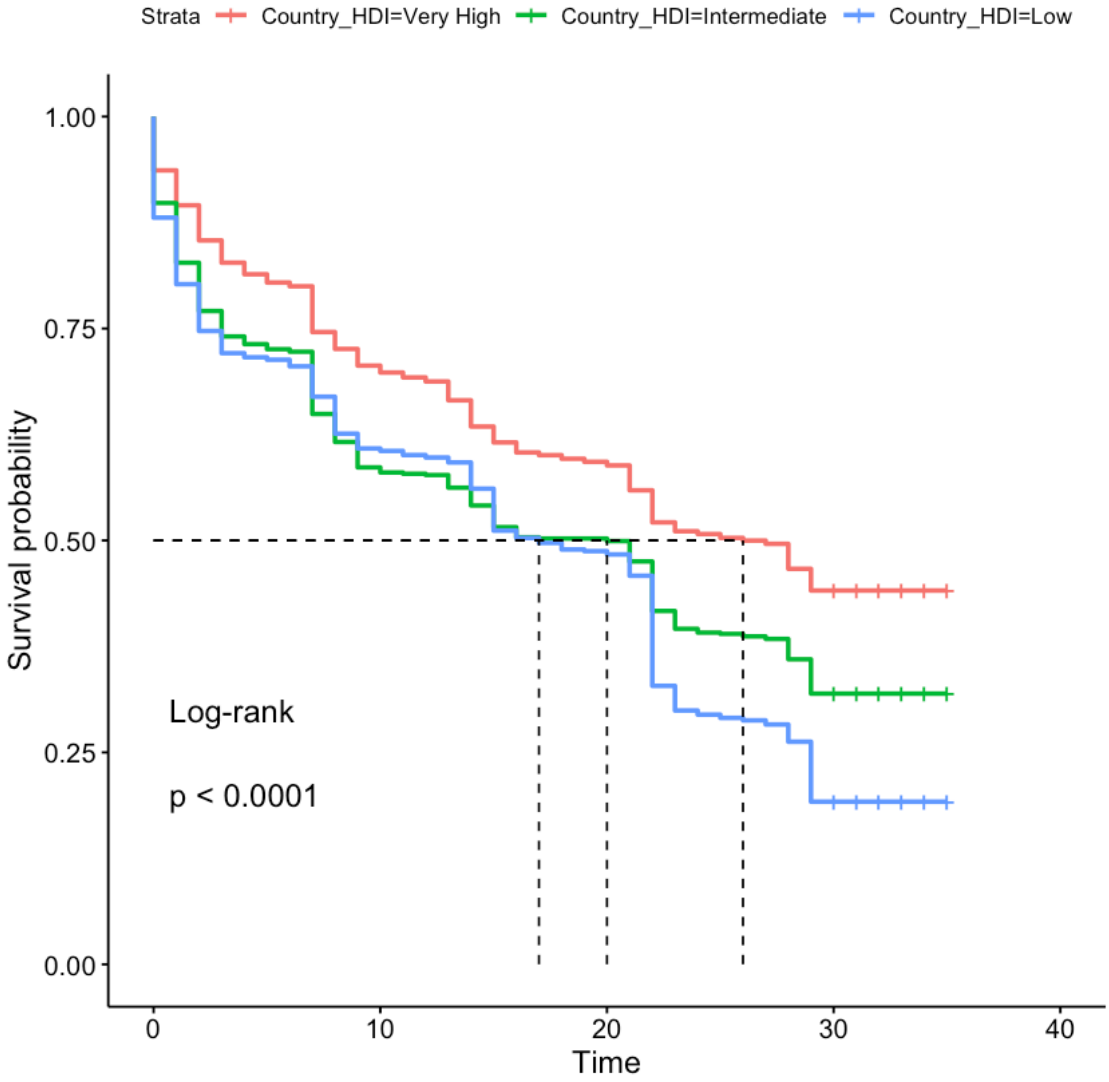
[21]:
```
df <- df %>% mutate(status = case_when(last.video < 30 ~ 1,
                                       TRUE ~ 0))

df <- df %>% mutate(Group = case_when(EngagementLevel == 1 ~ "Auditing",
                                      EngagementLevel == 2 ~ "Disengaging"))
df$Group <- factor(df$Group, levels = c("Disengaging","Auditing"))
```

## 3.1 Country's HDI

[22]:
```
# Reference: Very High
summary(coxph(formula = Surv(last.video, status) ~ Country_HDI, data = df))
survival_HDI <- survfit(Surv(last.video, status) ~ Country_HDI, data = df)
ggsurvplot(
  survival_HDI,
  conf.int = FALSE,
  surv.median.line = c('hv'),
  data = df,
  pval = TRUE,
  pval.method = TRUE,
  risk.table = FALSE)
```

```
Call:
coxph(formula = Surv(last.video, status) ~ Country_HDI, data = df)

  n= 8963, number of events= 5349
   (7957 observations deleted due to missingness)

                           coef exp(coef) se(coef)      z Pr(>|z|)
Country_HDIIntermediate 0.33867   1.40308  0.04950  6.842  7.8e-12 ***
Country_HDILow          0.56331   1.75648  0.03808 14.791  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

                        exp(coef) exp(-coef) lower .95 upper .95
Country_HDIIntermediate     1.403     0.7127     1.273     1.546
Country_HDILow              1.756     0.5693     1.630     1.893
```

```
Concordance= 0.538  (se = 0.003 )
Likelihood ratio test= 219.5  on 2 df,   p=<2e-16
Wald test            = 243.1  on 2 df,   p=<2e-16
Score (logrank) test = 248.9  on 2 df,   p=<2e-16
```

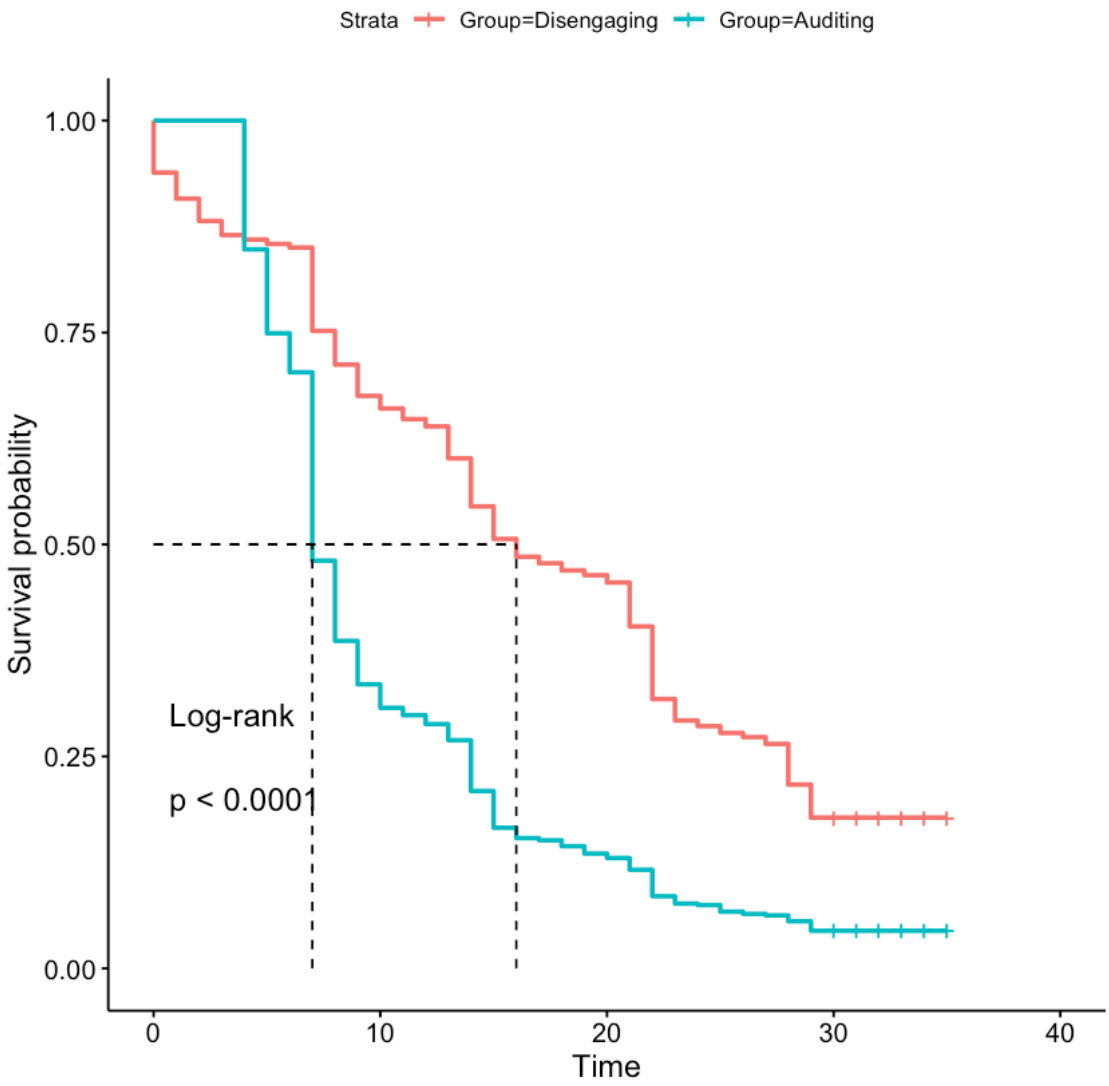



### 3.2 Level of engagement

[23]:
```
# Reference: Disengaging
summary(coxph(formula = Surv(last.video, status) ~ Group, data = df))
survival_Group <- survfit(Surv(last.video, status) ~ Group, data = df)
ggsurvplot(
```

```
  survival_Group,
  conf.int = FALSE,
  surv.median.line = c('hv'),
  data = df,
  pval = TRUE,
  pval.method = TRUE,
  risk.table = FALSE)
```

```
Call:
coxph(formula = Surv(last.video, status) ~ Group, data = df)

  n= 6252, number of events= 5294
   (10668 observations deleted due to missingness)

                 coef exp(coef) se(coef)     z Pr(>|z|)
GroupAuditing 0.78863   2.20038  0.03464 22.77   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

              exp(coef) exp(-coef) lower .95 upper .95
GroupAuditing       2.2     0.4545     2.056     2.355

Concordance= 0.56  (se = 0.003 )
Likelihood ratio test= 446.6  on 1 df,   p=<2e-16
Wald test            = 518.4  on 1 df,   p=<2e-16
Score (logrank) test = 544.2  on 1 df,   p=<2e-16
```


Strata
Group=Disengaging
Group=Auditing
1.00
0.75
0.50
0.25
0.00
Survival probability
Log-rank
p < 0.0001
0
10
20
30
40
Time

[ ]: