Data Visualization Assignment

DrPH Epidemiology 2023/2024

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Introduction

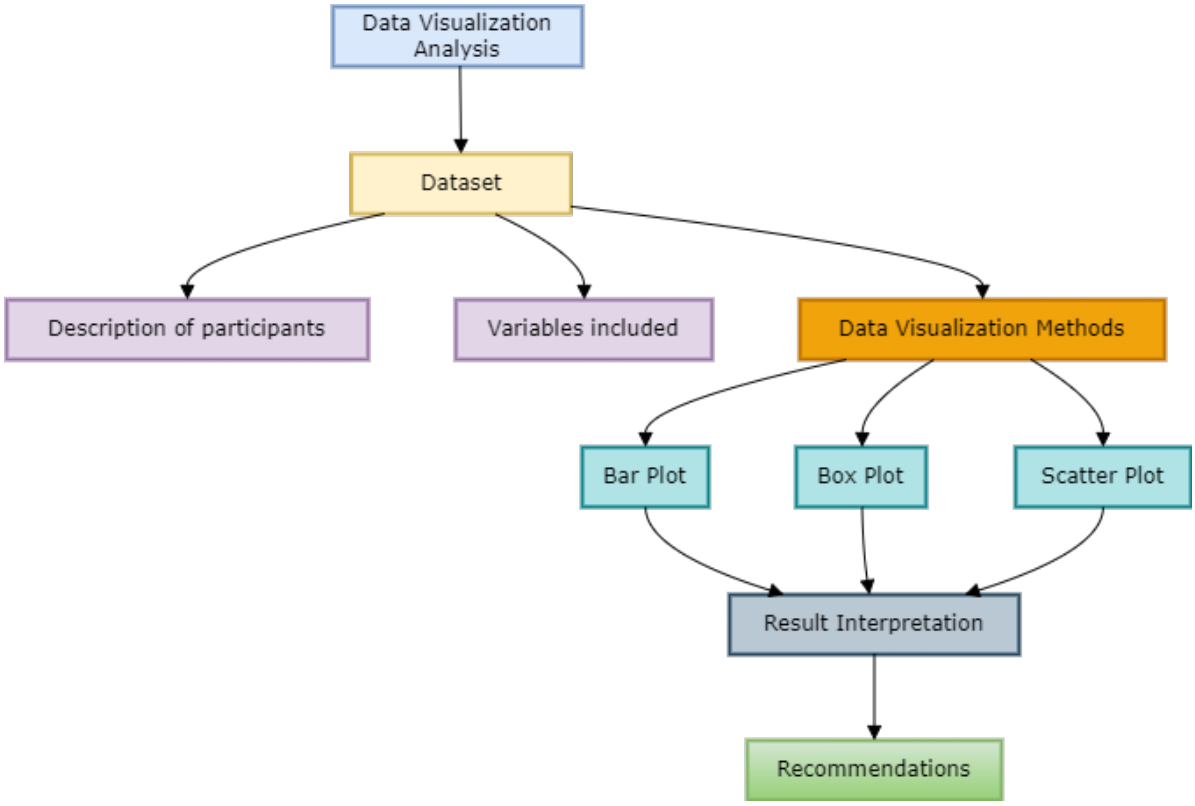
Purpose

The purpose of this assignment is to provide data visualization analysis of the working conditions and perceived management quality within five nursing homes in Norway. This analysis aims to offer insights into the current state of the workforce, highlight areas of strength, and identify opportunities for improvement.

Overview of the Dataset

The dataset comprises information from 288 participants distributed across five nursing homes in Norway. This hierarchical dataset includes two levels of sampling: individual staff members (Level 1) and the nursing homes they belong to (Level 2). The variables in this dataset are as follows:

- Nursing Home ID (`nhid`): Identifies the nursing home to which each staff member belongs (Nursing Home 1 to Nursing Home 5).
- Position (`status`): Indicates whether a staff member holds a permanent or intermediate position.
- Norwegian Mother Tongue (`mother`): Specifies whether a staff member's mother tongue is Norwegian (Yes or No).
- Score of Working Condition (`scorewc`): Reflects staff members' perceptions of their working conditions, with higher scores indicating more favorable conditions.
- Score of Perceived Good Management (`scorepom`): Reflects staff members' perceptions of management quality, with higher scores indicating more favorable perceptions.



Libraries

```
library(haven)
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

```
library(gtsummary)
```

#Uighur

```
library(dplyr)
library(summarytools)
```

```
Attaching package: 'summarytools'

The following object is masked from 'package:tibble':

    view
```

```
library(ggplot2)
library(patchwork)
library(GGally)
```

```
Registered S3 method overwritten by 'GGally':
  method from
  +.gg   ggplot2
```

Read Dataset

```
nursing_homes <- read_sav("nursing_homes.sav")
summary(nursing_homes)
```

```
     nhid                job              age             gender
 Length:288         Min.   : 2.000   Min.   :1.000   Min.   :1
 Class :character   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.:2
 Mode  :character   Median : 3.000   Median :1.000   Median :3
                    Mean   : 3.217   Mean   :1.062   Mean   :3
                    3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.:4
                    Max.   :10.000   Max.   :2.000   Max.   :5
                    NA's   :25       NA's   :31      NA's   :24
 workexperience      worknh          shift           change          status
 Min.   :1.000   Min.   :1.00   Min.   :1.000   Min.   :2.000   Min.   :1.000
```

```
 1st Qu.:2.000   1st Qu.:2.00   1st Qu.:4.000   1st Qu.:3.000   1st Qu.:1.000
 Median :3.500   Median :3.00   Median :4.000   Median :4.000   Median :1.000
 Mean   :3.338   Mean   :2.84   Mean   :3.857   Mean   :4.019   Mean   :1.163
 3rd Qu.:4.000   3rd Qu.:4.00   3rd Qu.:5.000   3rd Qu.:5.000   3rd Qu.:1.000
 Max.   :6.000   Max.   :6.00   Max.   :6.000   Max.   :5.000   Max.   :2.000
 NA's   :22      NA's   :20     NA's   :44      NA's   :31
    mothert         scorewc          scorepom
 Min.   :1.000   Min.   :  8.333   Min.   :  6.25
 1st Qu.:1.000   1st Qu.: 51.455   1st Qu.: 50.00
 Median :1.000   Median : 65.000   Median : 75.00
 Mean   :1.191   Mean   : 64.579   Mean   : 68.67
 3rd Qu.:1.000   3rd Qu.: 75.007   3rd Qu.: 91.67
 Max.   :2.000   Max.   :100.000   Max.   :100.00
```

Change Characters Into Factors

```
nursing_homes <- nursing_homes %>% mutate_if(is.character, as.factor)
summary(nursing_homes)
```

```
 nhid        job              age            gender   workexperience
 1:39   Min.   : 2.000   Min.   :1.000   Min.   :1    Min.   :1.000
 2:29   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.:2    1st Qu.:2.000
 3:95   Median : 3.000   Median :1.000   Median :3    Median :3.500
 4:70   Mean   : 3.217   Mean   :1.062   Mean   :3    Mean   :3.338
 5:55   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.:4    3rd Qu.:4.000
        Max.   :10.000   Max.   :2.000   Max.   :5    Max.   :6.000
        NA's   :25       NA's   :31      NA's   :24   NA's   :22
     worknh          shift           change          status         mothert
 Min.   :1.00   Min.   :1.000   Min.   :2.000   Min.   :1.000   Min.   :1.000
 1st Qu.:2.00   1st Qu.:4.000   1st Qu.:3.000   1st Qu.:1.000   1st Qu.:1.000
 Median :3.00   Median :4.000   Median :4.000   Median :1.000   Median :1.000
 Mean   :2.84   Mean   :3.857   Mean   :4.019   Mean   :1.163   Mean   :1.191
 3rd Qu.:4.00   3rd Qu.:5.000   3rd Qu.:5.000   3rd Qu.:1.000   3rd Qu.:1.000
 Max.   :6.00   Max.   :6.000   Max.   :5.000   Max.   :2.000   Max.   :2.000
 NA's   :20     NA's   :44      NA's   :31
    scorewc          scorepom
 Min.   :  8.333   Min.   :  6.25
 1st Qu.: 51.455   1st Qu.: 50.00
 Median : 65.000   Median : 75.00
```

```
 Mean   : 64.579   Mean   : 68.67
 3rd Qu.: 75.007   3rd Qu.: 91.67
 Max.   :100.000   Max.   :100.00
```

Convert Numerical Variables Into Categorical Variables

```r
# Convert nhid to categorical variable
nursing_homes$nhid <- factor(nursing_homes$nhid,
                  levels = c(1, 2, 3, 4, 5),
                  labels = c("Nursing Home 1", "Nursing Home 2", "Nursing Home 3", "Nursing H

# Convert status to categorical variable
nursing_homes$status <- factor(nursing_homes$status,
                    levels = c(1, 2),
                    labels = c("Permanent", "Intermediate"))

# Convert mother to categorical variable
nursing_homes$mothert <- factor(nursing_homes$mothert,
                    levels = c(1, 2),
                    labels = c("Yes", "No"))

# View updated dataset
summary(nursing_homes)
```

```
             nhid         job              age            gender
 Nursing Home 1:39   Min.   : 2.000   Min.   :1.000   Min.   :1
 Nursing Home 2:29   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.:2
 Nursing Home 3:95   Median : 3.000   Median :1.000   Median :3
 Nursing Home 4:70   Mean   : 3.217   Mean   :1.062   Mean   :3
 Nursing Home 5:55   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.:4
                     Max.   :10.000   Max.   :2.000   Max.   :5
                     NA's   :25       NA's   :31      NA's   :24
 workexperience      worknh         shift           change
 Min.   :1.000   Min.   :1.00   Min.   :1.000   Min.   :2.000
 1st Qu.:2.000   1st Qu.:2.00   1st Qu.:4.000   1st Qu.:3.000
 Median :3.500   Median :3.00   Median :4.000   Median :4.000
 Mean   :3.338   Mean   :2.84   Mean   :3.857   Mean   :4.019
 3rd Qu.:4.000   3rd Qu.:4.00   3rd Qu.:5.000   3rd Qu.:5.000
 Max.   :6.000   Max.   :6.00   Max.   :6.000   Max.   :5.000
```

```
 NA's   :22      NA's   :20     NA's   :44      NA's   :31
         status    mothert      scorewc           scorepom
 Permanent   :241   Yes:233   Min.   :  8.333   Min.   :  6.25
 Intermediate: 47   No : 55   1st Qu.: 51.455   1st Qu.: 50.00
                              Median : 65.000   Median : 75.00
                              Mean   : 64.579   Mean   : 68.67
                              3rd Qu.: 75.007   3rd Qu.: 91.67
                              Max.   :100.000   Max.   :100.00
```

Dataset with Selected Variables

```
nh_data <- nursing_homes %>% select(nhid, status, mothert, scorewc, scorepom)
summary(nh_data)
```

```
             nhid              status    mothert      scorewc
 Nursing Home 1:39   Permanent   :241   Yes:233   Min.   :  8.333
 Nursing Home 2:29   Intermediate: 47   No : 55   1st Qu.: 51.455
 Nursing Home 3:95                                Median : 65.000
 Nursing Home 4:70                                Mean   : 64.579
 Nursing Home 5:55                                3rd Qu.: 75.007
                                                  Max.   :100.000

    scorepom
 Min.   :  6.25
 1st Qu.: 50.00
 Median : 75.00
 Mean   : 68.67
 3rd Qu.: 91.67
 Max.   :100.00
```

Descriptive Table

```
# Create the descriptive table
table_summary <- nh_data %>%
  tbl_summary(
    by = nhid,
    statistic = list(
      all_continuous() ~ "{mean} ({sd})",
```

```
      all_categorical() ~ "{n} ({p}%)"
    ),
  ) %>%
  add_overall() %>%
  modify_header(label ~ "**Variable**") %>%
  modify_spanning_header(
    all_stat_cols() ~ "**Summary Statistics**"
  ) %>%
  modify_caption("**Descriptive Statistics of Nursing Homes Dataset**")

# Print the table
table_summary
```

```
Table printed with `knitr::kable()`, not {gt}. Learn why at
https://www.danieldsjoberg.com/gtsummary/articles/rmarkdown.html
To suppress this message, include `message = FALSE` in code chunk header.
```

Table 1: **Descriptive Statistics of Nursing Homes Dataset**

Variable	**Overall**, N = 288	**Nursing Home 1**, N = 39	**Nursing Home 2**, N = 29	**Nursing Home 3**, N = 95	**Nursing Home 4**, N = 70	**Nursing Home 5**, N = 55
status						
Permanent	241 (84%)	31 (79%)	25 (86%)	79 (83%)	56 (80%)	50 (91%)
Intermediate	47 (16%)	8 (21%)	4 (14%)	16 (17%)	14 (20%)	5 (9.1%)
mothert	233 (81%)	32 (82%)	17 (59%)	80 (84%)	63 (90%)	41 (75%)
scorewc	65 (19)	65 (17)	60 (18)	66 (20)	65 (18)	63 (17)
scorepom	69 (23)	72 (20)	65 (21)	67 (26)	71 (22)	68 (22)

Comment:

The table provides a summary of the distribution of position, Norwegian mother tongue, score of working condition, and score of perceived good management across 5 nursing homes which includes 288 participants. The majority of staffs across all nursing homes hold permanent positions (84%) and have Norwegian as their mother tongue (81%). Nursing Home 5 has the highest proportion of permanent staff (91%), while Nursing Home 2 has the lowest proportion of Norwegian-speaking staff (59%). The mean scores for working conditions and perceived good management are ranging from 60 to 66 and 65 to 72 respectively, across the nursing homes. The table shows that the nursing homes have a predominantly permanent and Norwegian-speaking workforce.

Data Visualization Methods

Bar Plot

The bar plot is used to visualize the distribution of staff employment status and their Norwegian mother tongue status across the five nursing homes. This visualization helps identify the composition of the workforce in terms of permanent and intermediate employment status, as well as the prevalence of staff who speak Norwegian as their mother tongue.

The `ggplot2` package was used to construct the bar plot, employing the `ggplot()` function to specify the dataset and aesthetic mappings. The `aes()` function mapped the `nhid` variable to the x-axis and the interaction between `status` and `mothert` to the fill aesthetic. To create side-by-side bars for each category combination of `status` and `mothert`, the `geom_bar()` function was utilized with the `position = "dodge"` argument. For clarity, the plot was customized with titles and labels using the `labs()` function to add a title and labels for the x-axis, y-axis, and fill legend. The `theme_minimal()` function was applied to give the plot a clean and simple appearance, while the `scale_fill_manual()` function was used to manually set the colors for the different fill categories, ensuring the plot is visually appealing and easy to interpret.

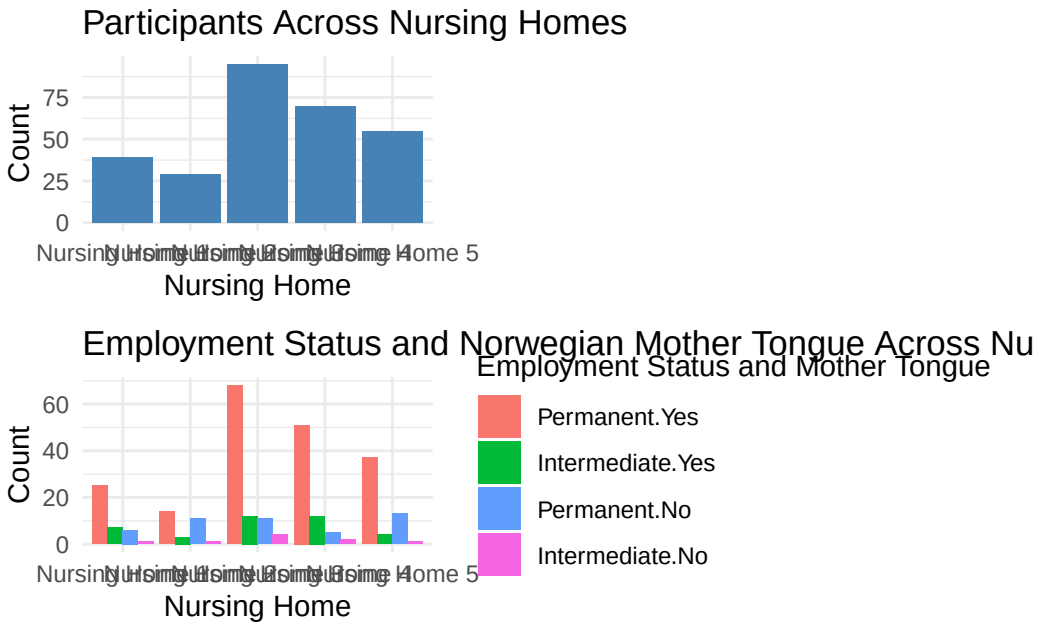
Figure 1

```
# Grouped bar plot for Position (status) and Norwegian Mother Tongue (mothert)
grouped_bar_plot <- ggplot(nh_data, aes(x = nhid, fill = interaction(status, mothert))) +
  geom_bar(position = "dodge") +
  labs(title = "Employment Status and Norwegian Mother Tongue Across Nursing Homes",
       x = "Nursing Home",
       y = "Count",
       fill = "Employment Status and Mother Tongue") +
  theme_minimal() +
  scale_fill_manual(values = c("#F8766D", "#00BA38", "#619CFF", "#F564E3"))

# Bar plot for nursing home counts
nursing_home_counts <- ggplot(nh_data, aes(x = nhid)) +
  geom_bar(fill = "steelblue") +
  labs(title = "Participants Across Nursing Homes",
       x = "Nursing Home",
       y = "Count") +
  theme_minimal()

# Combine the plots using patchwork
combined_plot1 <- nursing_home_counts / grouped_bar_plot
```

```r
# Display the combined plot
print(combined_plot1)
```



Comment:

Figure 1 contains two bar plots stacked vertically. The top bar plot shows the total number of staff members (participants) in each nursing home. The bottom bar plot illustrates the distribution of staff employment status and their Norwegian mother tongue status across different nursing homes.

Nursing Home 3 has the highest count of staff members, followed by Nursing Home 4. Nursing Home 1 and Nursing Home 5 have moderate counts, while Nursing Home 2 has the lowest count. There is a predominant presence of permanent staff with Norwegian as their mother tongue across all nursing homes. Nursing Home 3 has the highest count of permanent staff with Norwegian as their mother tongue. Intermediate staff without Norwegian as their mother tongue are relatively fewer in all nursing homes. The distribution in the graph shows that most staff members in these nursing homes are permanent and Norwegian-speaking, indicating a stable and linguistically homogenous workforce.

Box Plot

The first box plot visualizes the distribution of the scores of working conditions across the five nursing homes. This plot aims to compare the central tendency and variability of working

condition scores among the different nursing homes. The second box plot visualizes the distribution of the scores of perceived good management across the five nursing homes. This plot is designed to compare the central tendency and variability of management quality perceptions among different nursing homes.

The `ggplot2` package was used to construct both box plots, with the `ggplot()` function employed to specify the dataset and aesthetic mappings. For the first box plot, the `aes()` function mapped `nhid` to the x-axis and `scorewc` to the y-axis, while for the second box plot, `nhid` was mapped to the x-axis and `scorepom` to the y-axis. The `geom_boxplot()` function was utilized to create the plots, displaying the distribution of working condition scores and management quality scores within each nursing home, respectively. Titles and labels were added using the `labs()` function to provide clear titles and axis labels, and the `theme_minimal()` function was applied to ensure a clean and professional appearance. Additionally, the `scale_fill_brewer()` function was used to apply a specific color palette to the boxes, enhancing visual differentiation between the nursing homes.

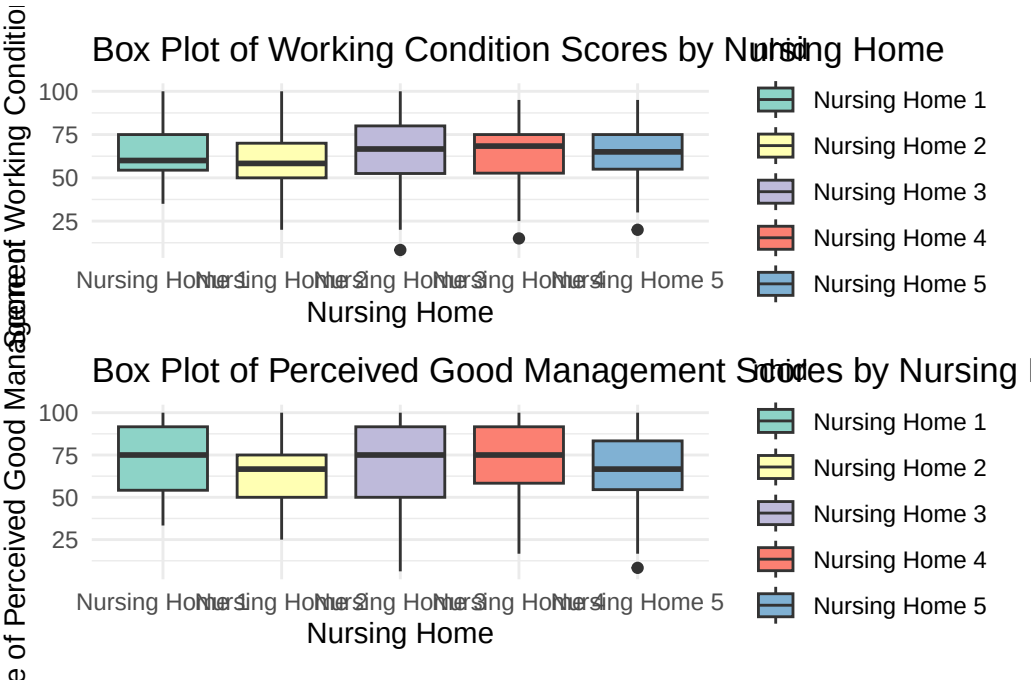
Figure 2

```
# Create box plot for Score of Working Condition
box_plot_wc <- ggplot(nh_data, aes(x = nhid, y = scorewc, fill = nhid)) +
  geom_boxplot() +
  labs(title = "Box Plot of Working Condition Scores by Nursing Home",
       x = "Nursing Home",
       y = "Score of Working Condition") +
  theme_minimal() +
  scale_fill_brewer(palette = "Set3")

# Create box plot for Score of Perceived Good Management
box_plot_pom <- ggplot(nh_data, aes(x = nhid, y = scorepom, fill = nhid)) +
  geom_boxplot() +
  labs(title = "Box Plot of Perceived Good Management Scores by Nursing Home",
       x = "Nursing Home",
       y = "Score of Perceived Good Management") +
  theme_minimal() +
  scale_fill_brewer(palette = "Set3")

# Combine both plots using patchwork
combined_plot2 <- box_plot_wc / box_plot_pom

# Display the combined plot
print(combined_plot2)
```



Comment:

Figure 2 contains two box plots stacked vertically, each illustrating the distribution of scores across five nursing homes. The top box plot shows the distribution of the score of working conditions for each nursing home. The bottom box plot shows the distribution of the score of perceived good management for each nursing home.

The median scores of working conditions center around 65 to 70 across nursing homes. Nursing Home 1 and Nursing Home 2 have lower median scores, suggesting that staff in these nursing homes perceive their working conditions to be less favorable compared to the other three nursing homes. Nursing Home 3 shows a broader spread of variability in scores. Outliers are present in Nursing Home 3, 4, and 5, indicating that there are individual staff members with different perceptions of working conditions compared to the majority.

The median scores of perceived good management center around 70 to 75 across nursing homes. Nursing Home 2 and Nursing Home 5 have lower median scores, suggesting that staff in these nursing homes perceive management quality to be less favorable compared to the other three nursing homes. Outliers are present only in Nursing Home 5, indicating that most staff members' perceptions of management quality are relatively consistent. While most nursing homes have similar median scores for perceived good management, Nursing Home 2 and Nursing Home 5 differ with lower median scores. This suggests potential areas for improvement in management practices in Nursing Home 2 and Nursing Home 5.

Scatter Plot

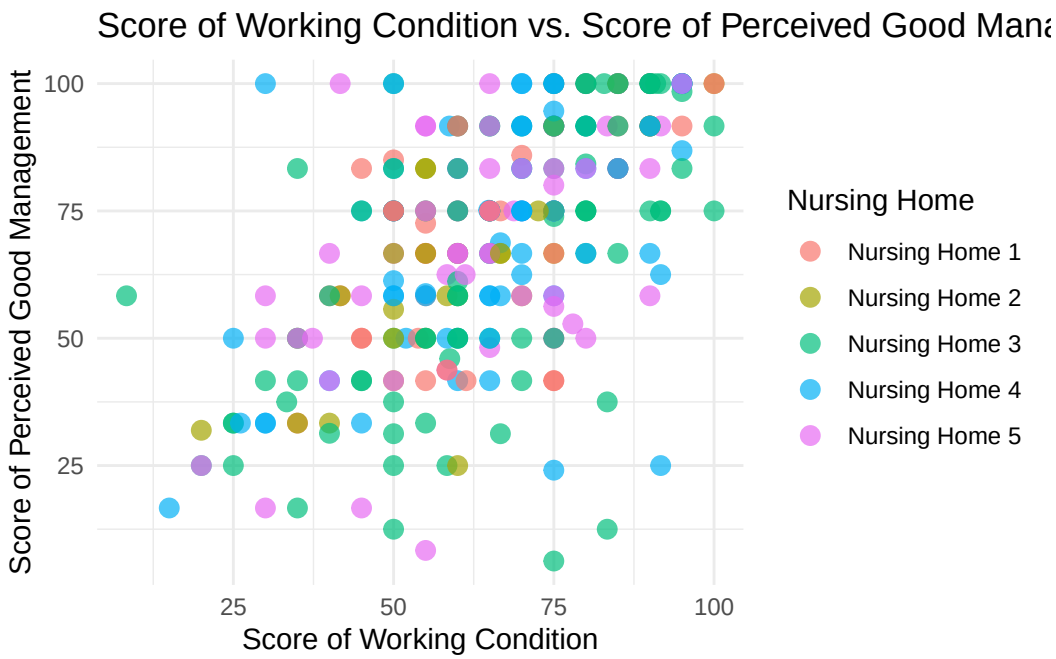
The scatter plot aims to explore the relationship between the scores of working condition and perceived good management across the five nursing homes. This visualization helps identify correlations between these two variables and examines how this relationship varies by nursing home, staff position, and language status.

The `ggplot2` package was used to construct the scatter plot. The `ggplot()` function was employed to specify the dataset and aesthetic mappings, with the `aes()` function mapping `scorewc` to the x-axis and `scorepom` to the y-axis, while `status` was mapped to the color aesthetic and `mothert` to the shape aesthetic. The `geom_point()` function was utilized to create the scatter plot, displaying individual data points representing staff members. Titles and labels were added using the `labs()` function to provide a clear title and axis labels. The `theme_minimal()` function was applied to ensure a clean and professional appearance, and the `facet_wrap()` function was used to create separate panels for each nursing home, allowing for a comparative view across all five nursing homes.

Figure 3

```
# Colored scatter plot for Score of Working Condition vs. Score of Perceived Good Management
colored_scatter_plot <- ggplot(nh_data, aes(x = scorewc, y = scorepom, color = nhid)) +
  geom_point(size = 3, alpha = 0.7) +
  labs(title = "Score of Working Condition vs. Score of Perceived Good Management Across Nurs
       x = "Score of Working Condition",
       y = "Score of Perceived Good Management",
       color = "Nursing Home") +
  theme_minimal()

# Display the scatter plot
print(colored_scatter_plot)
```



Comment:

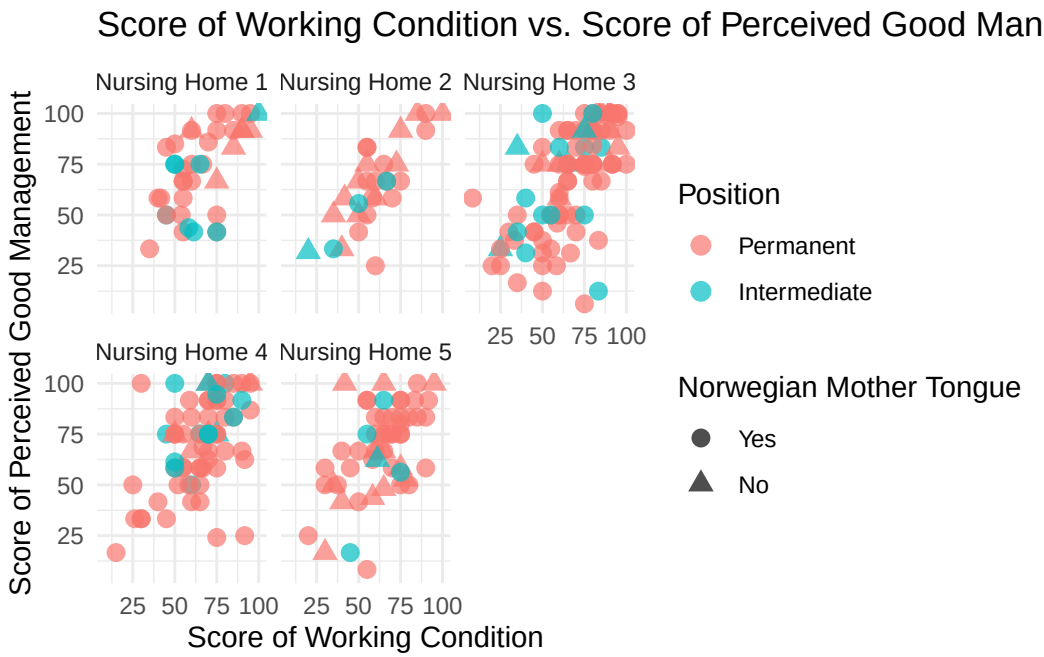
Figure 3 visualizes the relationship between the score of working conditions and the score of perceived good management across nursing homes, with each point representing an individual staff member's scores.

There is a general trend indicating a positive correlation between the scores of working conditions and perceived good management. Staff members who rate their working conditions highly also tend to rate management quality highly, and vice versa. The scores for both working conditions and perceived good management span almost the entire range from 0 to 100, suggesting a wide variety of perceptions among staff members across all nursing homes. The overall positive correlation suggests that improving working conditions could lead to better perceptions of management quality and vice versa. A few outliers are observed where scores are particularly high in the top-left and bottom-right corners. These outliers represent staff with significantly different perceptions compared to their peers

Figure 4

```
ggplot(nh_data, aes(x = scorewc, y = scorepom, color = status, shape = mothert)) +
  geom_point(size = 3, alpha = 0.7) +
  facet_wrap(~ nhid) +
  labs(title = "Score of Working Condition vs. Score of Perceived Good Management",
```

```
      x = "Score of Working Condition",
      y = "Score of Perceived Good Management",
      color = "Position",
      shape = "Norwegian Mother Tongue") +
theme_minimal()
```



Comment:

Figure 4 visualizes the relationship between the score of working conditions and the score of perceived good management across five different nursing homes. The scatter plot is faceted by nursing home, with each subplot representing one of the five nursing homes.

Higher scores in working conditions correlate with higher perceived management scores. Nursing Home 3 displays a diverse range of scores, indicating varied staff perceptions. Most staff members are in permanent positions in all nursing homes. Staff with Norwegian as their mother tongue are predominant across all nursing homes. There is consistency in high scores for both working conditions and management perceptions in Nursing Home 2, while other nursing homes show broader variability. These graphs suggest that while there is a general positive correlation between good working conditions and management perceptions, the extent of this correlation and the homogeneity of staff characteristics vary across different nursing homes.

Result Interpretation

1. The majority of staff across all nursing homes are in permanent positions, with most of them having Norwegian as their mother tongue. Nursing Home 3 and Nursing Home 5 have a more diverse staff composition in terms of language.
2. Most nursing homes have median scores around 65-75, indicating generally favorable working conditions. Nursing Home 2 stands out with a lower median score of working condition, suggesting room for improvement in working conditions. Nursing Home 3 showing a broader spread of variability in working condition scores, indicating diverse perceptions among staff.
3. The median scores for perceived good management show generally high median scores, around 70-75, across most nursing homes. However, Nursing Home 2 has a lower median score of perceived good management, suggesting that staff perceive management quality to be less favorable. Nursing Home 3 displaying more variability of perceived good management scores, indicating mixed perceptions.
4. There is a positive correlation between working condition scores and perceived good management scores across all nursing homes.

Recommendations

1. Given the lower median scores for both working conditions and perceived good management, a focused effort should be made to understand and address the specific challenges faced by staff in Nursing Home 2. This could involve implementing targeted interventions to improve working conditions and management practices.
2. The presence of intermediate staff with lower scores, especially in Nursing Home 2, indicates a need for better support and integration for these positions. Providing additional training could enhance their experience and performance.

Report Prepared By

1. Muhammad Saufi bin Abdullah 22307048
2. Hazlienor Binti Mohd Hatta 22307055
3. Amalina Binti Asmail @ Ismail 22307044
4. Mohamad Afiq Amsyar Bin Hamedin 23100003
5. Tiong Wen Ning 22307078

Appendix