Trend Analysis and Poisson Regression Analysis Report

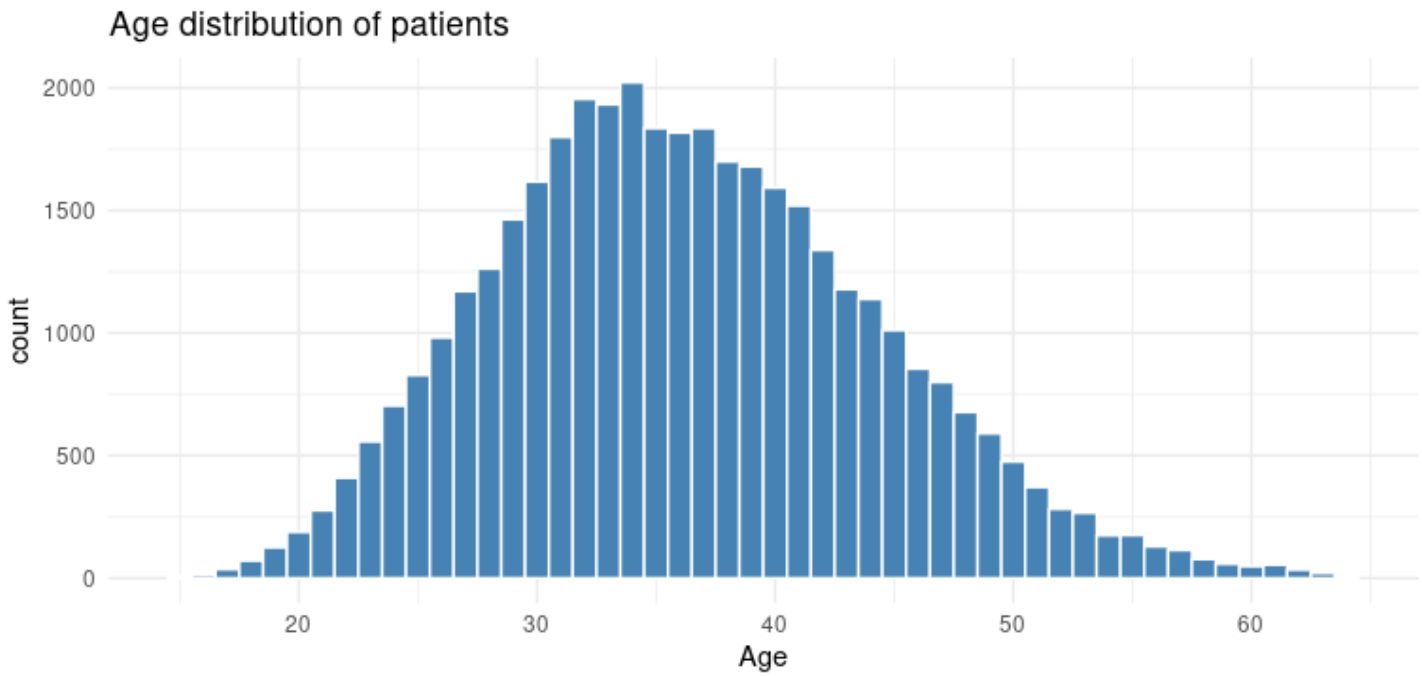
Trend Analysis

Basic Information

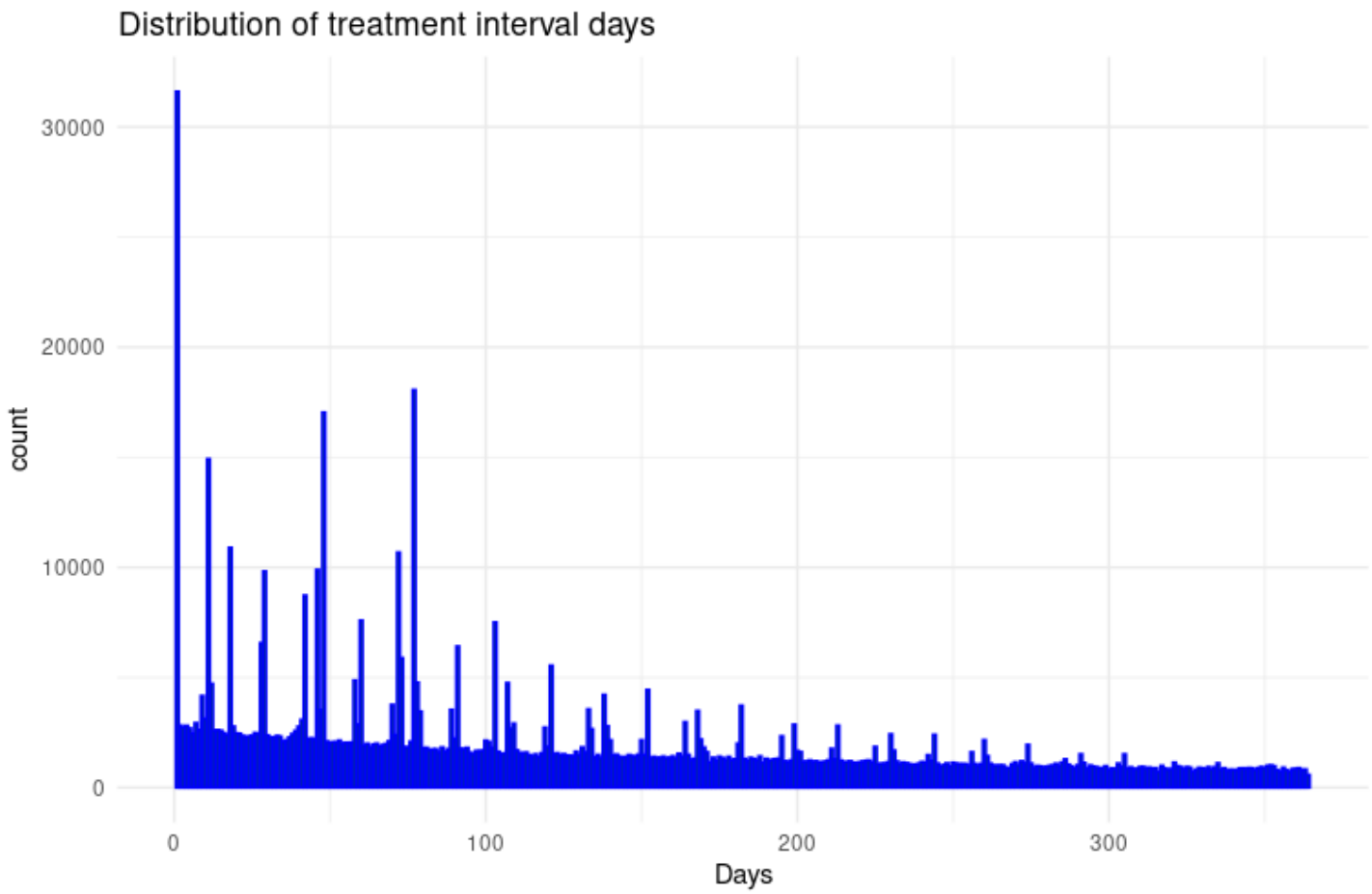
Code block

```
> str(cohort_data)
Classes ‘data.table’ and 'data.frame':        723853 obs. of  13 variables:
 $ IAIN         : Factor w/ 39251 levels "24000004","24000006",..: 1 1 1 2 3 3 3 3 3 3 ...
 $ age          : num  21 21 22 21 59 59 60 60 60 60 ...
 $ age_group    : Factor w/ 3 levels "15-34","35-49",..: 1 1 1 1 3 3 3 3 3 3 ...
 $ sex          : Factor w/ 2 levels "F","M": 2 2 2 2 2 2 2 2 2 2 ...
 $ nfod         : int  0 0 0 0 0 0 0 0 0 0 ...
 $ acm_flag     : num  0 0 0 0 0 0 0 0 0 0 ...
 $ drd_flag     : num  0 0 0 0 0 0 0 0 0 0 ...
 $ year         : int  2022 2023 2023 2022 2013 2013 2014 2014 2014 2014 ...
 $ DOB          : Date, format: "2001-01-01" "2001-01-01" "2001-01-01" "2001-01-01" ...
 $ drug         : Factor w/ 2 levels "opioids","poly": 1 1 1 1 1 1 1 1 1 1 ...
 $ days_at_risk : num  91 1 76 79 168 195 89 48 11 48 ...
 $ accommodation: Factor w/ 5 levels "Homeless","In Prison",..: 5 5 5 2 5 5 5 5 5 5 ...
 $ board        : Factor w/ 4 levels "Data missing",..: 3 3 3 3 3 3 3 3 3 3 ...
 - attr(*, ".internal.selfref")=<externalptr>
```

Age Distribution



Treatment Interval Statistics



Mortality Statistics

1. **All-Cause Mortality**:

```
table(death_summary$acm)
# Output:
#     0     1
# 32,397  6,866
```

   - **Survivors**: 32,397
   - **Deaths**: 6,866

2. **Drug-Related Deaths**:

```
table(death_summary$drd)
# Output:
#     0     1
# 35,630  3,633
```

   - **Non-drug-related**: 35,630
   - **Drug-related**: 3,633

Non-Fatal Overdose (NFOD) Events

```
table(nfod_summary$total_nfod)
# Output:
#    0     1     2     3     4     5     6     7     8     9    10    11    12
#   13    14    15    16    17    18    19    20    21    25    32    46
# 33,033 3,868 1,202   515   254   137    77    52    43    23    19    10
#    9     1     2     3     3     2     3     2     1     1     1     1     1
```

- **Key Findings**:
   - 33,033 patients had 0 NFOD events.

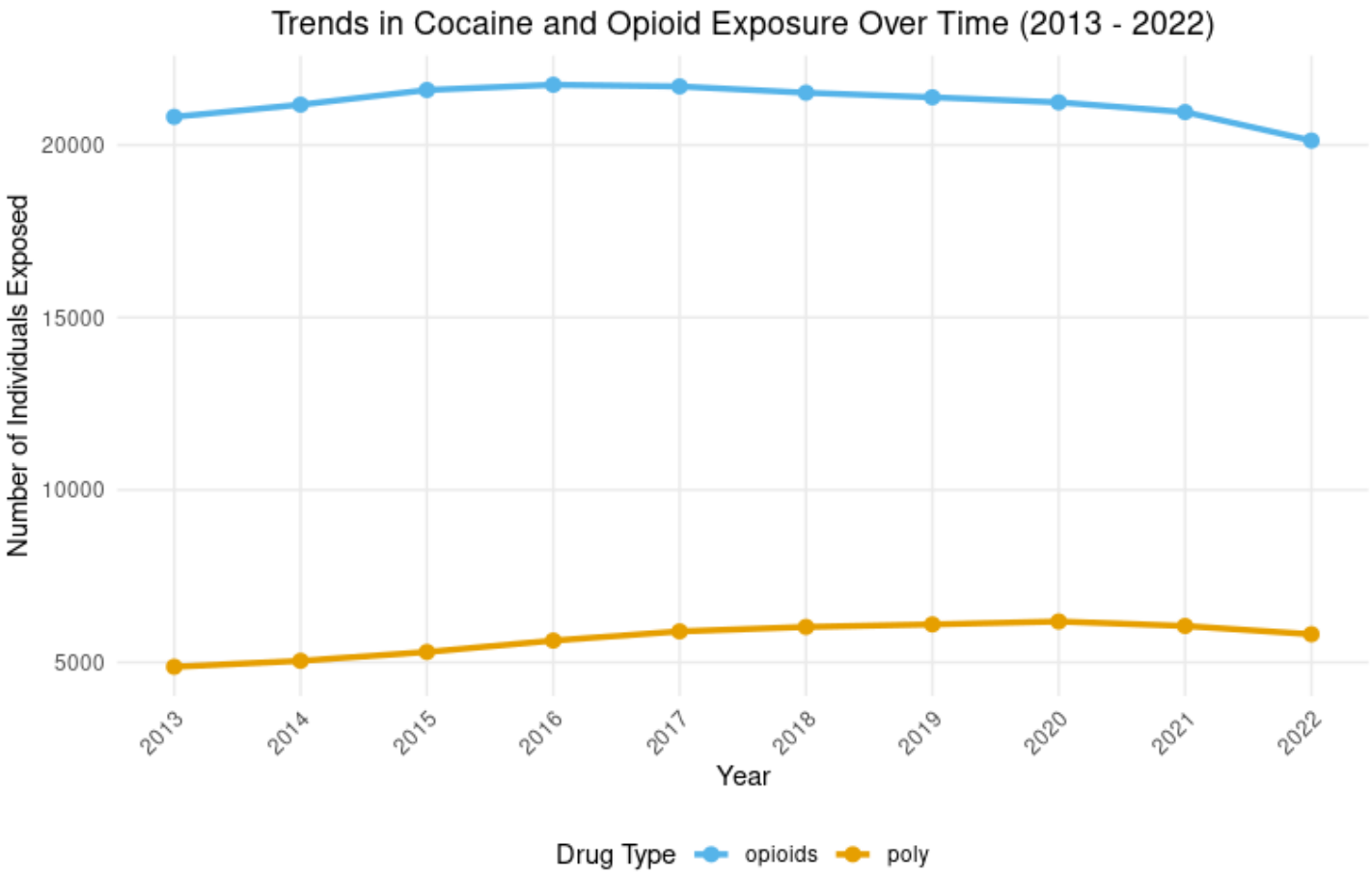
- Frequency decreases sharply with increasing events (e.g., 3,868 with 1 event, 1,202 with 2 events).
- Rare cases of ⩾20 events (max: 46).

Treatment Duration by Drug Type

Code block

```
drug_analysis %>%
  group_by(drug) %>%
  summarise(
    patients = n_distinct(IAIN),
    mean_days = mean(total_days),
    median_days = median(total_days)
  )
# Output:
#   drug    patients mean_days median_days
# 1 opioids    30,979     2,326       2,545
# 2 poly        8,284     2,311       2,512
```

- **Opioids**: 30,979 patients (mean: 2,326 days; median: 2,545).
- **Polydrug**: 8,284 patients (mean: 2,311 days; median: 2,512).



NHS Board distribution

Code block

```
> # NHS Board distribution-----------------------------------------------------
> nhsboard_dist <- cohort_data %>%
+   distinct(IAIN, .keep_all = TRUE) %>%
+   count(board, name = "Count") %>%
+   mutate(Percentage = round(Count / sum(Count) * 100, 2))
> print("NHS Board Distribution:")
[1] "NHS Board Distribution:"
> print(nhsboard_dist)
                            board Count Percentage
                           <fctr> <int>      <num>
1:                   Data missing    35       0.09
2:     Greater Glasgow and Clyde 10450      26.62
3: Other NHS regions in Scotland 25526      65.03
4:                       Tayside  3240       8.25
```

Accommodation

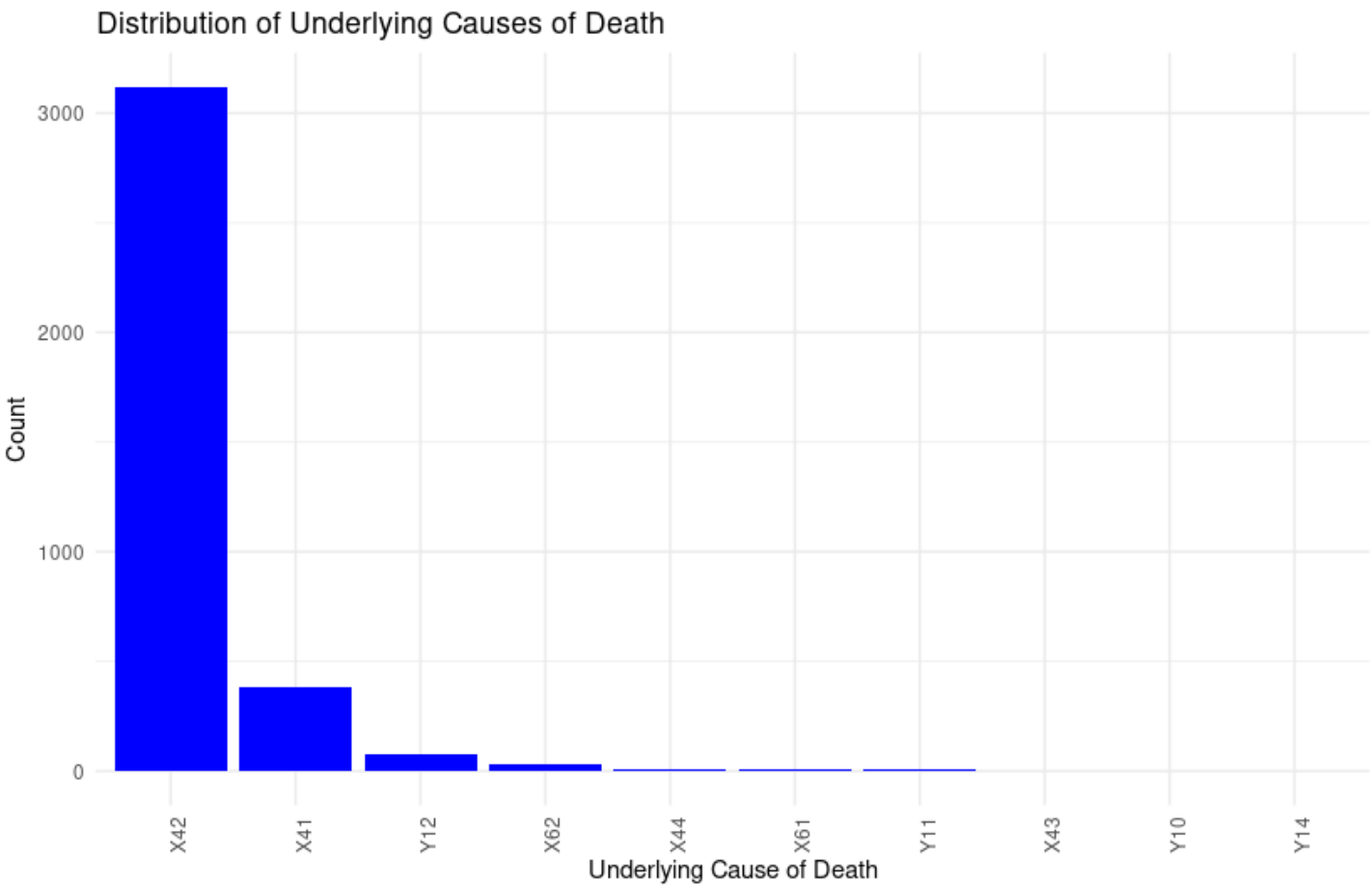
Code block

```
> accommodation_individual <- cohort_data %>%
+   distinct(IAIN, .keep_all = TRUE) %>%
+   count(accommodation, name = "Count") %>%
+   mutate(Percentage = Count / sum(Count) * 100)
> print("Classification of Accommodation:")
[1] "Classification of Accommodation:"
> print(accommodation_individual)
   accommodation Count Percentage
          <fctr> <int>      <num>
1:      Homeless  3568   9.090214
2:     In Prison  2803   7.141219
3:       Missing  3803   9.688925
4:         Other   644   1.640723
5:  Owned/Rented 28433  72.438919
```

Underlying Causes of Death （ICD）

Code block

```
[1] "Distribution of Underlying Causes of Death:"
       ICD Count Percentage
    <fctr> <int>      <num>
 1:    X42  3118      85.82
 2:    X41   383      10.54
 3:    Y12    78       2.15
 4:    X62    34       0.94
 5:    X44     6       0.17
 6:    X61     5       0.14
 7:    Y11     5       0.14
 8:    X43     2       0.06
 9:    Y10     1       0.03
10:    Y14     1       0.03
```



Code block

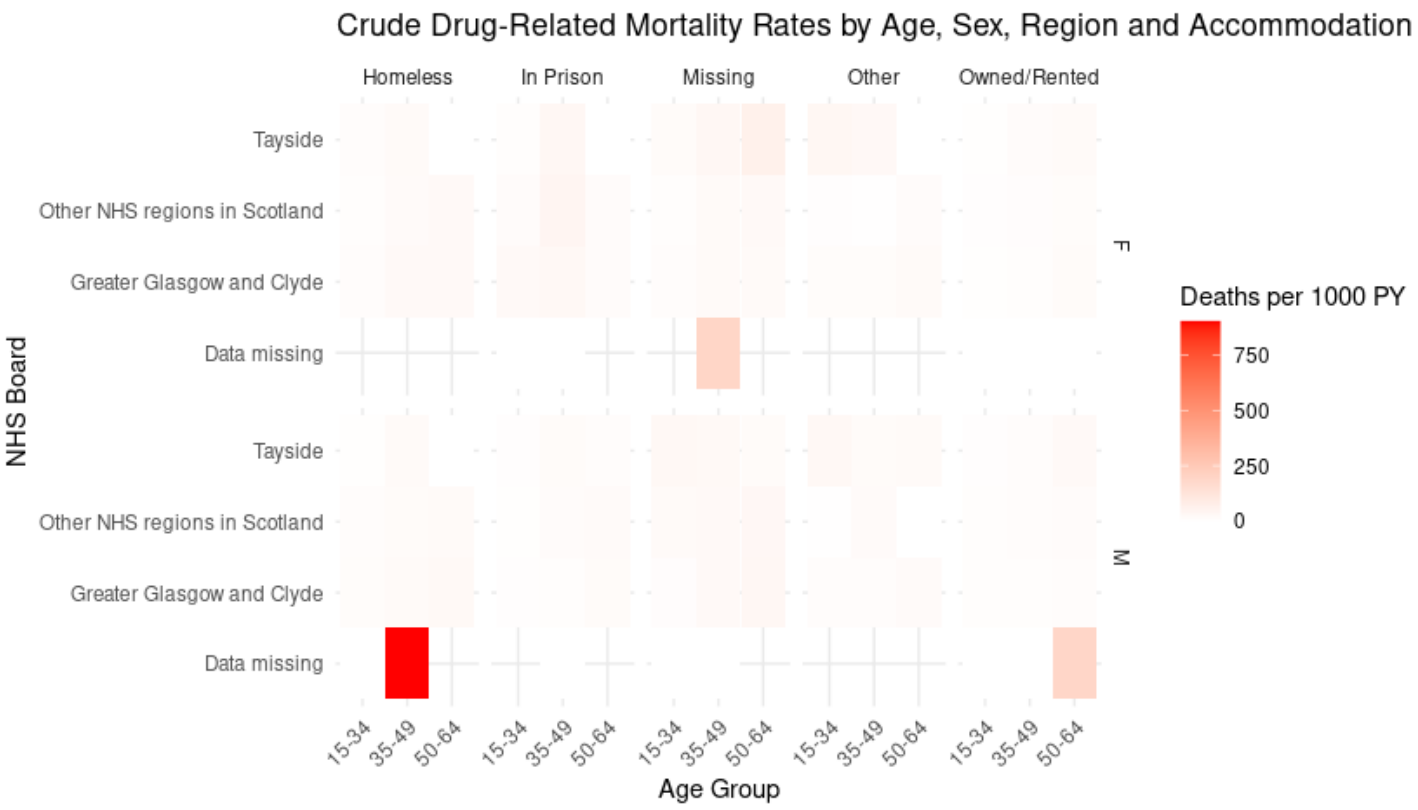
```
allDRD <- drds %>%
          select(IAIN, SMR99_HMMBimplic,  SMR99_DOD,
                 SMR99_UNDERLYING_CAUSE_OF_DEATH, type_of_death,
                 SMR99_poison,SMR99_alsopres) %>%
          mutate(across(c("IAIN"), as.character)) %>%
          #mutate(age= floor(as.duration(SMR99_DOB %--% SMR99_DOD) / ddays(365.25)))
          filter(SMR99_UNDERLYING_CAUSE_OF_DEATH %in% c(c("^F11", "^F12", "^F13", "^F14", "^F15",
                                                          "^F16", "^F19"),
                                                        c("X40", "X41", "X42", "X43", "X44", "X60",
                                                          "X61", "X62", "X63", "X64", "X85", "Y10",
                                                          "Y11", "Y12", "Y13", "Y14"))) %>%
          mutate(cause_of_death = SMR99_UNDERLYING_CAUSE_OF_DEATH) %>%
          #mutate(DOB=SMR99_DOB) %>%
          mutate(day=SMR99_DOD) %>%
          mutate(drd_flag=1) %>%
          select(IAIN,day,drd_flag,cause_of_death)
```

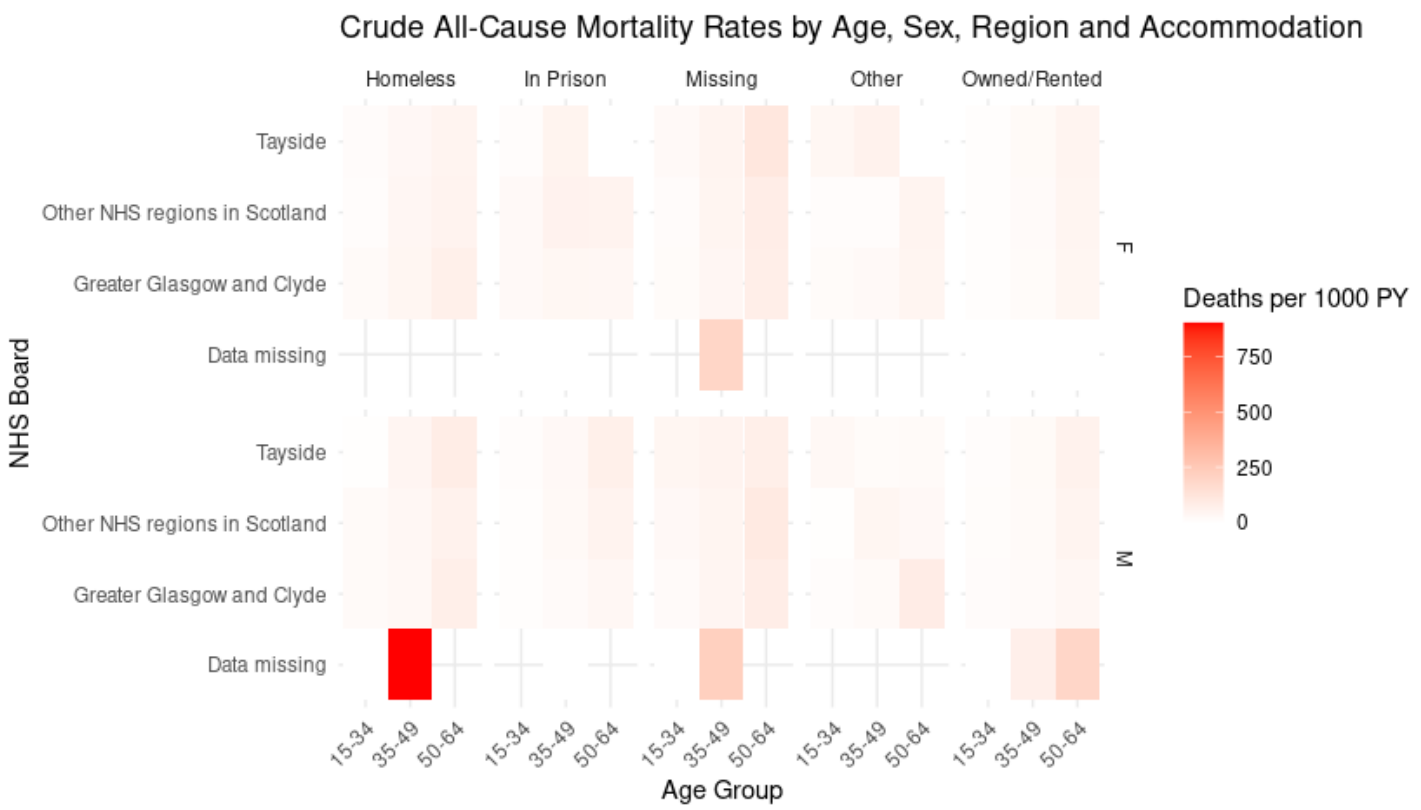
Crude Mortality Rate

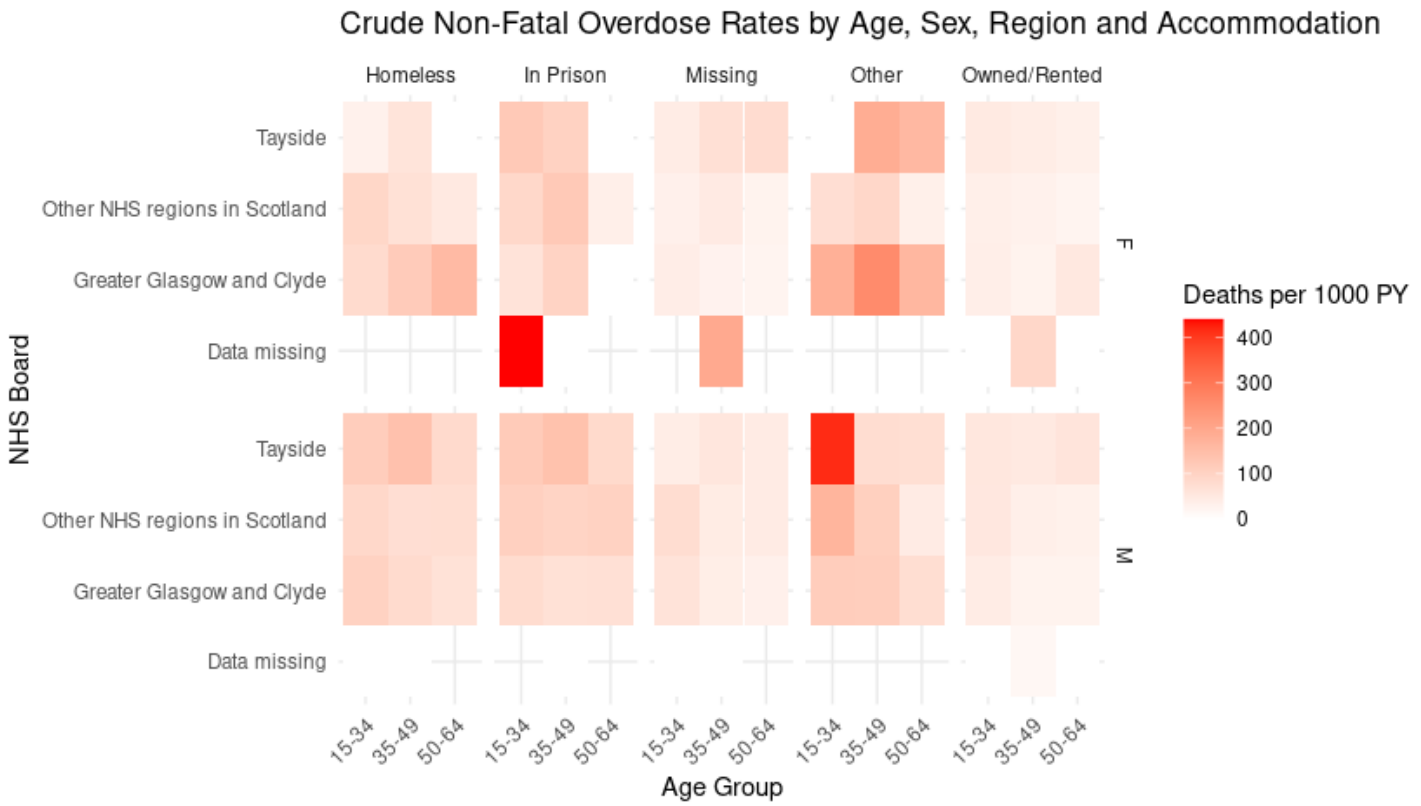
Code block

```
crude_rates <- cohort_data %>%
  group_by(age_group, sex, board, accommodation) %>%
  summarise(
    deaths = sum(drd_flag, na.rm = TRUE),
    person_years = sum(days_at_risk) / 365.25,
    .groups = "drop"
  ) %>%
  mutate(
    crude_rate = deaths / person_years * 1000,
    lower_ci = ifelse(deaths > 0, qchisq(0.025, 2 * deaths) / 2 / person_years * 1000, 0),
    upper_ci = qchisq(0.975, 2 * (deaths + 1)) / 2 / person_years * 1000,
    rate_with_ci = sprintf("%.1f (%.1f–%.1f)", crude_rate, lower_ci, upper_ci)
  )

```







The provided heatmap visualizes crude mortality rates by age group, sex, NHS Board region, and accommodation type. Here's a brief analysis:

1. **Age Group**: The mortality rates increase with age, with the highest rates observed in the older age groups (50+).

2. **Sex**: There appears to be a slight difference in mortality rates between sexes, though the specific differences are not clearly distinguishable in this visualization.

3. **Region (NHS Board)**: The mortality rates vary across different NHS Board regions, indicating regional differences in healthcare, socioeconomic factors that could influence health outcomes.

4. **Accommodation**: There is a notable variation in mortality rates based on accommodation type. For instance, individuals who are homeless tend to have higher mortality rates compared to those with stable accommodation like owned or rented housing.

5. **Color Gradient**: The color gradient from light to dark red indicates increasing mortality rates, with darker shades representing higher death rates per 1000 person-years.

6. **Data Gaps**: Some regions or accommodation types may have lighter shades, suggesting lower mortality rates or possibly fewer data points available for those categories.

Poisson Regression Analysis Report

1. Model Specification

Code block

```
model_data <- cohort_data %>%
  group_by( age_group, sex, board, accommodation, drug) %>%
  summarise(
    Deaths = sum(drd_flag),
    PY = sum(days_at_risk)/365.25,
    .groups = "drop"
```

```
  ) %>%
  filter(PY > 0)

model <- glm(
  Deaths ~ factor(age_group) + sex +
    factor(board) + factor(accommodation) + drug +
    offset(log(PY)),
  family = poisson,
  data = model_data
)


if(deviance(model)/df.residual(model) > 1.2){
  model <- update(model, family = quasipoisson)
}
#  Excessive dispersion was detected
#  deviance(model)/df.residual(model) = 1.66

tbl_regression(
  model,
  exponentiate = TRUE,
  label = list(
    "factor(age_group)" ~ "Age group",
    "sex" ~ "Sex",
    "factor(board)" ~ "NHS board",
    "factor(accommodation)" ~ "Accommodation"
  )
) %>%
  add_global_p() %>%
  bold_labels()

```

- **Dependent Variable**: Drug-related death flag (`drd_flag`)
- **Predictors**:
  - Age group
  - Sex
  - NHS Board region
  - Accommodation type
  - Drug type (opioids vs. polydrug)
- **Offset**: Person-years at risk (`days_at_risk/365.25`)

2. Key Results from Poisson Model

Characteristic	IRR	95% CI	p-value
Age group			<0.001
15-34	—	—	
35-49	1.56	1.38, 1.77	
50-64	2.1	1.80, 2.47	
Sex			0.4
F	—	—	
M	1.05	0.95, 1.16	
NHS board			0.025
Data missing	—	—	
Greater Glasgow and Clyde	0.28	0.11, 1.13	
Other NHS regions in Scotland	0.3	0.12, 1.20	
Tayside	0.35	0.14, 1.41	
Accommodation			<0.001
Homeless	—	—	
In Prison	0.78	0.62, 0.97	
Missing	1.26	1.05, 1.50	
Other	0.69	0.45, 1.01	
Owned/ Rented	0.58	0.50, 0.68	
drug			>0.9
opioids	—	—	
poly	1.01	0.89, 1.13	

Abbreviations: CI = Confidence Interval, IRR = Incidence Rate Ratio

Code block

```
> model

Call:  glm(formula = Deaths ~ factor(age_group) + sex + factor(board) +
    factor(accommodation) + drug + offset(log(PY)), family = quasipoisson,
    data = model_data)

Coefficients:
                                  (Intercept)
factor(age_group)35-49
                                      -3.09866
0.44455
                      factor(age_group)50-64
   sexM
                                       0.74408
0.04458
    factor(board)Greater Glasgow and Clyde  factor(board)Other NHS regions in
Scotland
                                      -1.26241
-1.19346
                        factor(board)Tayside
factor(accommodation)In Prison
                                      -1.03827
-0.24957
                 factor(accommodation)Missing
factor(accommodation)Other
                                       0.22817
-0.37517
           factor(accommodation)Owned/Rented
drugpoly
                                      -0.53832
0.00684

Degrees of Freedom: 192 Total (i.e. Null);  181 Residual
Null Deviance:            773.5
Residual Deviance: 301.7        AIC: NA
```