

# Demographic data

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## Introduction

```

source("Survival/utils.R")
library(forestplot)

# Setup analysis environment
analysis_setup <- setup_analysis()
paths <- analysis_setup$paths
demo <- analysis_setup$demo

flare.df <- readRDS(paste0(paths$outdir, "flares-controlled.RDS"))
flare.cd.df <- readRDS(paste0(paths$outdir, "flares-controlled-cd.RDS"))
flare.uc.df <- readRDS(paste0(paths$outdir, "flares-controlled-uc.RDS"))

cd.clin.forest <- readRDS(paste0(paths$outdir, "cd-clin-controlled.RDS"))
cd.hard.forest <- readRDS(paste0(paths$outdir, "cd-hard-controlled.RDS"))
uc.clin.forest <- readRDS(paste0(paths$outdir, "uc-clin-controlled.RDS"))
uc.hard.forest <- readRDS(paste0(paths$outdir, "uc-hard-controlled.RDS"))

```

This page describes associations between demographic data and time-to-flare. Sex and IMD are not covered here as they are covered in the [controlled variables section](#)

The page describing demographic variables in a descriptive manner can be found [here](#).

## Age

### Crohn's disease

#### Patient-reported flare

```

# Categorize age
flare.cd.df <- categorize_variable(flare.cd.df, "Age",
                                      breaks = c(0, 18, 30, 45, 65, Inf),
                                      labels = c("Under 18", "18-29", "30-44", "45-64", "65+"))

```

```

# Generate survival plot and run Cox model
analysis_result <- run_survival_analysis(
  data = flare.cd.df,
  var_name = "Age",
  outcome_time = "softflare_time",
  outcome_event = "softflare",
  legend_title = "Age",
  plot_base_path = "plots/cd/soft-flare/demographics/age",
  break_time_by = 200
)

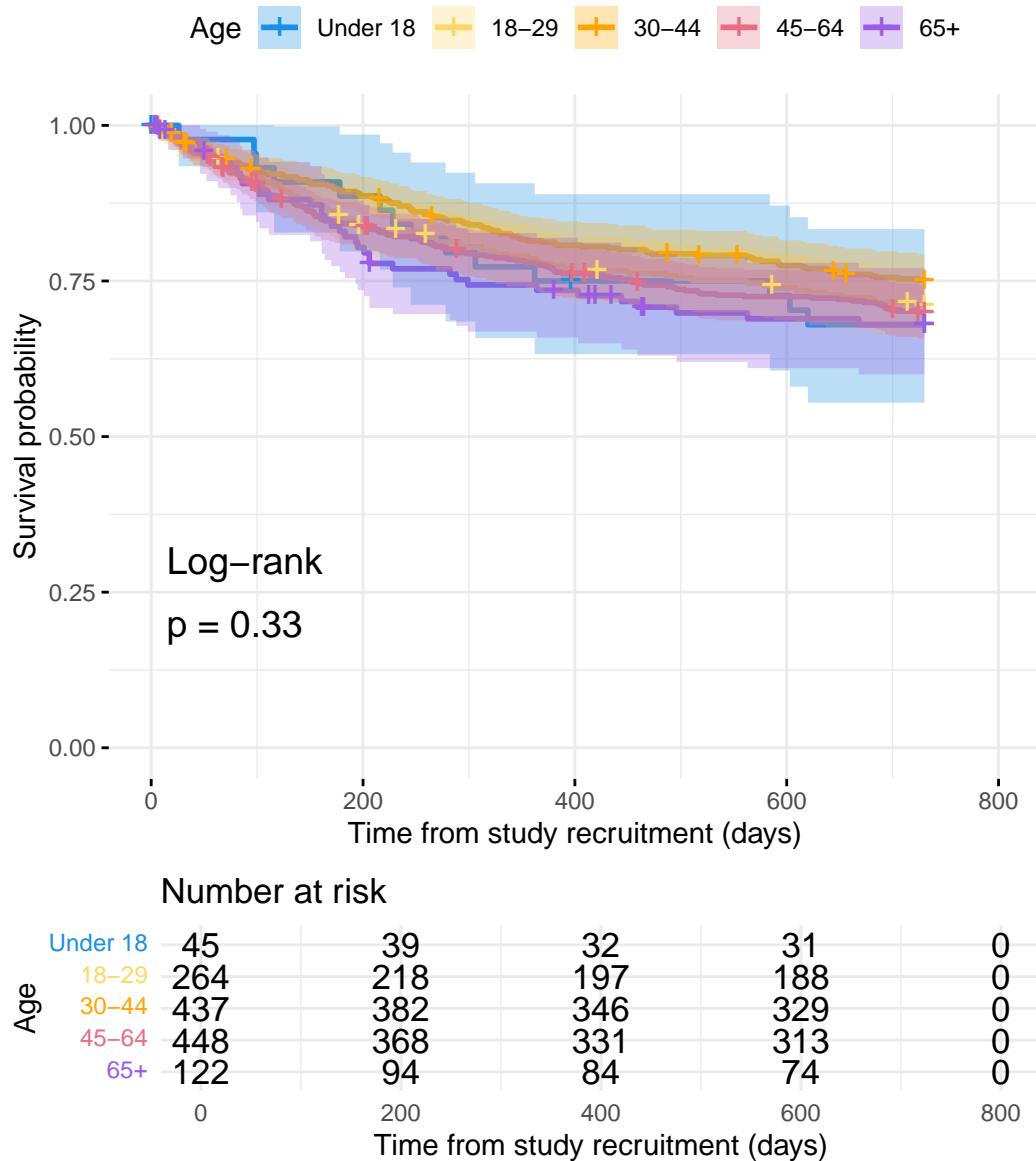
# Extract hazard ratio for Age (continuous variable)
fit.me <- coxph(
  Surv(softflare_time, softflare) ~ Sex + IMD + cat + Age + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.cd.df
)

cd.clin.forest <- rbind(cd.clin.forest, get_HR(fit.me, "Age"))

# Display plot and model summary
analysis_result$plot

```

### Time to patient-reported flare



```
invisible(cox_summary(fit.me))
```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.9948	1.5719	2.5314	0.0000
IMD2	0.9308	0.5932	1.4607	0.7552
IMD3	0.8884	0.5615	1.4056	0.6131
IMD4	0.9315	0.5990	1.4484	0.7527
IMD5	0.9621	0.6277	1.4748	0.8594
catFC 50-250	1.5738	1.2191	2.0316	0.0005
catFC > 250	2.4166	1.8207	3.2075	0.0000
Age	1.0049	0.9977	1.0121	0.1862

Diagnostics:

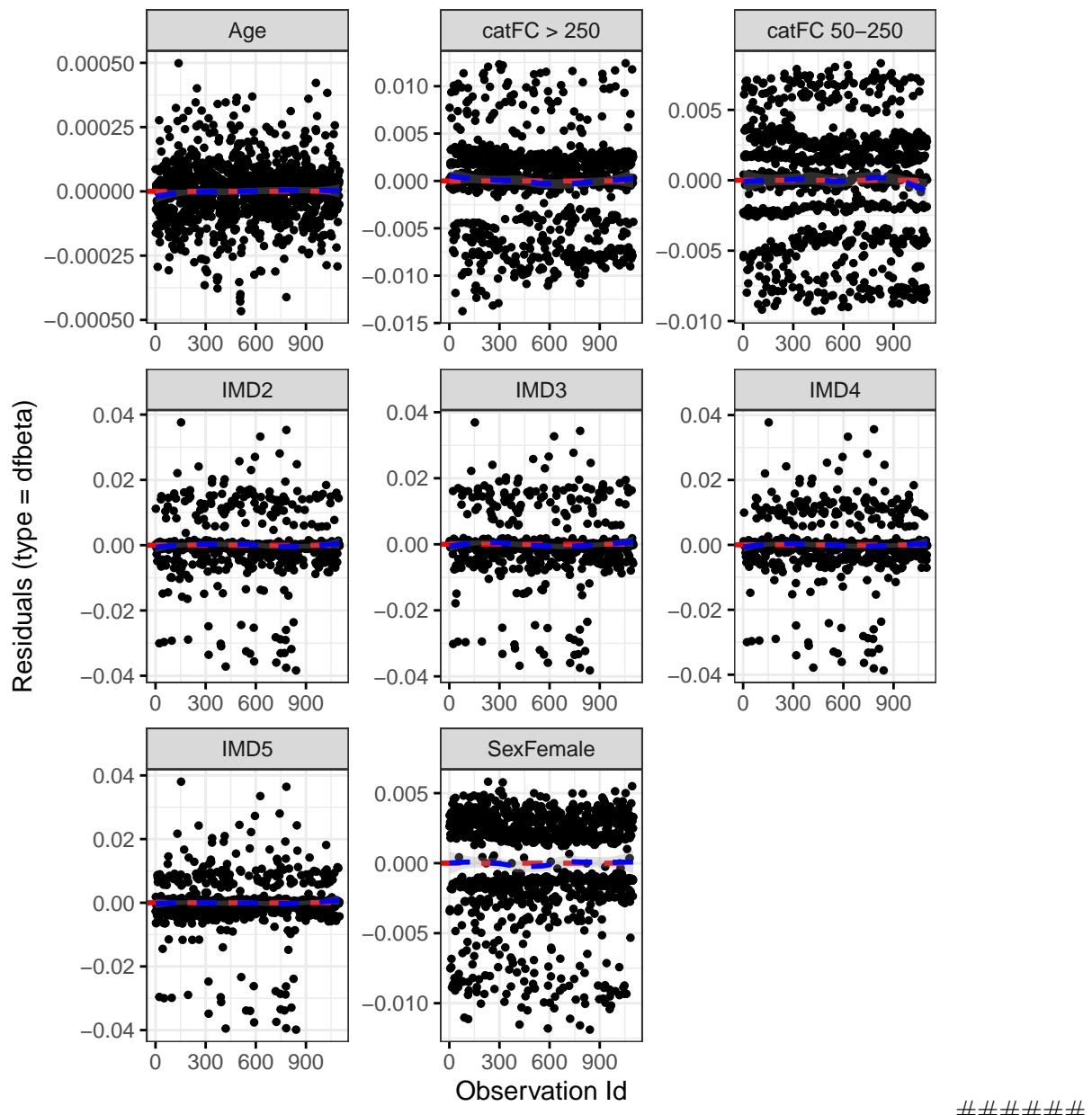
### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.2901	0.9920	0.5868
IMD	5.8012	3.9466	0.2090
cat	2.3892	1.9800	0.2989
Age	2.7170	0.9659	0.0948
GLOBAL	12.3923	15.5406	0.6865

### DF betas

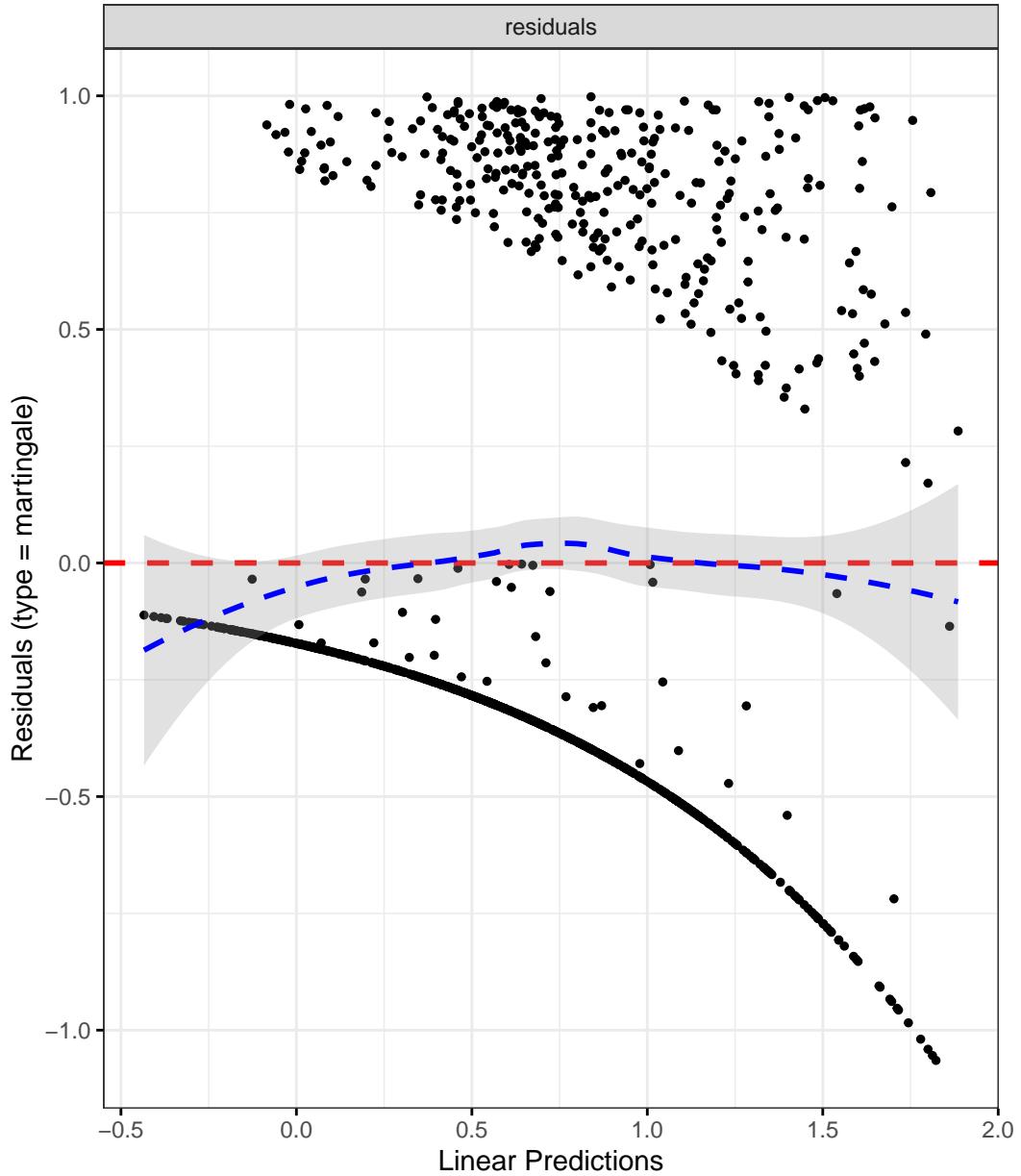
```
Warning: `gather_()` was deprecated in tidyverse 1.2.0.
  i Please use `gather()` instead.
  i The deprecated feature was likely used in the survminer package.
    Please report the issue at <https://github.com/kassambara/survminer/issues>.
```

```
`geom_smooth()` using formula = 'y ~ x'
```



Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



### Hard flare

```
# Generate survival plot and run Cox model for hard flare
analysis_result <- run_survival_analysis(
  data = flare.cd.df,
  var_name = "Age",
```

```

    outcome_time = "hardflare_time",
    outcome_event = "hardflare",
    legend_title = "Age",
    plot_base_path = "plots/cd/hard-flare/demographics/age",
    break_time_by = 500
)

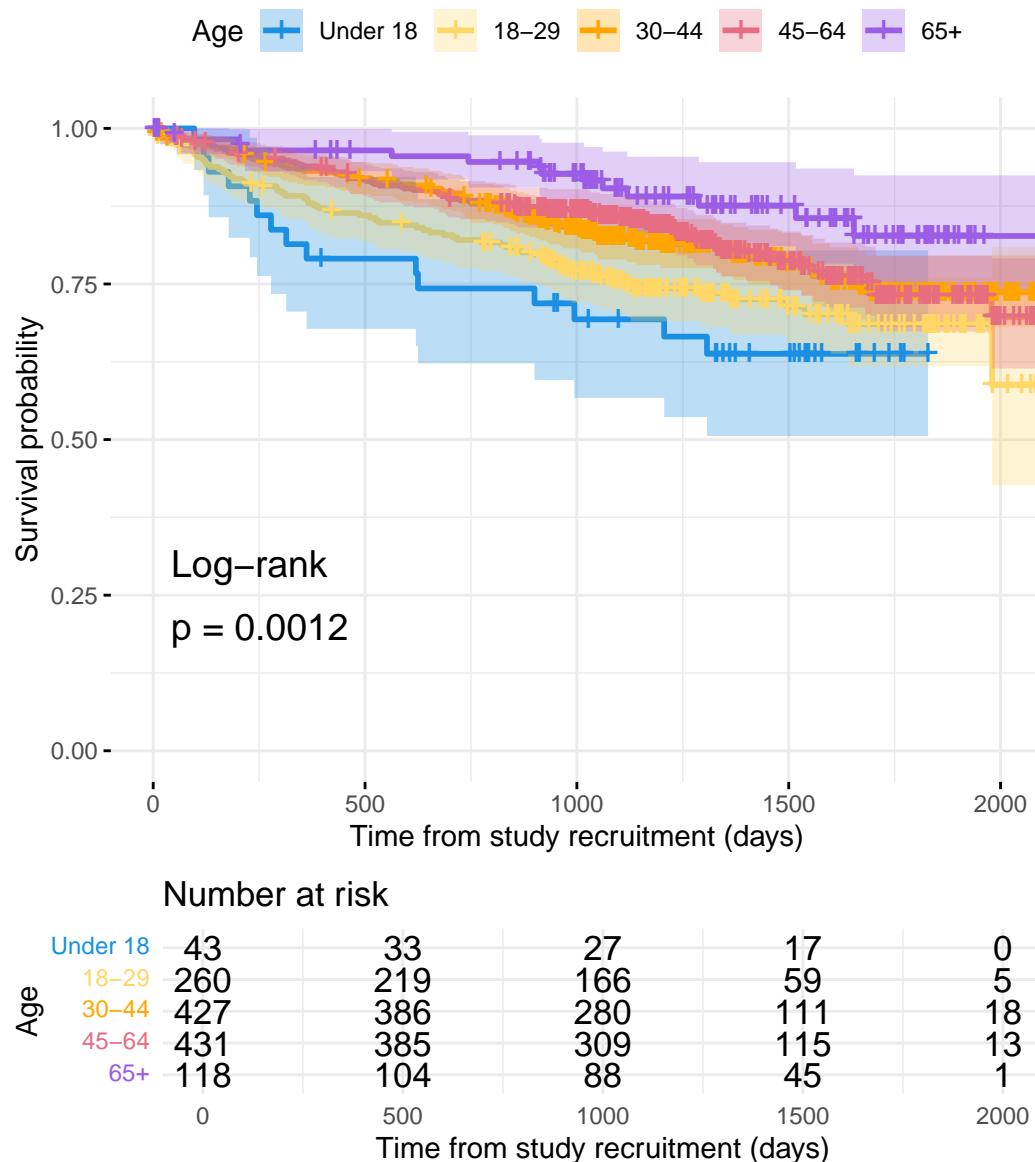
# Extract hazard ratio for Age (continuous variable)
fit.me <- coxph(
  Surv(hardflare_time, hardflare) ~ Sex + IMD + cat + Age + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.cd.df
)

cd.hard.forest <- rbind(cd.hard.forest, get_HR(fit.me, "Age"))

# Display plot and model summary
analysis_result$plot

```

### Time to hard flare



```
invisible(cox_summary(fit.me))
```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.4100	1.0742	1.8506	0.0133
IMD2	0.9220	0.5371	1.5828	0.7684
IMD3	0.9333	0.5377	1.6200	0.8061
IMD4	0.9037	0.5282	1.5462	0.7117
IMD5	0.9530	0.5672	1.6014	0.8559
catFC 50-250	2.0702	1.5083	2.8414	0.0000
catFC > 250	3.3191	2.3583	4.6712	0.0000
Age	0.9865	0.9779	0.9953	0.0026

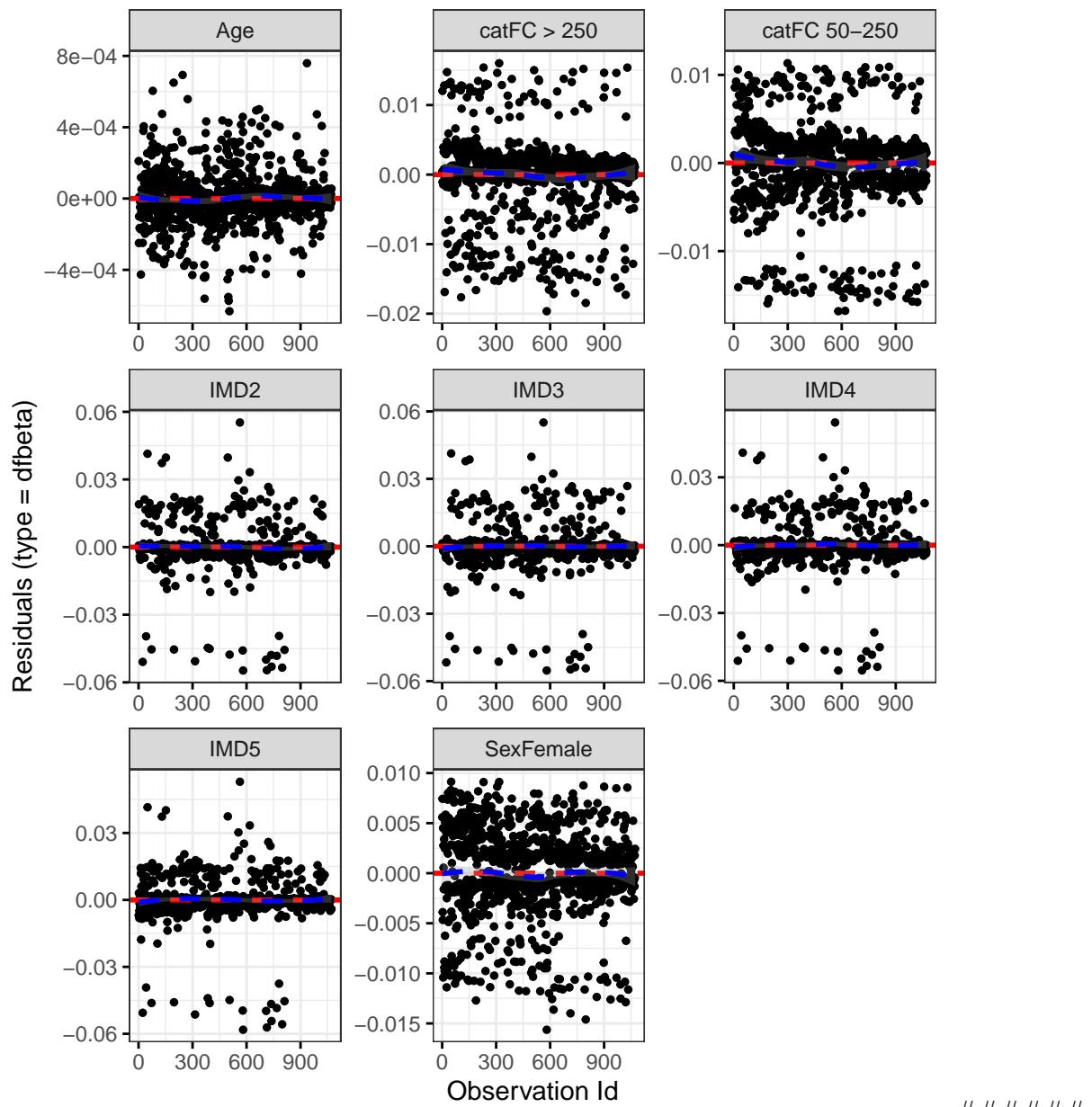
Diagnostics:

### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.2070	0.9856	0.6432
IMD	4.3372	3.9449	0.3546
cat	8.6873	1.9855	0.0128
Age	3.3245	0.9503	0.0635
GLOBAL	16.4294	18.2438	0.5790

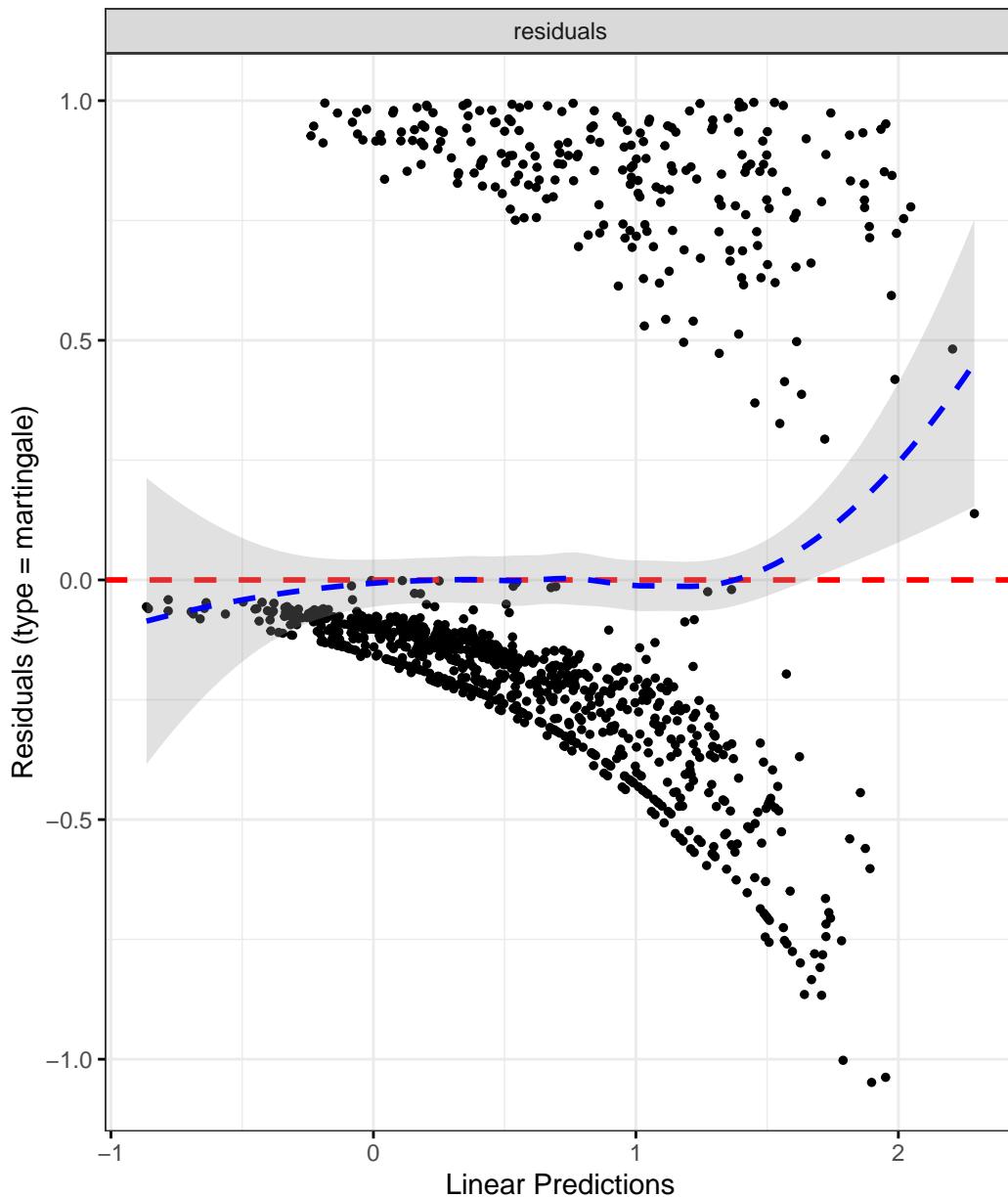
### DF betas

```
`geom_smooth()` using formula = 'y ~ x'
```



Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



**Ulcerative colitis**

**Patient-reported flare**

```
# Categorize age  
flare.uc.df <- categorize_variable(flare.uc.df, "Age",
```

```

        breaks = c(0, 18, 30, 45, 65, Inf),
        labels = c("Under 18", "18-29", "30-44", "45-64", "65+"))

# Generate survival plot and run Cox model
analysis_result <- run_survival_analysis(
  data = flare.uc.df,
  var_name = "Age",
  outcome_time = "softflare_time",
  outcome_event = "softflare",
  legend_title = "Age",
  plot_base_path = "plots/uc/soft-flare/demographics/age",
  break_time_by = 200
)

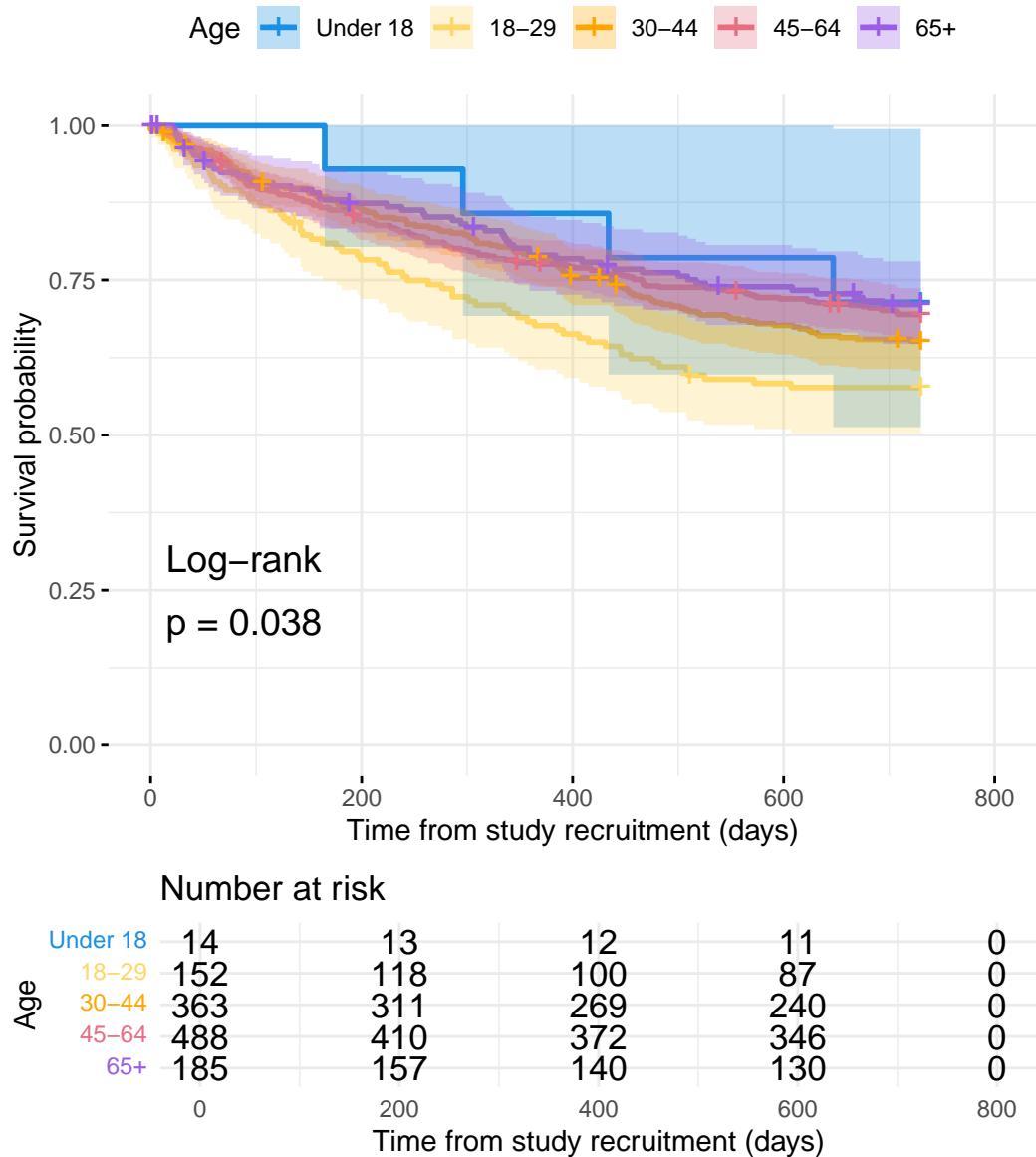
# Extract hazard ratio for Age (continuous variable)
fit.me <- coxph(
  Surv(softflare_time, softflare) ~ Sex + IMD + cat + Age + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.uc.df
)

uc.clin.forest <- rbind(uc.clin.forest, get_HR(fit.me, "Age"))

# Display plot and model summary
analysis_result$plot

```

### Time to patient-reported flare



```
invisible(cox_summary(fit.me))
```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.5135	1.2220	1.8747	0.0001
IMD2	1.2074	0.7621	1.9129	0.4220
IMD3	1.0923	0.6966	1.7126	0.7006
IMD4	1.4407	0.9378	2.2131	0.0955
IMD5	1.2134	0.7953	1.8512	0.3695
catFC 50-250	1.5856	1.2399	2.0277	0.0002
catFC > 250	2.1185	1.6228	2.7658	0.0000
Age	0.9928	0.9857	0.9998	0.0449

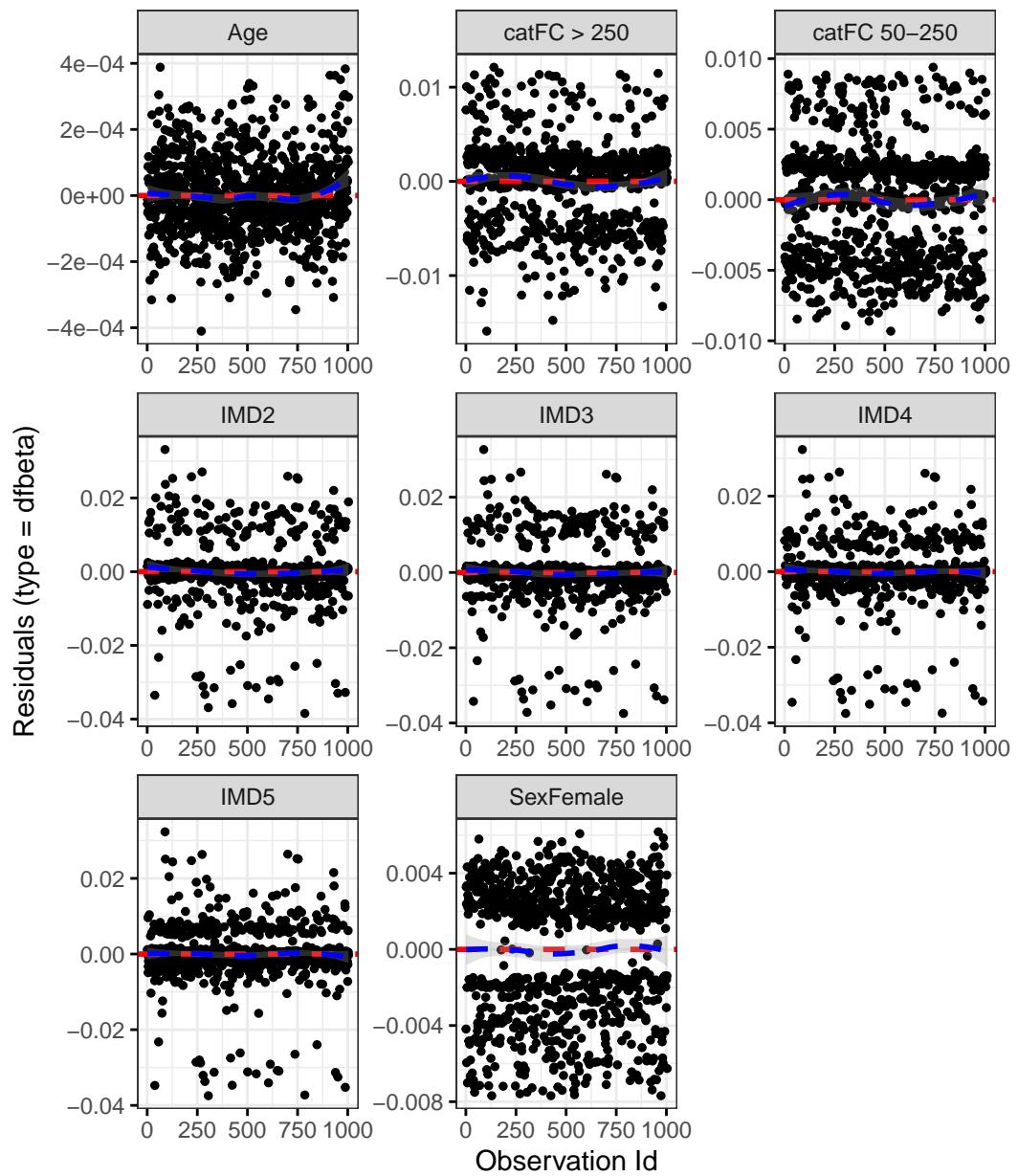
Diagnostics:

### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	1.2765	0.9891	0.2555
IMD	3.9850	3.9439	0.3998
cat	5.7478	1.9712	0.0549
Age	0.2636	0.9656	0.5931
GLOBAL	11.8199	19.6624	0.9132

### DF betas

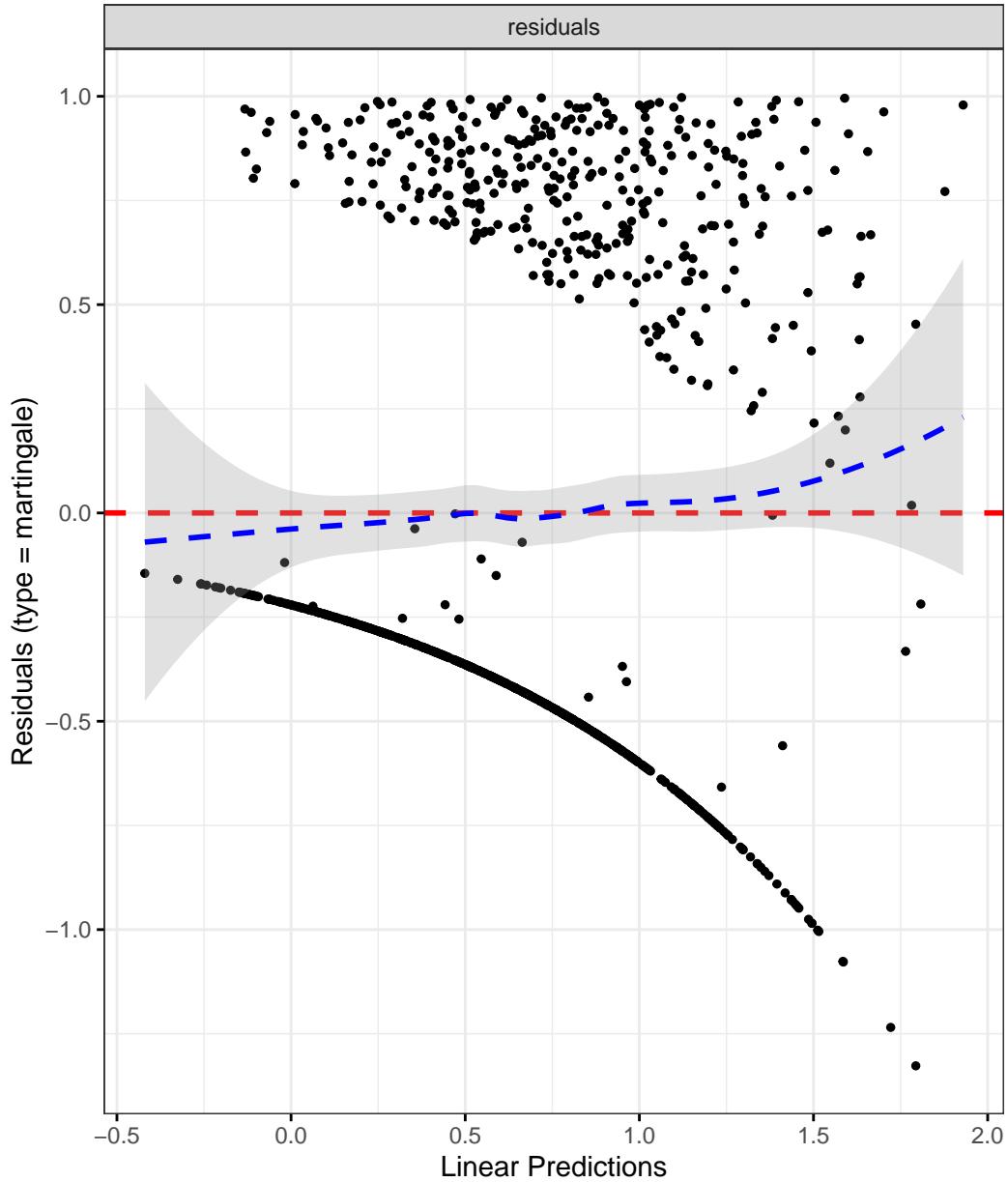
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



### Hard flare

```
# Generate survival plot and run Cox model for hard flare
analysis_result <- run_survival_analysis(
  data = flare.uc.df,
  var_name = "Age",
```

```

    outcome_time = "hardflare_time",
    outcome_event = "hardflare",
    legend_title = "Age",
    plot_base_path = "plots/uc/hard-flare/demographics/age",
    break_time_by = 500
)

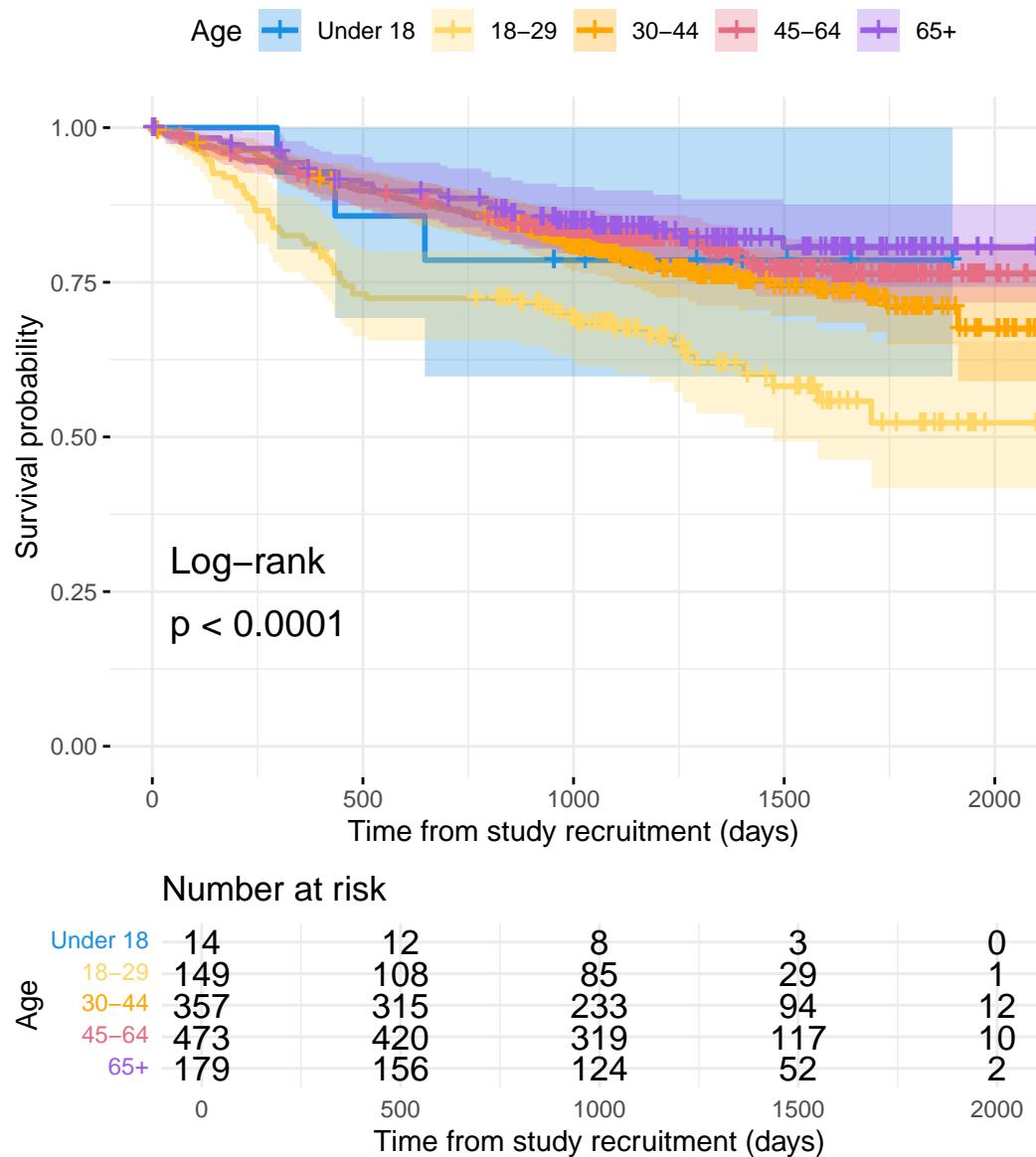
# Extract hazard ratio for Age (continuous variable)
fit.me <- coxph(
  Surv(hardflare_time, hardflare) ~ Sex + IMD + cat + Age + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.uc.df
)

uc.hard.forest <- rbind(uc.hard.forest, get_HR(fit.me, "Age"))

# Display plot and model summary
analysis_result$plot

```

### Time to hard flare



```
invisible(cox_summary(fit.me))
```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.2937	0.9958	1.6807	0.0538
IMD2	1.3555	0.7565	2.4289	0.3067
IMD3	1.3777	0.7842	2.4203	0.2650
IMD4	1.7536	1.0168	3.0242	0.0434
IMD5	1.3509	0.7875	2.3173	0.2747
catFC 50-250	2.0872	1.5288	2.8495	0.0000
catFC > 250	3.1867	2.3015	4.4124	0.0000
Age	0.9882	0.9794	0.9971	0.0094

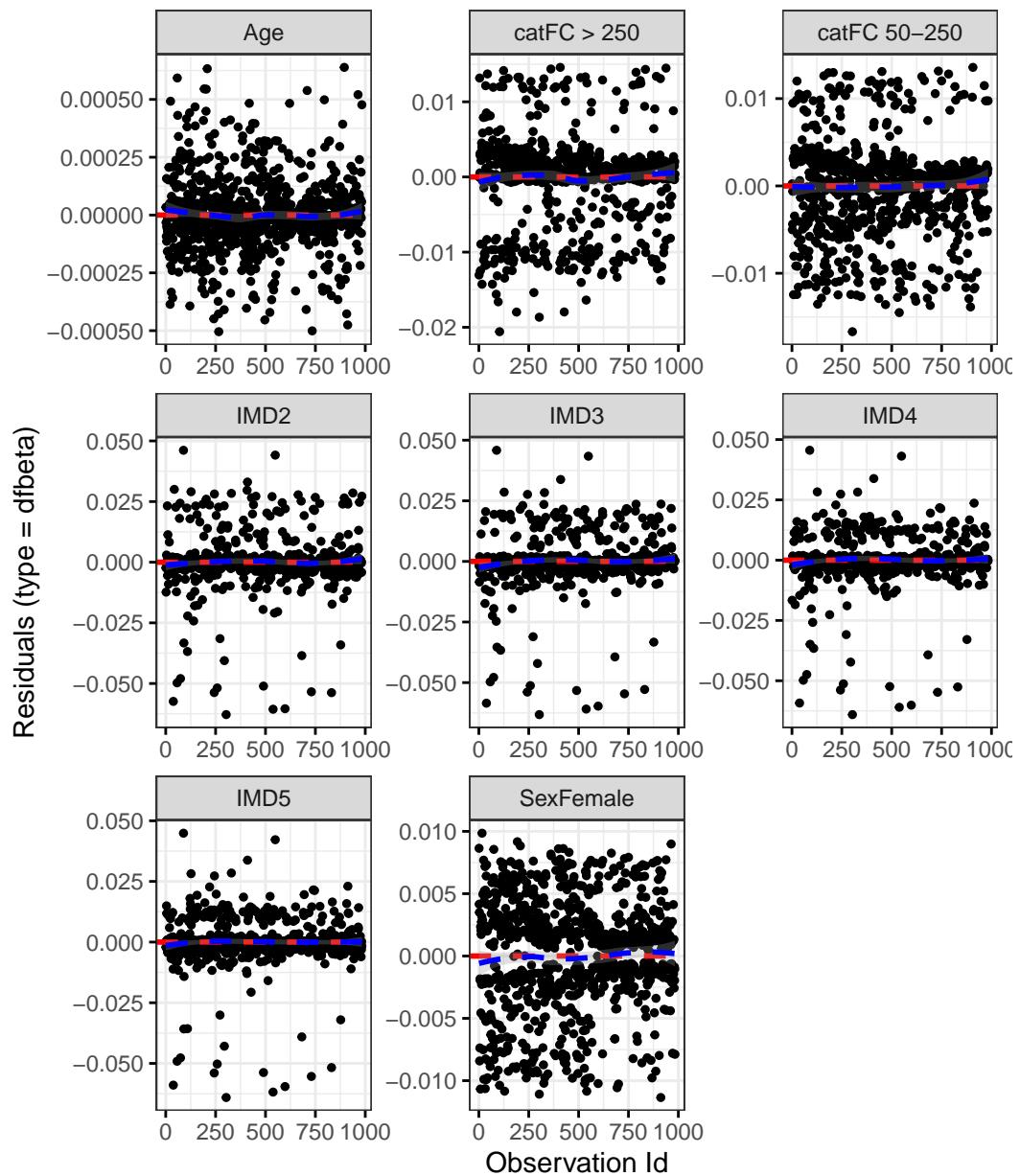
Diagnostics:

### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.1150	0.9847	0.7285
IMD	2.7089	3.9421	0.5986
cat	4.0990	1.9687	0.1255
Age	0.3529	0.9656	0.5381
GLOBAL	7.4819	23.1362	0.9991

### DF betas

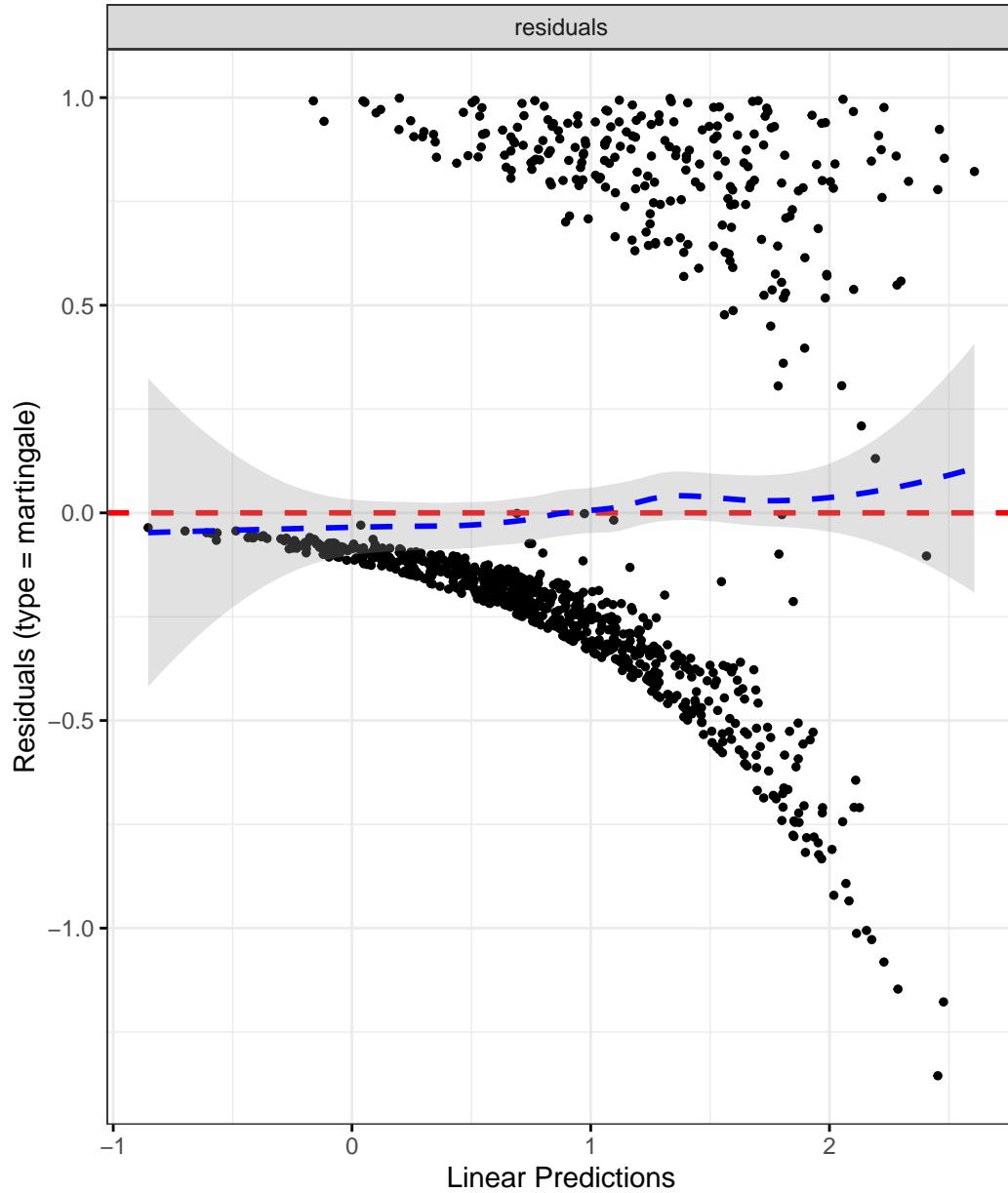
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



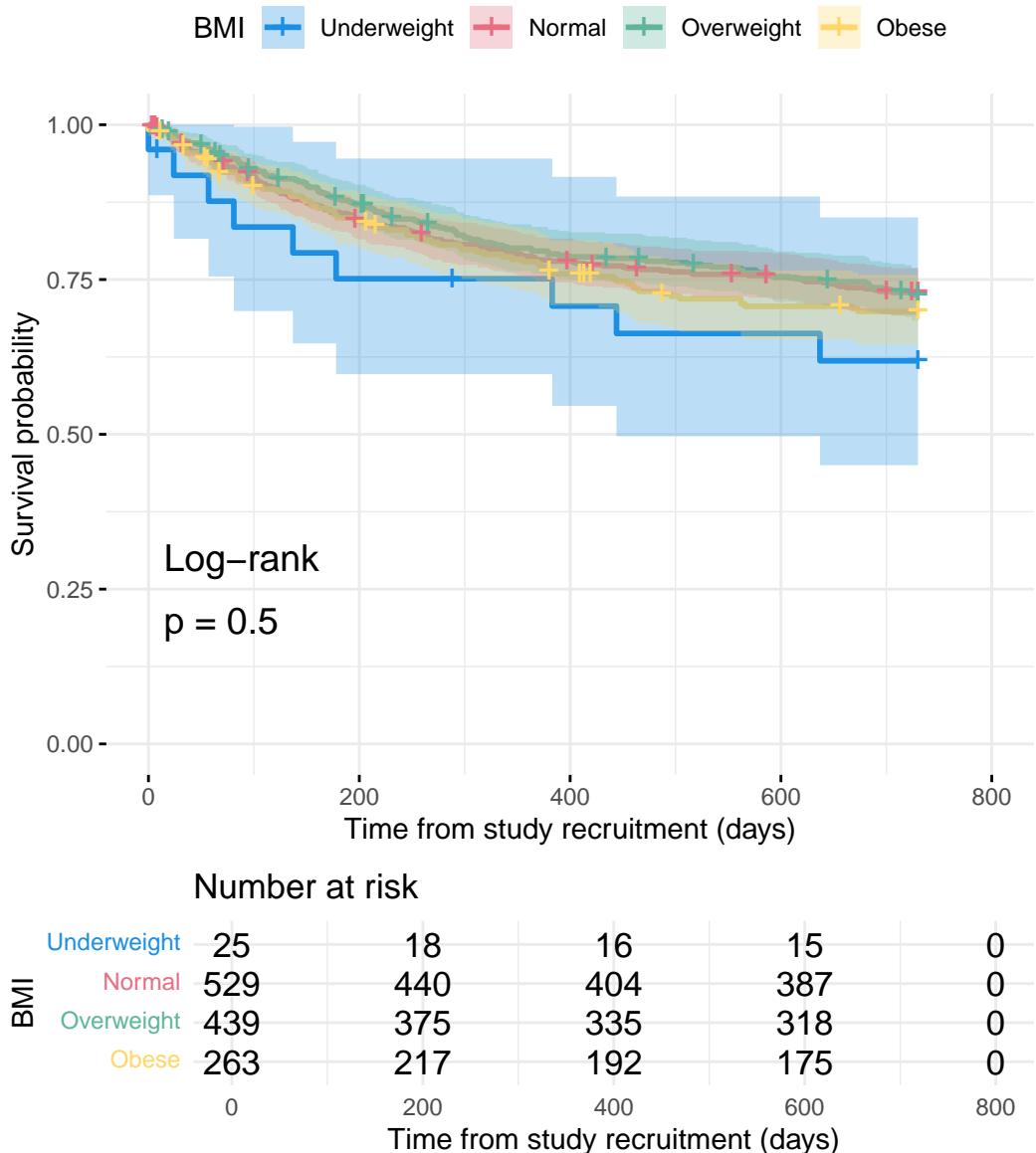
**BMI**

**Crohn's disease**

**Patient-reported flare**

```
p <- generate_survival_plot(  
  data = flare.cd.df,  
  formula = Surv(softflare_time, softflare) ~ BMIcat,  
  legend_title = "BMI",  
  legend_labs = c("Underweight", "Normal", "Overweight", "Obese"),  
  palette = c("#1A8FE3", "#E76D83", "#5FB49C", "#FED766"),  
  xlab = "Time from study recruitment (days)",  
  title = "Time to clinical flare",  
  break_time_by = 200,  
  plot_path = "plots/cd/soft-flare/demographics/bmi"  
)  
  
print(p, newpage = FALSE)
```

### Time to clinical flare



```

fit.me <- coxph(
  Surv(softflare_time, softflare) ~
    Sex + IMD + cat + BMI + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.cd.df
)

```

```

cd.clin.forest <- rbind(
  cd.clin.forest,
  get_HR(fit.me, c("BMI"))
)

invisible(cox_summary(fit.me))

```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	2.1473	1.6736	2.7550	0.0000
IMD2	0.8998	0.5671	1.4279	0.6542
IMD3	0.8895	0.5555	1.4243	0.6258
IMD4	0.9343	0.5951	1.4667	0.7676
IMD5	0.9772	0.6332	1.5081	0.9171
catFC 50-250	1.5540	1.1972	2.0170	0.0009
catFC > 250	2.2569	1.6787	3.0342	0.0000
BMI	1.0122	0.9911	1.0337	0.2594

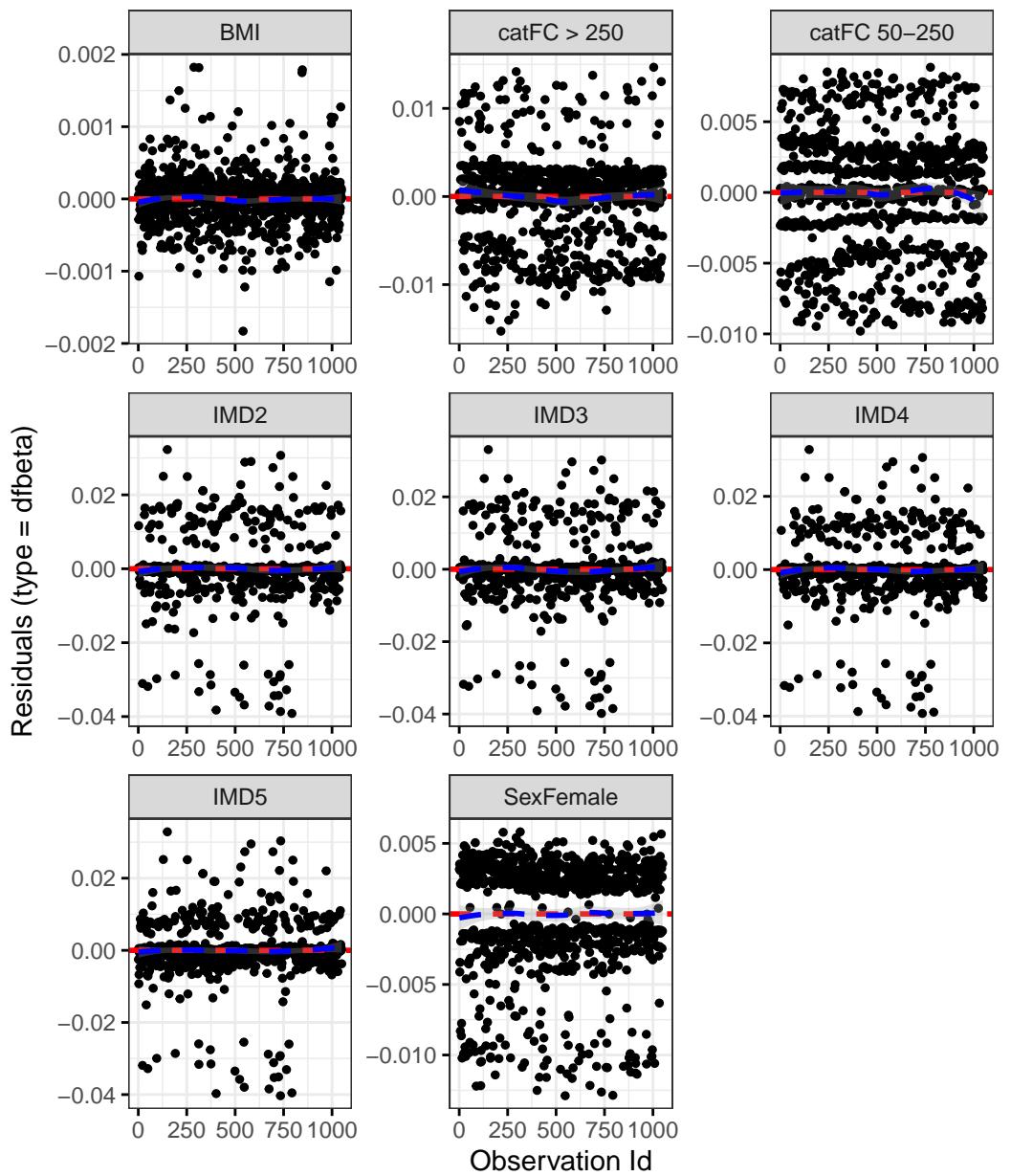
Diagnostics:

### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.1734	0.9925	0.6740
IMD	6.5777	3.9477	0.1556
cat	1.5900	1.9797	0.4468
BMI	2.3144	0.9900	0.1265
GLOBAL	10.2401	14.8159	0.7941

### DF betas

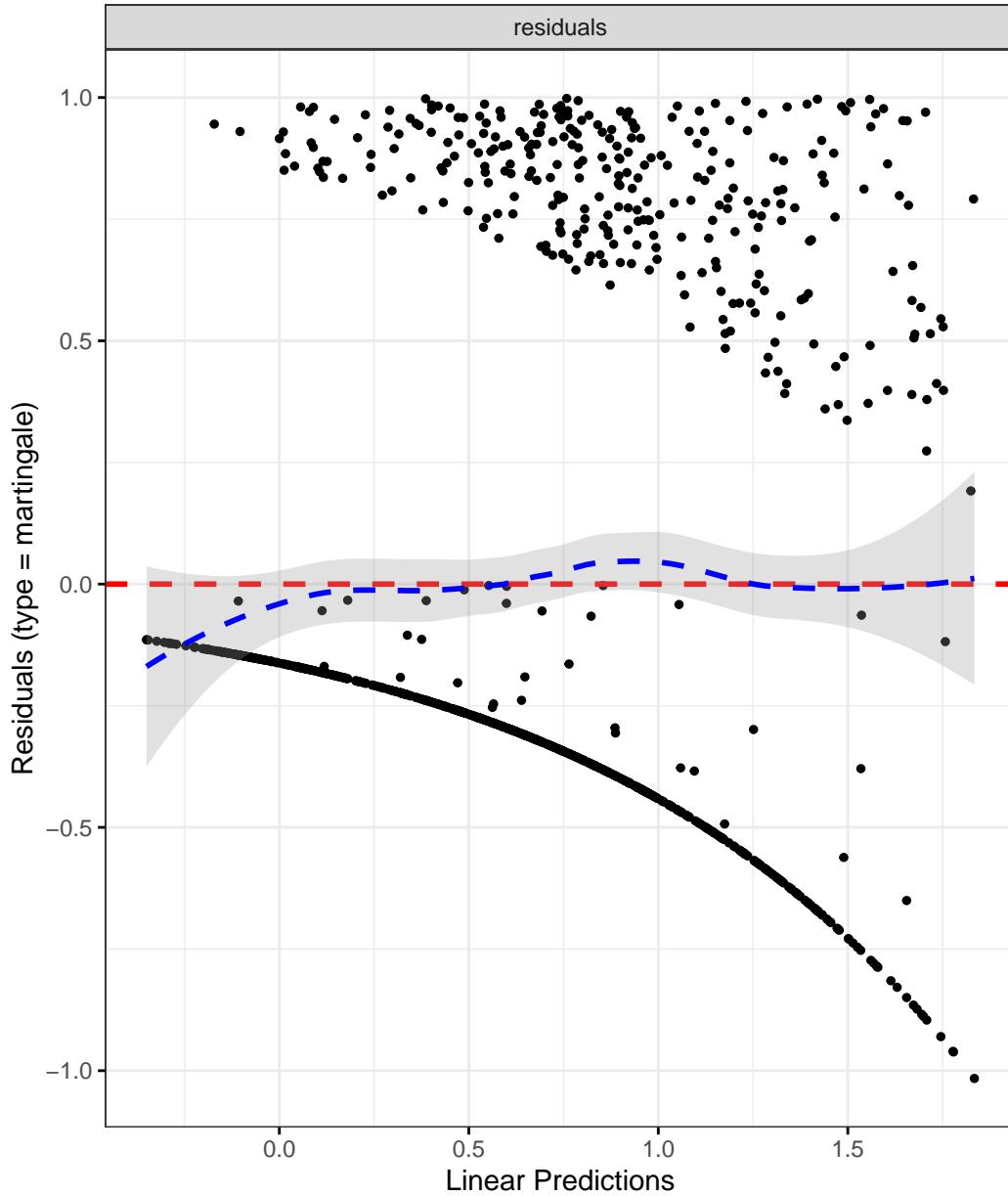
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```

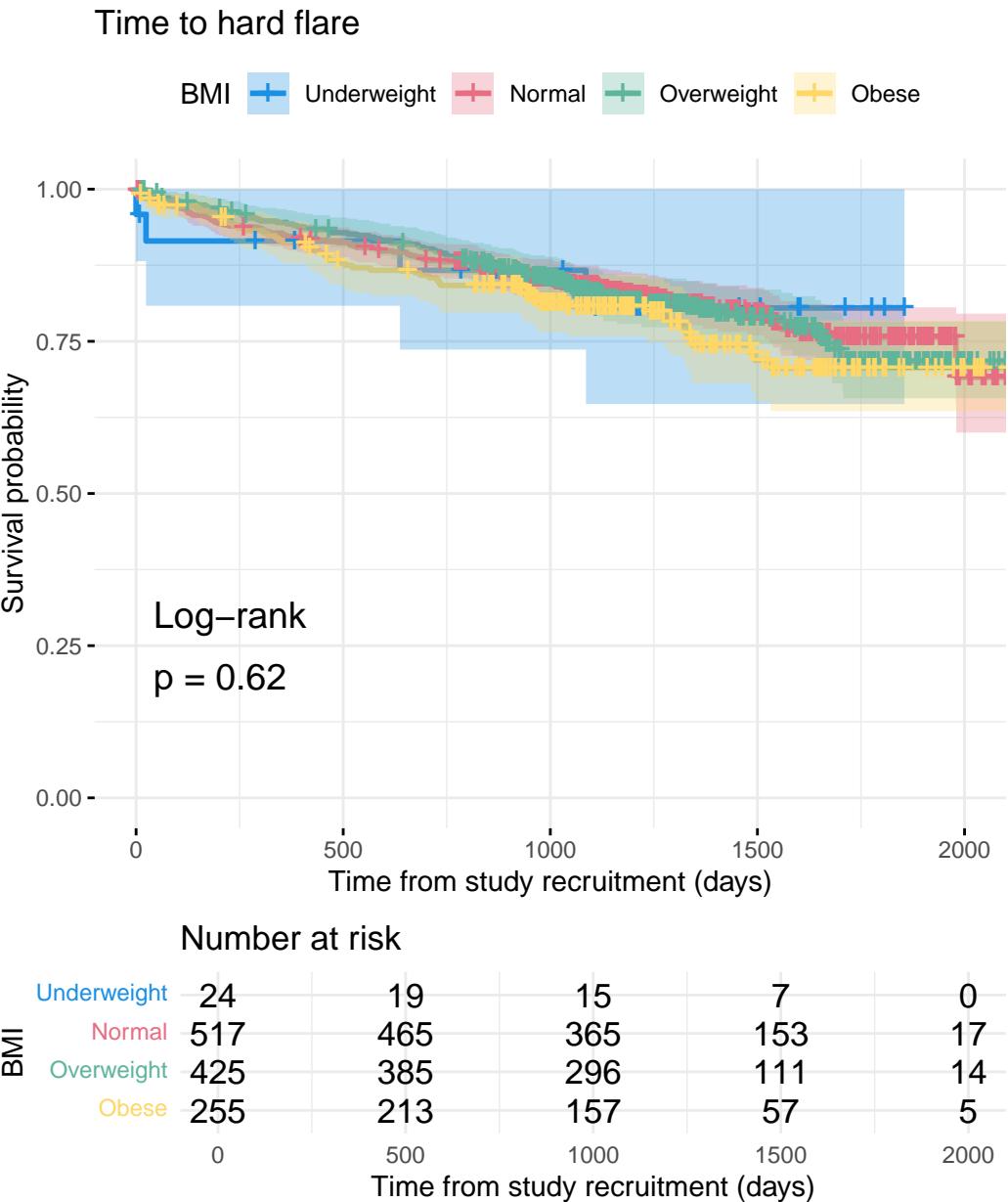


## Hard flare

```
p <- generate_survival_plot(  
  data = flare.cd.df,  
  formula = Surv(hardflare_time, hardflare) ~ BMIcat,  
  legend_title = "BMI",
```

```
legend_labs = c("Underweight", "Normal", "Overweight", "Obese"),
palette = c("#1A8FE3", "#E76D83", "#5FB49C", "#FED766"),
xlab = "Time from study recruitment (days)",
title = "Time to hard flare",
break_time_by = 500,
plot_path = "plots/cd/hard-flare/demographics/bmi"
)

print(p, newpage = FALSE)
```



```
fit.me <- coxph(
  Surv(hardflare_time, hardflare) ~
    Sex + IMD + cat + BMI + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.cd.df
)
```

```

cd.hard.forest <- rbind(
  cd.hard.forest,
  get_HR(fit.me, c("BMI"))
)

invisible(cox_summary(fit.me))

```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.5011	1.1295	1.9950	0.0051
IMD2	0.9513	0.5451	1.6599	0.8604
IMD3	0.9658	0.5454	1.7103	0.9050
IMD4	0.8451	0.4830	1.4788	0.5556
IMD5	0.9334	0.5478	1.5906	0.8001
catFC 50-250	2.0103	1.4508	2.7857	0.0000
catFC > 250	3.1451	2.1945	4.5074	0.0000
BMI	1.0200	0.9949	1.0456	0.1187

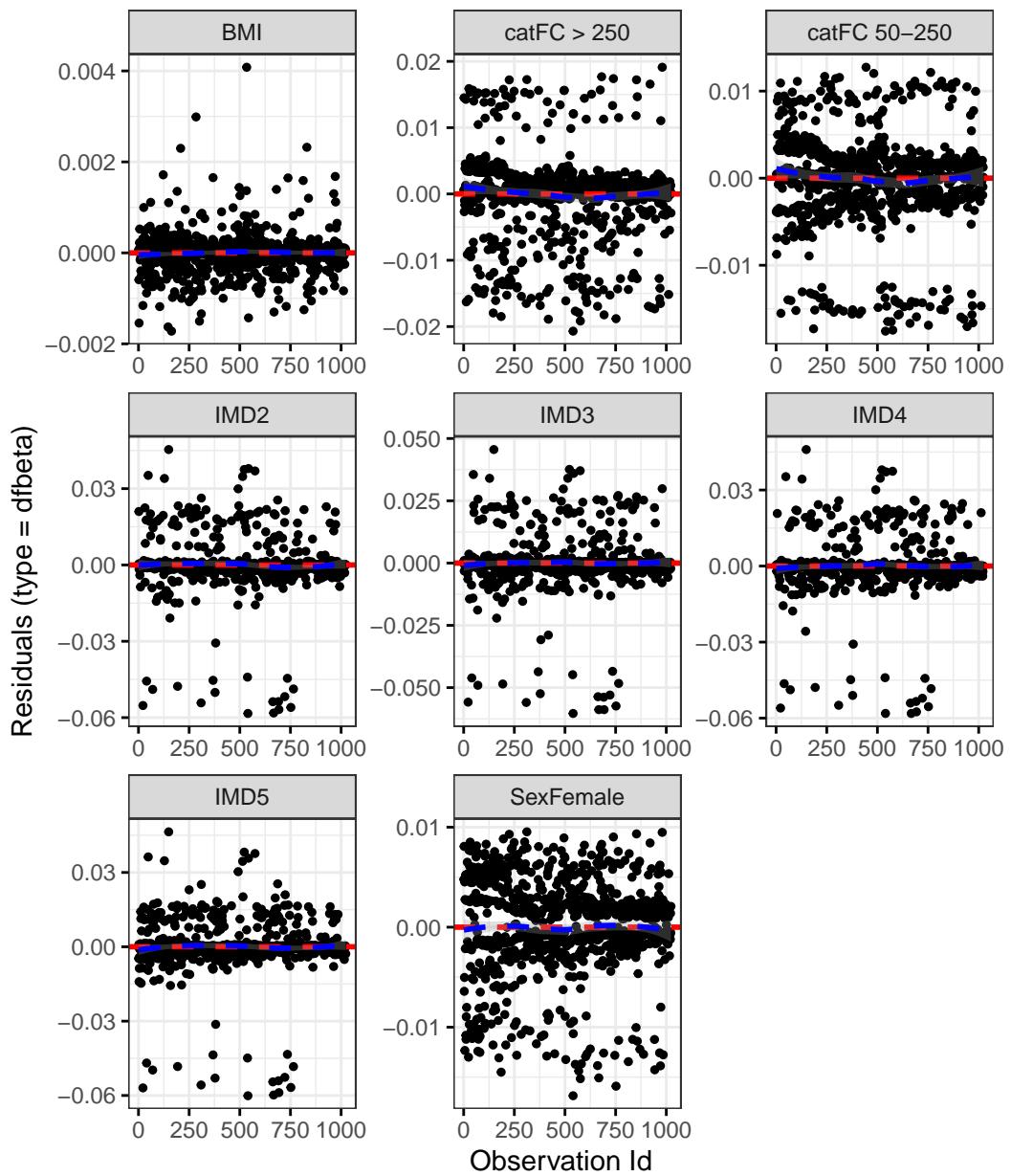
Diagnostics:

### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.8263	0.9880	0.3591
IMD	3.6654	3.9453	0.4448
cat	7.2453	1.9854	0.0263
BMI	3.8299	0.9886	0.0495
GLOBAL	15.1563	17.4781	0.6169

### DF betas

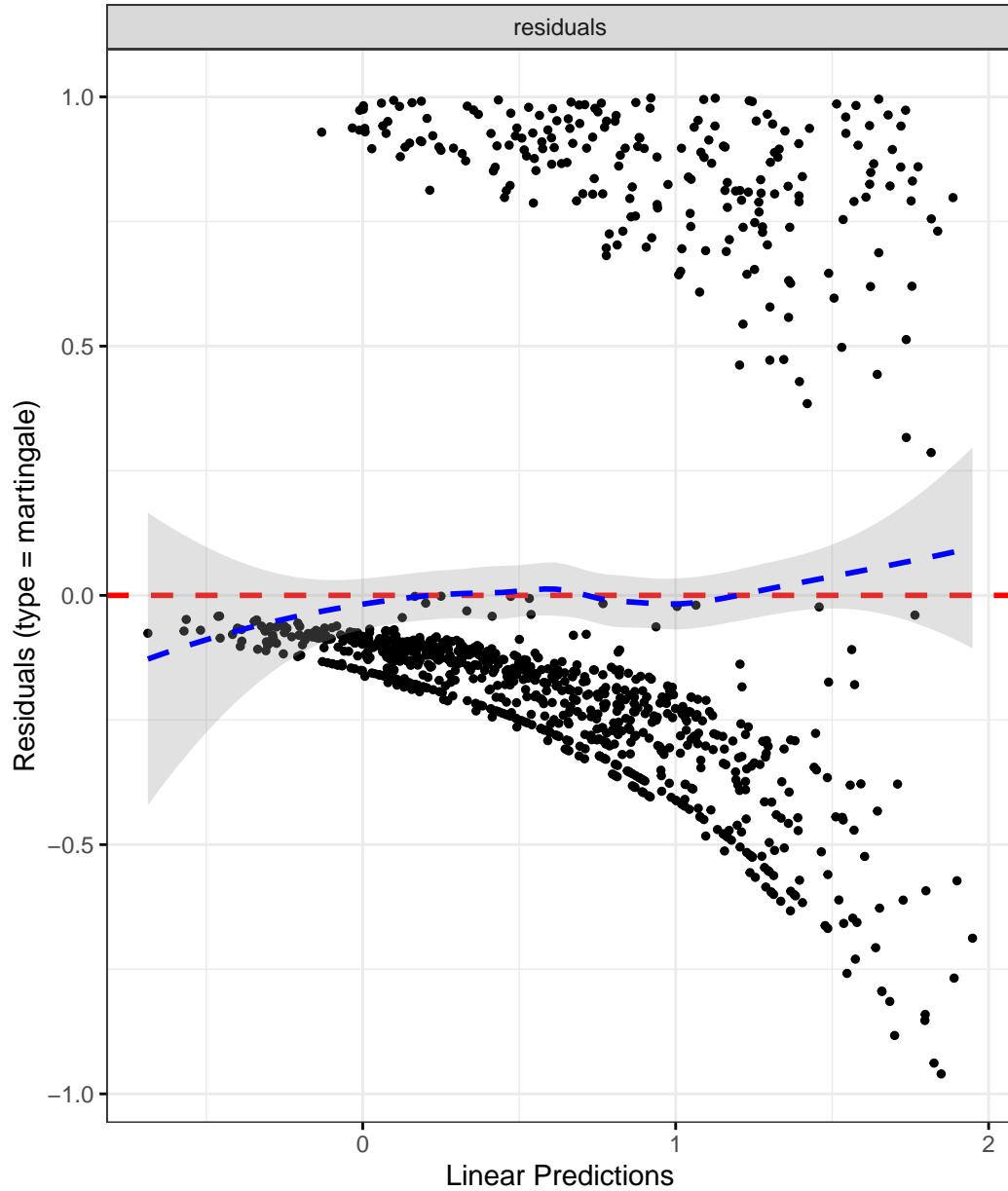
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```

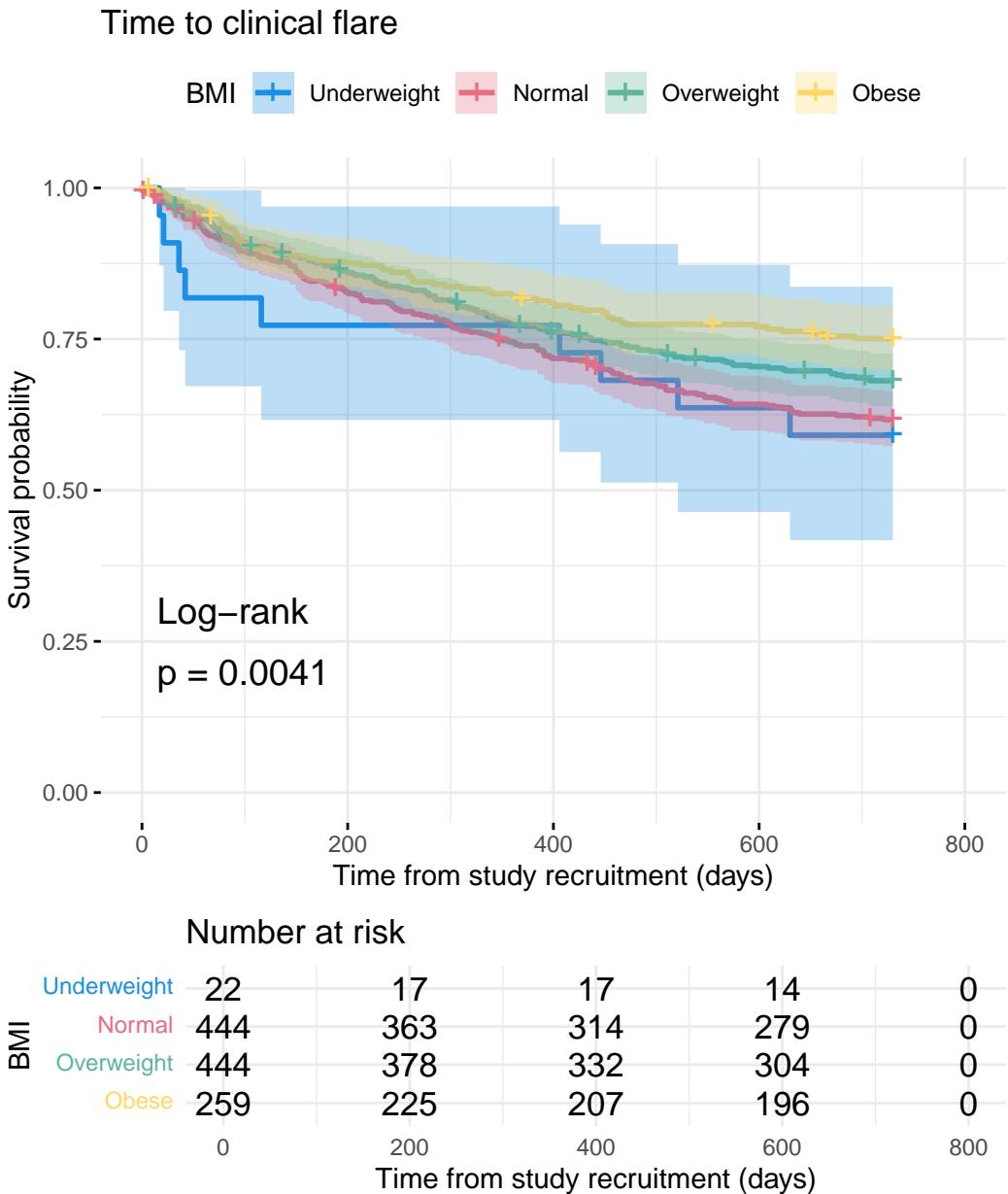


**Ulcerative colitis**

**Patient-reported flare**

```
p <- generate_survival_plot(  
  data = flare.uc.df,
```

```
formula = Surv(softflare_time, softflare) ~ BMIcat,
legend_title = "BMI",
legend_labs = c("Underweight", "Normal", "Overweight", "Obese"),
palette = c("#1A8FE3", "#E76D83", "#5FB49C", "#FED766"),
xlab = "Time from study recruitment (days)",
title = "Time to clinical flare",
break_time_by = 200,
plot_path = "plots/uc/soft-flare/demographics/bmi"
)
print(p, newpage = FALSE)
```



```
fit.me <- coxph(
  Surv(softflare_time, softflare) ~
    Sex + IMD + cat + BMI + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.uc.df
)
uc.clin.forest <- rbind(
```

```

uc.clin.forest,
get_HR(fit.me, c("BMI"))
)
invisible(cox_summary(fit.me))

```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.5667	1.2601	1.9478	0.0001
IMD2	1.2357	0.7747	1.9711	0.3743
IMD3	1.0037	0.6340	1.5890	0.9873
IMD4	1.4156	0.9159	2.1878	0.1177
IMD5	1.1137	0.7241	1.7128	0.6240
catFC 50-250	1.6181	1.2586	2.0803	0.0002
catFC > 250	2.1566	1.6473	2.8235	0.0000
BMI	0.9686	0.9481	0.9896	0.0035

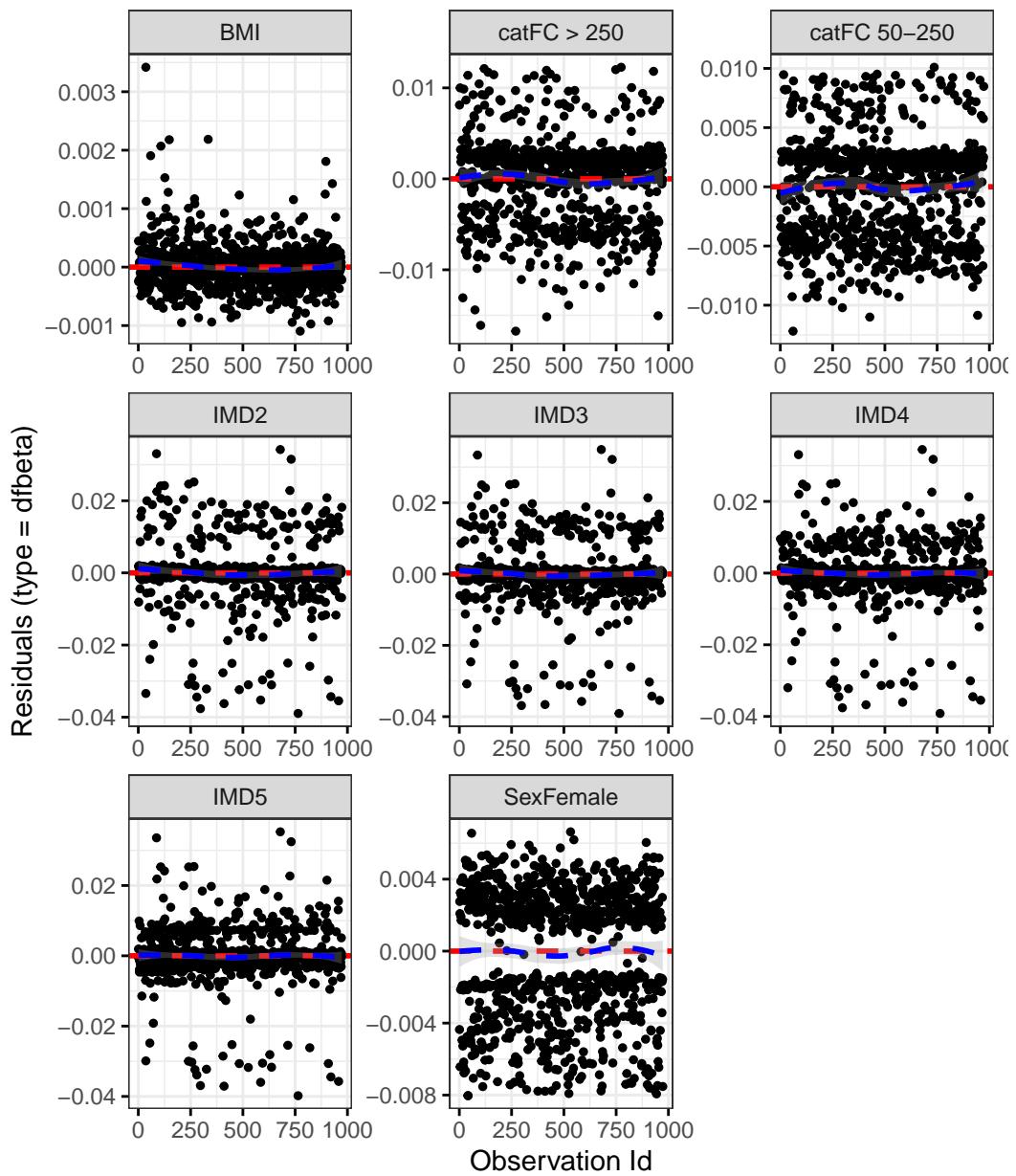
Diagnostics:

#### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	1.3437	0.9904	0.2438
IMD	3.8474	3.9456	0.4189
cat	4.7128	1.9726	0.0925
BMI	0.4838	0.9851	0.4807
GLOBAL	10.4559	17.3504	0.8958

#### DF betas

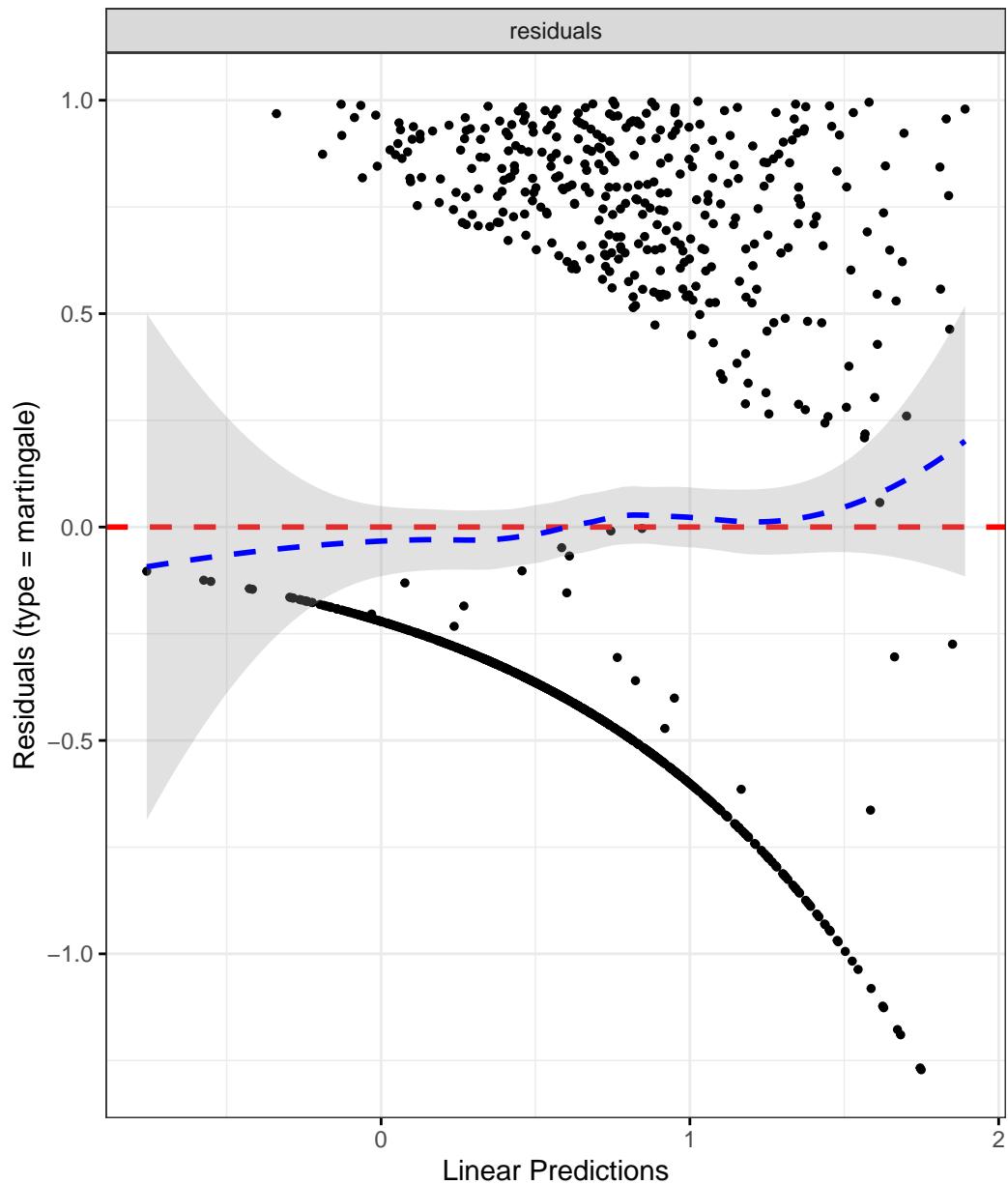
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



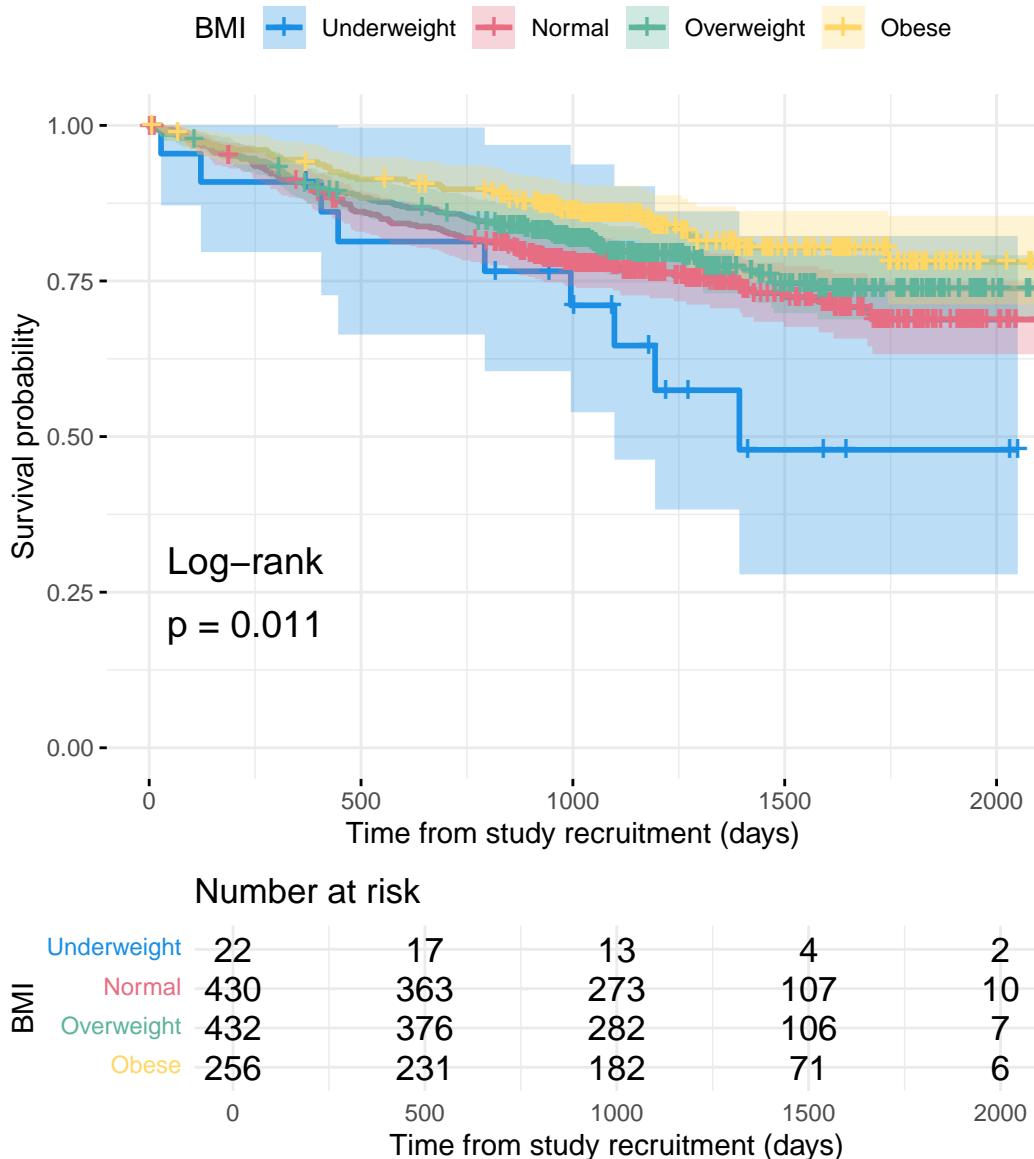
### Hard flare

```
p <- generate_survival_plot(
  data = flare.uc.df,
  formula = Surv(hardflare_time, hardflare) ~ BMIcat,
  legend_title = "BMI",
```

```
legend_labs = c("Underweight", "Normal", "Overweight", "Obese"),
palette = c("#1A8FE3", "#E76D83", "#5FB49C", "#FED766"),
xlab = "Time from study recruitment (days)",
title = "Time to hard flare",
break_time_by = 500,
plot_path = "plots/uc/hard-flare/demographics/bmi"
)

print(p, newpage = FALSE)
```

### Time to hard flare



```
fit.me <- coxph(
  Surv(hardflare_time, hardflare) ~
    Sex + IMD + cat + BMI + frailty(SiteNo),
  control = coxph.control(outer.max = 20),
  data = flare.uc.df
)
uc.hard.forest <- rbind(
```

```

uc.hard.forest,
get_HR(fit.me, "BMI")
)
invisible(cox_summary(fit.me))

```

Cox model summary:

Variable	HR	Lower 95%	Upper 95%	P-value
SexFemale	1.3542	1.0359	1.7703	0.0265
IMD2	1.4226	0.7804	2.5931	0.2499
IMD3	1.3567	0.7598	2.4225	0.3024
IMD4	1.7491	0.9986	3.0636	0.0506
IMD5	1.2764	0.7316	2.2270	0.3902
catFC 50-250	2.0568	1.4948	2.8299	0.0000
catFC > 250	3.2137	2.3058	4.4790	0.0000
BMI	0.9808	0.9558	1.0065	0.1415

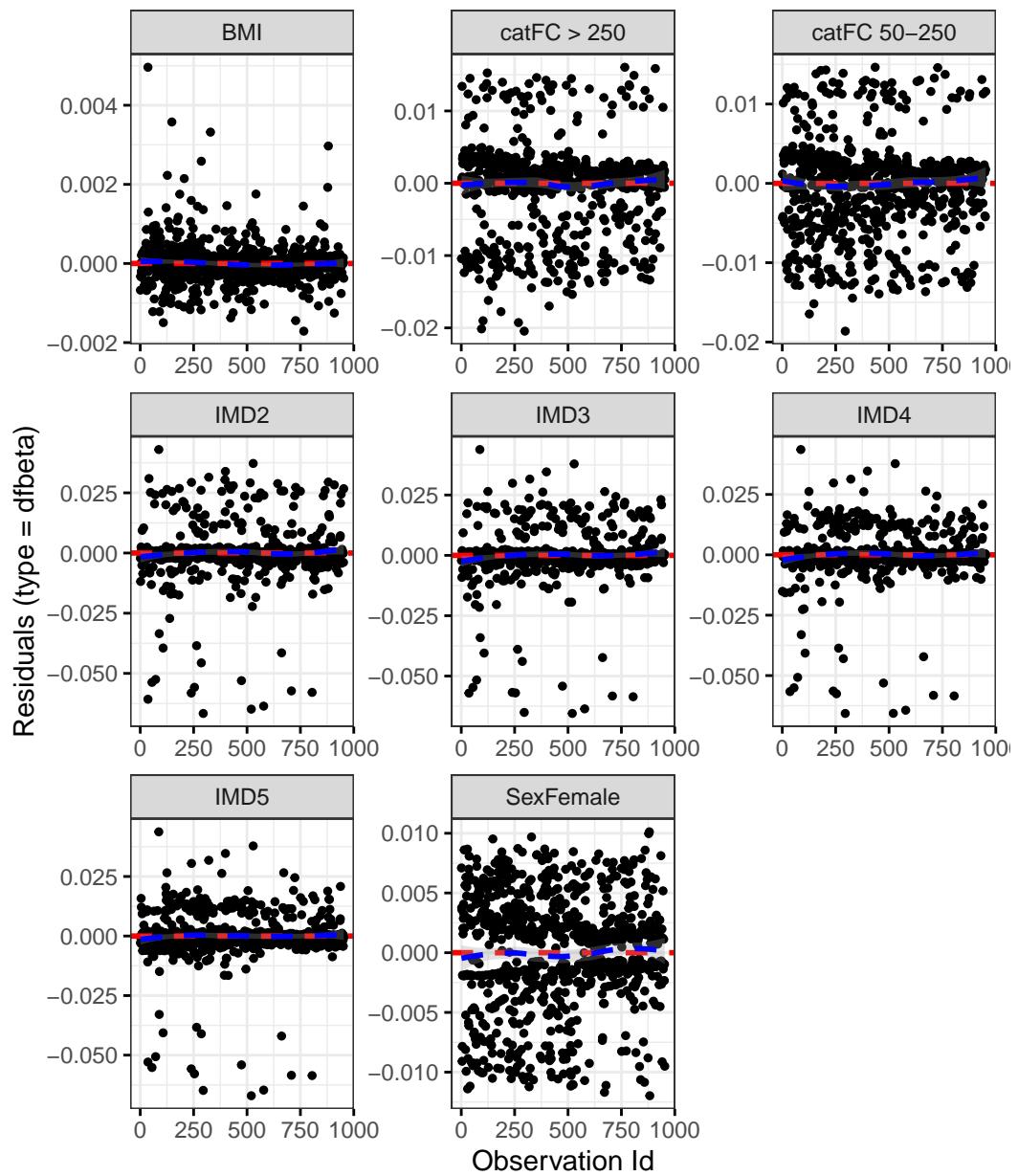
Diagnostics:

#### Proportional hazards assumption test

	Chi-squared statistic	DF	P-value
Sex	0.1486	0.9850	0.6938
IMD	2.5015	3.9358	0.6345
cat	3.5648	1.9672	0.1640
BMI	0.1512	0.9853	0.6915
GLOBAL	6.9035	22.4944	0.9993

#### DF betas

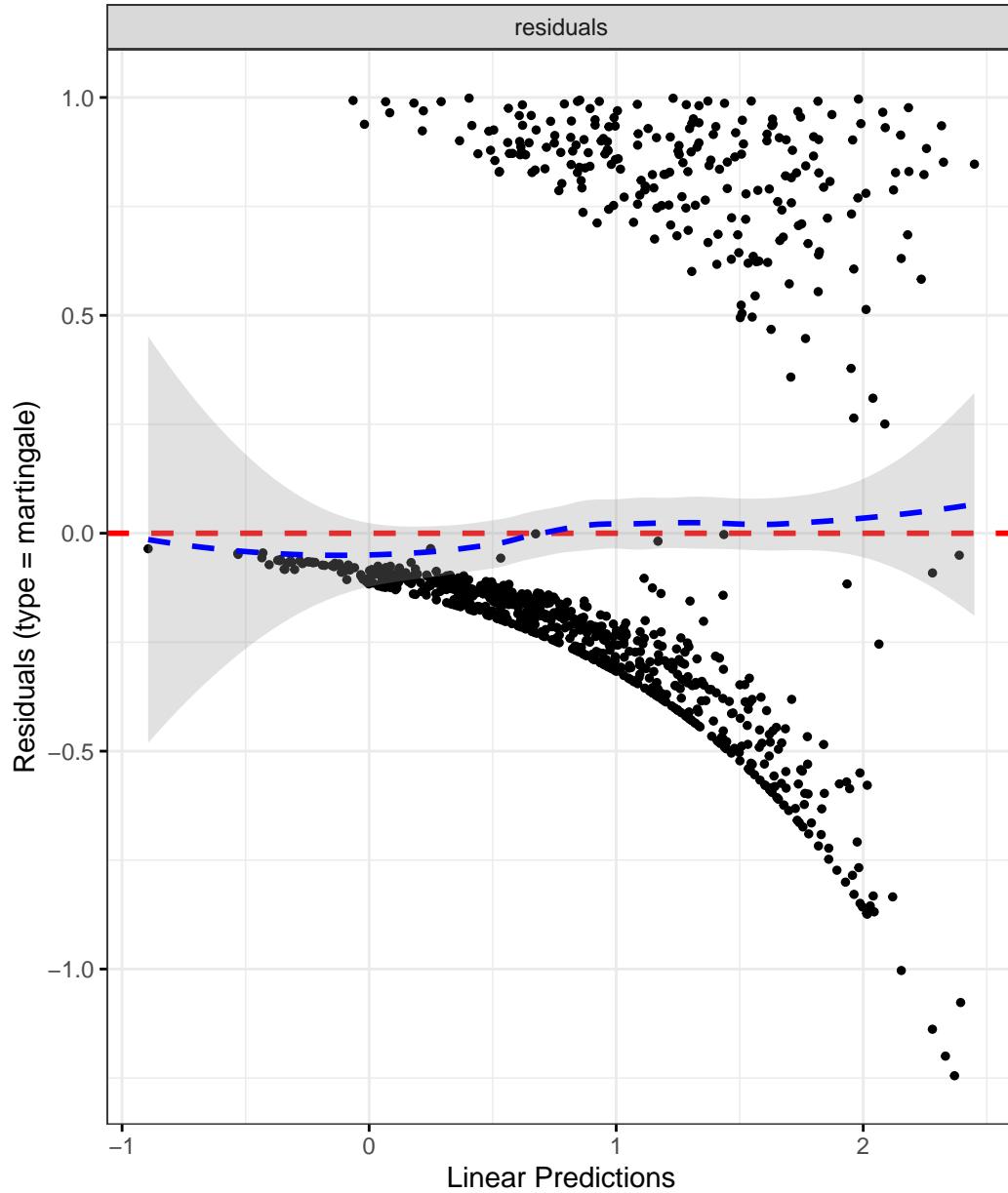
```
`geom_smooth()` using formula = 'y ~ x'
```



#####

Martingale residuals

```
`geom_smooth()` using formula = 'y ~ x'
```



```

saveRDS(flare.df, paste0(paths$outdir, "flares-demographics.RDS"))
saveRDS(flare.cd.df, paste0(paths$outdir, "flares-demographics-cd.RDS"))
saveRDS(flare.uc.df, paste0(paths$outdir, "flares-demographics-uc.RDS"))

saveRDS(cd.clin.forest, paste0(paths$outdir, "cd-clin-demographics.RDS"))
saveRDS(cd.hard.forest, paste0(paths$outdir, "cd-hard-demographics.RDS"))
saveRDS(uc.clin.forest, paste0(paths$outdir, "uc-clin-demographics.RDS"))

```

```
saveRDS(uc.hard.forest, paste0(paths$outdir, "uc-hard-demographics.RDS"))
```

## Reproduction and reproducibility

Session info

**R version 4.4.0 (2024-04-24)**

**Platform:** aarch64-unknown-linux-gnu

**locale:** *LC\_CTYPE=en\_US.UTF-8, LC\_NUMERIC=C, LC\_TIME=en\_US.UTF-8, LC\_COLLATE=en\_US.UTF-8, LC\_MONETARY=en\_US.UTF-8, LC\_MESSAGES=en\_US.UTF-8, LC\_PAPER=en\_US.UTF-8, LC\_NAME=C, LC\_ADDRESS=C, LC\_TELEPHONE=C, LC\_MEASUREMENT=en\_US.UTF-8 and LC\_IDENTIFICATION=C*

**attached base packages:** *grid, stats, graphics, grDevices, utils, datasets, methods and base*

**other attached packages:** *gtsummary(v.1.7.2), DescTools(v.0.99.54), finalfit(v.1.0.7), coxme(v.2.2-20), bdsmatrix(v.1.3-7), pander(v.0.6.5), survminer(v.0.4.9), ggpibr(v.0.6.0), survival(v.3.5-8), datefixR(v.1.6.1), lubridate(v.1.9.3), forcats(v.1.0.0), stringr(v.1.5.1), dplyr(v.1.1.4), purrr(v.1.0.2), readr(v.2.1.5), tidyverse(v.3.5.1), tibble(v.3.2.1), ggplot2(v.3.5.1), tidyverse(v.2.0.0), readxl(v.1.4.3), forestplot(v.3.1.6), abind(v.1.4-5) and checkmate(v.2.3.2)*

**loaded via a namespace (and not attached):** *gridExtra(v.2.3), gld(v.2.6.6), rlang(v.1.1.3), magrittr(v.2.0.3), e1071(v.1.7-14), compiler(v.4.4.0), mgcv(v.1.9-1), vctrs(v.0.6.5), pkgconfig(v.2.0.3), shape(v.1.4.6.1), fastmap(v.1.2.0), backports(v.1.5.0), labeling(v.0.4.3), KMsurv(v.0.1-5), utf8(v.1.2.4), rmarkdown(v.2.27), markdown(v.1.12), tzdb(v.0.4.0), nloptr(v.2.0.3), xfun(v.0.44), glmnet(v.4.1-8), jomo(v.2.7-6), jsonlite(v.1.8.8), pan(v.1.9), broom(v.1.0.6), R6(v.2.5.1), stringi(v.1.8.4), car(v.3.1-2), boot(v.1.3-30), rpart(v.4.1.23), cellranger(v.1.1.0), Rcpp(v.1.0.12), iterators(v.1.0.14), knitr(v.1.47), zoo(v.1.8-12), Matrix(v.1.7-0), splines(v.4.4.0), nnet(v.7.3-19), timechange(v.0.3.0), tidyselect(v.1.2.1), rstudioapi(v.0.16.0), yaml(v.2.3.8), ggtext(v.0.1.2), codetools(v.0.2-20), lattice(v.0.22-6), withr(v.3.0.0), evaluate(v.0.23), proxy(v.0.4-27), xml2(v.1.3.6), survMisc(v.0.5.6), pillar(v.1.9.0), carData(v.3.0-5), mice(v.3.16.0), foreach(v.1.5.2), generics(v.0.1.3), hms(v.1.1.3), commonmark(v.1.9.1), munsell(v.0.5.1), scales(v.1.3.0), rootSolve(v.1.8.2.4), minqa(v.1.2.7), xtable(v.1.8-4), class(v.7.3-22), glue(v.1.7.0), lmom(v.3.0), tools(v.4.4.0), data.table(v.1.15.4), lme4(v.1.1-35.3), ggsignif(v.0.6.4), Exact(v.3.2), mvtnorm(v.1.2-5), colorspace(v.2.1-0), nlme(v.3.1-164), cli(v.3.6.2), km.ci(v.0.5-6), fansi(v.1.0.6), expm(v.0.999-9), broom.helpers(v.1.15.0), gt(v.0.10.1), gtable(v.0.3.5), rstatix(v.0.7.2), digest(v.0.6.35), farver(v.2.1.2), htmltools(v.0.5.8.1), lifecycle(v.1.0.4), httr(v.1.4.7), mitml(v.0.4-5), gridtext(v.0.1.5) and MASS(v.7.3-60.2)*

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