Physiotherapeutic data-driven perspective on respiratory diseases

UUN S2616861

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Table of Contents


```
## Libraries
# Loading packages
pacman::p_load(tidyverse, openai, gridExtra, gt, webshot2, janitor, here)

## Set variables
OPENAI_API_KEY = Sys.getenv("OPENAI_API_KEY") # Setting API key for OpenAI
YEAR = 2019 # Setting year for analysis
CITY = "Milano" # Setting city for analysis

# List files in working directory
list.files("./")

## [1] "Presentation.R" "Report.docx"    "Report.R"       "Report.Rmd"
```

1 Introduction, context, and audience

Note: *The report builds on the presentation for the management, but looks at more factors influencing possible respiratory diseases and adds a country-specific view.*

This is data-driven report about respiratory diseases from a physiotherapeutic perspective. It is stored in a public **Github Repository**.

The purpose of this report is to show the present audience, Physiotherapists of the **Good Hope Clinic** in Milano, the **importance of physiotherapeutic measures** in cases of respiratory diseases as this health restriction is widespread long before COVID-19. For instance, China is facing a rise in respiratory diseases after lifting zero-COVID restrictions (Hawkings, A., 2023).

Another major public health problem is obesity. In view of increasing life expectancy, the prevalence of obesity is rising steadily in older age groups (Jura, M. & Kozak, L. P., 2016). World Health Organization (2023) defines overweight as a body mass index (BMI) of **25** to **29.9 kg/m2** and obesity as a BMI of **30 kg/m2** or higher. Obesity is a risk factor for many diseases, such as cardiovascular diseases, diabetes mellitus, cancer and musculoskeletal diseases.

Some researchers see a relation between high amount of **abdominal fat** and the function of the **respiratory system** (Rauch, E., 2015). From policy maker side, there are initiatives to reduce the occurrence of obesity, for instance Columbia introduced a tax for fast food (Daniels, J. P., 2023).

The aim of this study is to determine the degree of relevance of the topic "Obesity" for professionals working in the field of physiotherapy with clients that have a resp. disease.

Is obesity a risk factor for respiratory diseases?

2 Data wrangling and coding

The data was found on the *Organisation for Economic Cooperation and Development (OECD)* data repository as on different websites - for instance from *Statista*, a global data and business intelligence platform.

The data from OECD shows the total number of **respiratory diseases** per country and year.

```
## Processing OECD Health data of respiratory diseases
{
  # Source:
https://stats.oecd.org/viewhtml.aspx?datasetcode=HEALTH_PROC&lang=en#
  oecd_data_raw <- read_csv(here("raw_data/",
```

```
"HEALTH_PROC_10112023095631477.csv"))

  # Eyeballing data
  oecd_data_raw %>% glimpse() # Country names are in English language,
`Türkiye` is used instead of `Turkey` see
  # https://www.theguardian.com/world/2022/jun/03/turkey-changes-name-to-
turkiye-as-other-name-is-for-the-birds
  oecd_data_raw %>% skimr::skim()
  oecd_data_raw %>% tabyl(Country, Year, show_na = FALSE) %>% # Shows 2018
the highest number of observations
    adorn_totals("row") %>%
    adorn_percentages("row") %>%
    adorn_pct_formatting(digits = 1) %>%
    adorn_ns %>%
    adorn_title %>%
    head(5)

  # Preparing the OECD data
  oecd_data_tidy <- oecd_data_raw %>%
    filter(Variable == "Diseases of the respiratory system") %>%
    # Get the absolute number of resp. diseases
    filter(Measure == "Number") %>%
    select(Year, Country, Variable, Value) %>%
    arrange(Year) %>%
    pivot_wider(names_from = Variable, values_from = Value) %>%
    filter(Year == YEAR) %>%
    select(Country, starts_with("Diseases")) %>%
    mutate(Country = Country %>%
      factor())
}

## Rows: 259,263
## Columns: 11
## $ VAR          <chr> "ACATHEPB", "ACATHEPB", "ACATHEPB", "ACATHEPB",
"ACATHEPB…
## $ Variable     <chr> "Immunisation: Hepatitis B", "Immunisation: Hepatitis
B",…
## $ UNIT         <chr> "ENFANTTX", "ENFANTTX", "ENFANTTX", "ENFANTTX",
"ENFANTTX…
## $ Measure      <chr> "% of children immunised", "% of children immunised",
"% …
## $ COU          <chr> "AUS", "AUS", "AUS", "AUS", "AUS", "AUS", "AUS",
"AUS", "…
## $ Country      <chr> "Australia", "Australia", "Australia", "Australia",
"Aust…
## $ YEA          <dbl> 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018,
201…
## $ Year         <dbl> 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018,
201…
## $ Value        <dbl> 91.6, 91.6, 91.8, 91.0, 91.2, 92.8, 94.2, 94.7, 94.5,
```

```
94.…
## $ `Flag Codes` <chr> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA,
"E", …
## $ Flags        <chr> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA,
"Esti…
```

On a Github repository data about **air pollution** is available. This data is captured for countries and cities of Europe. Several air pollution indicators are present. In this report the *PM2.5* (particulate matter with a diameter size of 2.5 micrometers or smaller) is used.

As the air pollution data is also available per city, it will be filtered by the `CITY` variable, which is set to Milano, as this report is adopted to Physiotherapists in a clinic in Milan.

```
## Processing air pollution data
{
  # Source: https://github.com/dw-data/edjnet-pm2p5)
  # Reading data
  air_pollution_data_raw <- read_csv(here("raw_data/", "CAMS-Europe-
Renalaysis-Countries-Yearly-2018-2022.csv"))
  air_pollution_cities_data_raw <- read_csv(here("raw_data/", "CAMS-Europe-
Renalysis-Yearly-2018-2022.csv"))

  # Eyeballing data
  air_pollution_data_raw %>% glimpse() # Country names are each in their
local language
  air_pollution_data_raw %>% skimr::skim()
  air_pollution_data_raw %>% tabyl(`Name (latin characters)`, Year, show_na =
FALSE) %>% # Shows for all years (2018 - 2022) the same amount of
observations
    adorn_totals("row") %>%
    adorn_percentages("row") %>%
    adorn_pct_formatting(digits = 1) %>%
    adorn_ns %>%
    adorn_title %>%
    head(5)
  air_pollution_cities_data_raw %>% glimpse() # Country names are each in
their short code
  air_pollution_cities_data_raw %>% skimr::skim()
  air_pollution_cities_data_raw %>% tabyl(`Name (latin characters)`, Day,
show_na = FALSE) %>% # Shows for all years (2018 - 2022) the same amount of
observations
    adorn_totals("row") %>%
    adorn_percentages("row") %>%
    adorn_pct_formatting(digits = 1) %>%
    adorn_ns %>%
    adorn_title %>%
    head(5)

  # Preparing the air pollution data
  air_pollution_data_tidy <- air_pollution_data_raw %>%
```

```
    select(Year, "Name (latin characters)", "Yearly PM 2.5 average (µg/m³)",
"Population estimate (GHSL 2020)") %>%
    rename(Country = "Name (latin characters)", PM2.5 = "Yearly PM 2.5
average (µg/m³)", Pop = "Population estimate (GHSL 2020)") %>%
    filter(Year == YEAR) %>%
    select(Country, PM2.5, Pop) %>%
    mutate(Country = Country %>%
      factor())

  # Preparing the air pollution data for cities
  air_pollution_cities_data_tidy <- air_pollution_cities_data_raw %>%
  select(Day, `Country code`, "Name (latin characters)", "Daily PM 2.5
average (µg/m³)") %>%
    rename(Code = `Country code`, City = "Name (latin characters)", PM2.5 =
"Daily PM 2.5 average (µg/m³)") %>%
    filter(Day == paste0(YEAR, "-12-31")) %>%
    select(City, Code, PM2.5) %>%
    mutate(City = City %>%
             factor(),
           Code = Code %>%
             factor())
  # Storing PM2.5 value for the selected city
  city_pm <- air_pollution_cities_data_tidy %>%
    filter(City == CITY) %>%
    select(PM2.5) %>%
    as.numeric()
}
```

```
## Rows: 205
## Columns: 19
## $ Column1                          <dbl> 0, 1, 2, 3, 4, 5, 6, 7, 8, 9,
10, 11…
## $ Year                             <dbl> 2018, 2019, 2020, 2021, 2022,
2018, …
## $ `NUTS ID`                        <chr> "FR", "FR", "FR", "FR", "FR",
"HR", …
## $ `Country code`                   <chr> "FR", "FR", "FR", "FR", "FR",
"HR", …
## $ `Name (latin characters)`        <chr> "France", "France", "France",
"Franc…
## $ `Yearly PM 2.5 average (µg/m³)`  <dbl> 8.115917, 8.010881, 7.143126,
7.5490…
## $ `Population estimate (GHSL 2020)` <dbl> 63026742, 63026742, 63026742,
630267…
## $ `0–5µg/m³ - population`          <dbl> 89203, 43901, 201984, 164288,
11839,…
## $ `5–10µg/m³ - population`         <dbl> 38248345, 39335096, 57924834,
498049…
## $ `10–15µg/m³ - population`        <dbl> 24689193, 23647745, 4899923,
1305745…
```

```
## $ `15–20µg/m³ - population`         <dbl> 0, 0, 0, 0, 0, 913689, 1516356,
1361…
## $ `20–25µg/m³ - population`         <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, …
## $ `25+ µg/m³ - population`          <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, …
## $ `0–5µg/m³ - percentage`           <dbl> 0.001415322, 0.000696552,
0.00320474…
## $ `5–10µg/m³ - percentage`          <dbl> 0.606858999, 0.624101685,
0.91905170…
## $ `10–15µg/m³ - percentage`         <dbl> 0.39172568, 0.37520176,
0.07774355, …
## $ `15–20µg/m³ - percentage`         <dbl> 0.00000000, 0.00000000,
0.00000000, …
## $ `20–25µg/m³ - percentage`         <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, …
## $ `25+ µg/m³ - percentage`          <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, …
## Rows: 10,935
## Columns: 7
## $ ...1                                       <dbl> 0, 1, 2, 3, 4, 5, 6, 7,
8, …
## $ Day                                        <date> 2018-12-31, 2019-12-
31, 20…
## $ `NUTS ID`                                  <chr> "DE254", "DE254",
"DE254", …
## $ `Country code`                             <chr> "DE", "DE", "DE", "DE",
"DE…
## $ `Name (latin characters)`                  <chr> "Nürnberg, Kreisfreie
Stadt…
## $ `Daily PM 2.5 average (µg/m³)`             <dbl> 11.77, 10.52, 10.07,
10.23,…
## $ `EU Air Quality Guidelines classification` <chr> "Fair (10-20)", "Fair
(10-2…
```

From a clinical perspective, **overweight and obesity** data is of interest as it is a risk factor for many health-related problems. The data taken is available on the OECD website.

```r
## Processing overweight / obesity data
{
  # Source: https://data.oecd.org/healthrisk/overweight-or-obese-
population.htm
  # Reading data
  obesity_data_raw <- read_csv(here("raw_data/",
"DP_LIVE_02112023125750641.csv"))

  # Eyeballing data
  obesity_data_raw %>% glimpse() # Country names are in a 3-letter country-
code format
  obesity_data_raw %>% skimr::skim()
  obesity_data_raw %>% tabyl(LOCATION, TIME, show_na = FALSE) %>% # Shows
2019 the highest number of observations
    adorn_totals("row") %>%
    adorn_percentages("row") %>%
    adorn_pct_formatting(digits = 1) %>%
    adorn_ns %>%
    adorn_title %>%
    head(5)

  # Preparing the obesity data
  obesity_data_tidy <- obesity_data_raw %>%
    filter(TIME == YEAR) %>%
    select(LOCATION, Value) %>%
    rename(Country = LOCATION) %>%
    group_by(Country) %>%
    # Explain why I used the mean and not dropped the `self_measured` column
    summarise(Value = mean(Value, na.rm = TRUE)) %>%
    mutate(Country = Country %>%
           factor())
}
```

```
## Rows: 80
## Columns: 8
## $ LOCATION     <chr> "AUT", "BEL", "CAN", "CAN", "CAN", "CAN", "CAN",
"CZE", "…
## $ INDICATOR    <chr> "OVEROBESE", "OVEROBESE", "OVEROBESE", "OVEROBESE",
"OVER…
## $ SUBJECT      <chr> "SELFREPORTED", "SELFREPORTED", "MEASURED",
"SELFREPORTED…
## $ MEASURE      <chr> "PC_POP15", "PC_POP15", "PC_POP15", "PC_POP15",
"PC_POP15…
## $ FREQUENCY    <chr> "A", "A", "A", "A", "A", "A", "A", "A", "A", "A",
"A", "A…
## $ TIME         <dbl> 2019, 2018, 2019, 2018, 2019, 2020, 2021, 2019, 2018,
201…
## $ Value        <dbl> 51.1, 49.3, 59.8, 53.8, 54.2, 54.4, 55.5, 58.4, 55.0,
57.…
```

```
## $ `Flag Codes` <chr> NA, NA, NA, NA, NA, NA, NA, NA, "D", NA, "D", NA, NA,
NA,…
```

Smoking is a major risk factor for many diseases, as an extensive body of academic literature and research is showing. Smoking is predominantly associated with the etiology of lung cancer and a range of pulmonary diseases. Therefore, data on the percentage of smokers in the population are also included in the analysis.

```
## Processing smoke data
{
  # Source: https://www.statista.com/statistics/433390/individuals-who-
currently-smoke-cigarettes-in-european-countries/
  # Reading data
  smoking_data_raw <- read_csv(here("raw_data/", "statistic_id433390_current-
smokers-in-europe-2020-by-country.csv"))

  # Eyeballing data
  smoking_data_raw %>% glimpse()

  # Preparing the obesity data
  smoking_data_tidy <- smoking_data_raw %>%
    mutate(Country = Country %>%
             factor())
}
```

```
## Rows: 28
## Columns: 2
## $ Country                 <chr> "Greece", "Bulgaria", "Croatia", "Latvia",
"Cz…
## $ `Percentage of smokers` <dbl> 42, 38, 36, 32, 30, 30, 28, 28, 28, 28,
27, 26…
```

On the **CIA Factbook**, the index of the *median age*, that summarizes the age distribution of a population, is distributed. Currently, the median age per country ranges from a low of about 15 in Niger or Uganda to 45 or more in several European countries or Japan. The `Median age` variable can be seen as a potential confounder on the correlation between `respiratory diseases` (dependent) and other variables like `air pollution` (independent).

```
## Processing median age data
{
  # Source: https://www.cia.gov/the-world-factbook/field/median-age/country-
comparison/
  # Reading data
  age_data_raw <- read_csv(here("raw_data/", "cia_factbook_median_age.csv"))

  # Eyeballing data
  age_data_raw %>% glimpse()

  # Preparing the obesity data
  age_data_tidy <- age_data_raw %>%
    select(name, value) %>%
    rename(Country = name, `Median age` = value) %>%
    mutate(Country = Country %>%
             factor())

  # Remove unused data / values from Global Environment
  rm(list = c("air_pollution_data_raw", "obesity_data_raw", "oecd_data_raw",
"air_pollution_cities_data_raw", "air_pollution_cities_data_tidy",
"smoking_data_raw", "age_data_raw"))
}
```

```
## Rows: 227
## Columns: 6
## $ name                <chr> "Monaco", "Japan", "Saint Pierre and
Miquelon", "G…
## $ slug                <chr> "monaco", "japan", "saint-pierre-and-
miquelon", "g…
## $ value               <dbl> 55.4, 48.6, 48.5, 47.8, 46.5, 46.2, 45.6,
45.6, 45…
## $ date_of_information <dbl> 2020, 2020, 2020, 2020, 2020, 2020, 2020,
2020, 20…
## $ ranking             <dbl> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15,…
## $ region              <chr> "Europe", "East and Southeast Asia", "North
Americ…
```

Note: *The different datasets used incompatible encodings for the country variable, English language, local language or a code, which lead to the need to normalize them to a standardized convention. In this case the English naming for country and continent is chosen.*

As Large Language Models (LLM) are an effective way to automate the processing of large amounts of text, the OpenAI API is used to convert the country variables in a consistent matching format. Secondly, the API is used to associate each state with its corresponding continental landmass, as this data is missing and needed for grouping by continents.

```r
## Checking common countries in the datasets
## ChatGPT or loading existing data
if (nchar(OPENAI_API_KEY) == 51) {
  message("API key is valid, requesting data from OpenAI")

  ## Filter unique countries and continents
  # Filter dataset `oecd_data_tidy`
  countries_oecd <- oecd_data_tidy %>%
    select(Country) %>%
    distinct() %>%
    arrange(Country)

  # Filter dataset `air_pollution_data_tidy`
  countries_airpol <- air_pollution_data_tidy %>%
    select(Country) %>%
    distinct() %>%
    arrange(Country)

  # Filter dataset `obesity_data_tidy`
  countries_obesity <- obesity_data_tidy %>%
    select(Country) %>%
    distinct() %>%
    arrange(Country)

  # Filter dataset `smoking_data_tidy`
  countries_smoking <- smoking_data_tidy %>%
    select(Country) %>%
    distinct() %>%
    arrange(Country)

  # Filter dataset `age_data_tidy`
  countries_age <- age_data_tidy %>%
    select(Country) %>%
    distinct() %>%
    arrange(Country)

  ## Convert country tibbles to chr
  # Create empty vector
  countries <- character()
  # OECD data,
  countries <- append(countries, list(levels(countries_oecd$Country)))
  # air pollution data
  countries <- append(countries, list(levels(countries_airpol$Country)))
  # smoking data,
  countries <- append(countries, list(levels(countries_smoking$Country)))
  # age data,
  countries <- append(countries, list(levels(countries_age$Country)))
  # OECD obesity data
  countries <- append(countries, list(levels(countries_obesity$Country)))
```

```r
  ## Request AI completion to standardize the country names
  # Loop through OpenAI ChatGPT completion
  countries_cleaned <- vector()
  check <- character()
  country <- character()
  continent_list <- ""
  for (i in 1:5) {
    # Remove unneeded character from country lists
    countries[i] <- countries[i] %>% gsub("\n", "", .) %>% gsub('\\"', "", .)
%>% gsub("c(", "", ., fixed = TRUE) %>% gsub(")", "", ., fixed = TRUE)

    # Request AI completion, as long as output has same length as input
    while (length(strsplit(as.character(countries[i]), ", ")[[1]]) !=
length(strsplit(as.character(countries_cleaned[i]), ", ")[[1]])) {
      print("Input")
      print(paste(countries[i], collapse = ", "))
      print(paste0("Countries: ", length(strsplit(as.character(countries[i]),
", ")[[1]])))
      request <- create_chat_completion(model = "gpt-3.5-turbo",
openai_api_key = OPENAI_API_KEY, messages = list(
        list("role" = "system", "content" = "You are a translator of country
names or descriptions which comes often in national language, several anmes
or abbrevations, into a single standard english country name. Use `Türkiye`
instead of `Turkey`."),
        list("role" = "user", "content" = "I will give you a list of
countries and I need you to reply just the english country names, comma
seperated, without any further content! Please give me an sample output of '
                                          Türkiye, Danmark, DEU,
Schweiz/Suisse/Svizzera, Shqipëria'."),
        list("role" = "assistant", "content" = "Türkiye, Denmark, Germany,
Switzerland, Albania"),
        list("role" = "user", "content" = "Exactly, like that! Now I give you
the list. `Türkiye` is the new name for formerly `Turkey`"),
        list("role" = "user", "content" = paste(countries[i], collapse = ",
"))))
      countries_cleaned[i] <- request$choices$message.content
      print("Output")
      print(countries_cleaned[i])
      print(paste0("Countries: ",
length(strsplit(as.character(countries_cleaned[i]), ", ")[[1]])))
      print("------------------")
    }

    # From chr to vector
    check <- append(check, list(strsplit(as.character(countries[i]), split =
", ")[[1]]))
    country <- append(country, list(strsplit(countries_cleaned[i], split = ",
")[[1]]))
```

```
    # Continent list
    if (i == 5) {
      # Loop as long number of countries are not equal to number continents
      while (length(unlist(country[i])) != length(continent_list)) {
        print("Input")
        print(paste(countries_cleaned[i], collapse = ", "))
        print(paste0("Country list length: ", length(unlist(country[i]))))
        request <- create_chat_completion(model = "gpt-3.5-turbo",
openai_api_key = OPENAI_API_KEY, messages = list(
          list("role" = "system", "content" = "You convert country names to
the english continent names they are on."),
          list("role" = "user", "content" = "I will give you a list of
countries and I need you to print out the english continent names, comma
seperate all countries, without any further content! Please give me an sample
output of 'Germany, Mexico, Japan, Chile'."),
          list("role" = "assistant", "content" = "Europe, North Amercia,
Asia, South America"),
          list("role" = "user", "content" = "Exactly, like that! Now I give
you the list."),
          list("role" = "user", "content" = paste(countries_cleaned[i],
collapse = ", "))))
        continent_list <- request$choices$message.content
        continent_list <- strsplit(continent_list, split = ", ")[[1]]
        print("Output")
        print(paste(continent_list, collapse = ", "))
        print(paste0("Continent list length: ", length(continent_list)))
      }

      # Find common countries in the lists
      country_list <-
intersect(intersect(intersect(intersect(unlist(country[1]),
unlist(country[2])), unlist(country[3])), unlist(country[4])),
unlist(country[5]))

      # Save lists
      saveRDS(country_list, here("processed_data/", "country_list.rds"))
      saveRDS(continent_list, here("processed_data/", "continent_list.rds"))
      saveRDS(check, here("processed_data/", "check.rds"))
      saveRDS(country, here("processed_data/", "country.rds"))
    }
  }
} else {
  message("API key is invalid, loading data from disk ...")

  # Load lists, if API key is missing
  country_list <- readRDS(here("processed_data/", "country_list.rds"))
  continent_list <- readRDS(here("processed_data/", "continent_list.rds"))
  check <- readRDS(here("processed_data/", "check.rds"))
```

```
  country <- readRDS(here("processed_data/", "country.rds"))
}

## Show common countries
{
  print("##############################")
  print(paste0("### Common countries: ", length(country_list), " ###"))
  print("##############################")

  # Remove unused data / values from Global Environment
  rm(list = c("i", "request", "countries" ,"countries_cleaned",
"countries_airpol", "countries_obesity", "countries_oecd",
"countries_smoking", "countries_age"))
}

## [1] "##############################"
## [1] "### Common countries: 13 ###"
## [1] "##############################"
```

Note: *If no OpenAI API Key is provided, the code falls back to already stored data in the repository.*

To prepare the datasets for plotting, it is needed to drop all observations in the datasets which are not in the common country list. This is done in the following code chunk.

```
## Cleaning country descriptions
{
  ## Create dataset `oecd_data_plot`
  # Standardize country names ...
  oecd_plot <- oecd_data_tidy
  for (i in 1:length(unlist(country[1]))) {
    oecd_plot <- oecd_plot %>%
      mutate(Country = if_else(Country == unlist(check[1])[i],
unlist(country[1])[i], Country))
  }
  # ... and filter for common countries in datasets
  oecd_plot <- oecd_plot %>%
    filter(Country %in% country_list)

  ## Create dataset `air_pollution_plot`
  # Standardize country names ...
  air_pollution_plot <- air_pollution_data_tidy
  for (i in 1:length(unlist(country[2]))) {
    air_pollution_plot <- air_pollution_plot %>%
      mutate(Country = if_else(Country == unlist(check[2])[i],
unlist(country[2])[i], Country))
  }
  # ... and filter for common countries in datasets
  air_pollution_plot <- air_pollution_plot %>%
    filter(Country %in% country_list)
```

```
  ## Create dataset `smoking_data_plot`
  # Standardize country names ...
  smoking_plot <- smoking_data_tidy
  for (i in 1:length(unlist(country[3]))) {
    smoking_plot <- smoking_plot %>%
      mutate(Country = if_else(Country == unlist(check[3])[i],
unlist(country[3])[i], Country))
  }
  # ... and filter for common countries in datasets
  smoking_plot <- smoking_plot %>%
    filter(Country %in% country_list)

  ## Create dataset `age_data_plot`
  # Standardize country names ...
  age_plot <- age_data_tidy
  for (i in 1:length(unlist(country[4]))) {
    smoking_plot <- smoking_plot %>%
      mutate(Country = if_else(Country == unlist(check[4])[i],
unlist(country[4])[i], Country))
  }
  # ... and filter for common countries in datasets
  age_plot <- age_plot %>%
    filter(Country %in% country_list)

  ## Create dataset `obesity_plot`
  # Standardize country names
  obesity_plot <- obesity_data_tidy
  for (i in 1:length(unlist(country[5]))) {
    obesity_plot <- obesity_plot %>%
      mutate(Country = if_else(Country == unlist(check[5])[i],
unlist(country[5])[i], Country))
  }
  # ... and filter for common countries in datasets
  obesity_plot <- obesity_plot %>%
    filter(Country %in% country_list)

  # Remove unused data / values from Global Environment
  rm(list = c("air_pollution_data_tidy", "obesity_data_tidy",
"oecd_data_tidy", "smoking_data_tidy", "i", "check", "country",
"country_list", "continent_list"))
}
```

To create the final dataset for plotting, the OECD data about resp. diseases is enriched with other datasets (`air_pollution`, `obesity`, `smoking` and `age`).

```r
## Preparation of the plotting datasets
{
  ## Combining the datasets
  # Joining OECD data and air pollution data
  data <- left_join(oecd_plot, air_pollution_plot, by = "Country")

  # Joining obesity data
  data <- left_join(data, obesity_plot, by = "Country")

  # Joining smoking data
  data <- left_join(data, smoking_plot, by = "Country")

  # Joining age data
  data <- left_join(data, age_plot, by = "Country")

  ## Prepare the dataset for plotting
  # Calculate the diseases per 100.000
  data_plot <- data %>%
    mutate("Diseases of the respiratory system" = `Diseases of the
respiratory system` / Pop * 100000) %>%
    rename("Resp. diseases per 100.000" = `Diseases of the respiratory
system`) %>%
    rename("Obesity" = Value) %>%
    rename("Smoker" = `Percentage of smokers`)

  # Remove unused data / values from Global Environment
  rm(list = c("data", "oecd_plot", "air_pollution_plot", "obesity_plot",
"smoking_plot", "age_plot"))
}
```

Note: *The data is in a tidy format, meaning each variable is in it's own column and each observation in it's own row, and ready for plotting.*

3 Data visualisation

After finding the data for `median age`, `smoking`, `obesity / overweight` and `air pollution`, it is now set into relation to the `respiratory diseases` variable. The following visualizations is proving if there are **correlations** between any of them.

```
## Visualisation
{
  ## Figure A1: Point figure with a linear regression line
  # Calculate dependence of respiratory diseases in correlation to air
pollution
  model = lm(`Resp. diseases per 100.000` ~ PM2.5, data = data_plot)
  p = round(summary(model)$coefficients[,4][2], digits = 3)

  # Predict resp. diseases per 100,000 for selected city
  city_value <- data.frame(PM2.5 = city_pm)
  city_resp_diseases <- as.numeric(predict(model, newdata = city_value))
  data_plot_with_city <- data_plot %>%
    add_row(Country = CITY, `Resp. diseases per 100.000` =
city_resp_diseases, PM2.5 = city_pm, `Median age` = NA)
  # Show correlation between respiratory diseases and air pollution, plus
selected city
  p1a <- data_plot_with_city %>%
    ggplot(aes(x = PM2.5, y = `Resp. diseases per 100.000`, color = Country))
+
    geom_point(aes(color = Country, size = `Resp. diseases per 100.000`)) +
    geom_smooth(method = "lm", se = FALSE, color = "gray") +
    geom_text(aes(label = Country, color = `Resp. diseases per 100.000` >
2000), hjust = -0.1, vjust = 1.5) +
    labs(title = paste0("Figure A1: Respiratory diseases in ",
length(data_plot$Country)," european countries"),
         subtitle = paste0("in correlation to air pollution (year ", YEAR,
"), plus prediction of ", CITY),
         x = "Air pollution (particulate matter as PM2.5)", y = "Respiratory
diseases (per 100.000)",
         caption = "Data source: OECD health data & https://github.com/dw-
data/edjnet-pm2p5") +
    scale_y_continuous(labels = scales::label_comma()) +
    expand_limits(x = c(1, 30), y = c(660, 2400)) +
    coord_cartesian(expand = FALSE) +
    annotate("text", x = 15, y = 1650, label = paste0("p-value = ", p), size
= 3) +
    annotate("text", x = 25, y = 1400, label =
paste0(round(city_resp_diseases, digits = 0), " per 100,000"), size = 3) +
    annotate("text", x = 25, y = 1275, label = "predicted resp. diseases",
size = 3) +
    annotate("text", x = 25, y = 1150, label = "(1,37m total population)",
size = 3) +
    theme_bw() +
    theme(legend.position = "none",
```

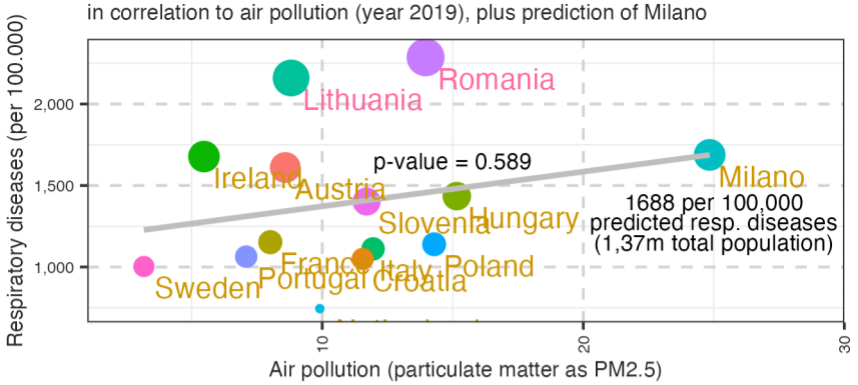
```
          plot.caption = element_text(face = "italic", hjust = 0),
          panel.grid.major = element_line(colour = "lightgrey", linetype =
"dashed"),
          plot.title = element_text(size = 10, colour = "#2b2828", hjust =
0),
          plot.subtitle = element_text(size = 8, colour = "#2b2828", hjust =
0),
          axis.text.y = element_text(size = 6, colour = "#2b2828"),
          axis.text.x = element_text(size = 6, colour = "#2b2828", angle =
90, vjust = 0.5),
          axis.title = element_text(size = 8, hjust = 0.5, colour =
"#2b2828"))

  ## Figure A2: Point figure with a linear regression line
  # Calculate dependence of respiratory diseases in correlation to obesity
  model = lm(`Resp. diseases per 100.000` ~ Obesity, data = data_plot)
  p = round(summary(model)$coefficients[,4][2], digits = 3)
  # Correlation between respiratory diseases and overweight & obesity
  p1b <- data_plot %>%
    ggplot(aes(x = Obesity, y = `Resp. diseases per 100.000`, color =
Country)) +
    geom_point(aes(color = Country, size = `Resp. diseases per 100.000`)) +
    geom_text(aes(label = Country, color = `Resp. diseases per 100.000` >
2000), hjust = -0.1, vjust = 1.5) +
    geom_smooth(method = "lm", se = FALSE, color = "gray") +
    annotate("text", x = 65, y = 1900, label = paste0("p-value = ", p), size
= 3) +
    labs(title = paste0("Figure A2: Respiratory diseases in ",
length(data_plot$Country), " european countries"),
         subtitle = paste0("in correlation to obesity (year ", YEAR, ")"),
         x = "Obesity (in percentage)", y = "Respiratory diseases (per
100.000)",
         caption = "Data source: OECD health data") +
    scale_x_continuous(labels = function(x) paste0(x, '%')) +
    scale_y_continuous(labels = scales::label_comma()) +
    expand_limits(x = c(45, 70), y = c(500, 2400)) +
    coord_cartesian(expand = FALSE) +
    theme_bw() +
    theme(legend.position = "none",
          plot.caption = element_text(face = "italic",hjust = 0),
          panel.grid.major = element_line(colour = "lightgrey", linetype =
"dashed"),
          plot.title = element_text(size = 10, colour = "#2b2828", hjust =
0),
          plot.subtitle = element_text(size = 8, colour = "#2b2828", hjust =
0),
          axis.text.y = element_text(size = 6, colour = "#2b2828"),
          axis.text.x = element_text(size = 6, colour = "#2b2828", angle =
90, vjust = 0.5),
          axis.title = element_text(size = 8, colour = "#2b2828"))
```

```r
  ## Figure A3: Point figure with a linear regression line
  # Calculate dependence of respiratory diseases in correlation to smoking
  model = lm(`Resp. diseases per 100.000` ~ Smoker, data = data_plot)
  p = round(summary(model)$coefficients[,4][2], digits = 3)
  # Correlation between respiratory diseases and smoking
  p1c <- data_plot %>%
    ggplot(aes(x = Smoker, y = `Resp. diseases per 100.000`, color =
Country)) +
    geom_point(aes(color = Country, size = `Resp. diseases per 100.000`)) +
    geom_text(aes(label = Country, color = `Resp. diseases per 100.000` >
2000), hjust = -0.1, vjust = 1.5) +
    geom_smooth(method = "lm", se = FALSE, color = "gray") +
    annotate("text", x = 35, y = 1800, label = paste0("p-value = ", p), size
= 3) +
    labs(title = paste0("Figure A3: Respiratory diseases in ",
length(data_plot$Country), " european countries"),
         subtitle = paste0("in correlation to smoking (year ", YEAR, ")"),
         x = "Smoker (in percentage)", y = "Respiratory diseases (per
100.000)",
         caption = "Data source:
https://www.statista.com/statistics/433390/individuals-who-currently-smoke-
cigarettes-in-european-countries/") +
    scale_x_continuous(labels = function(x) paste0(x, '%')) +
    scale_y_continuous(labels = scales::label_comma()) +
    expand_limits(x = c(15, 40), y = c(500, 2400)) +
    coord_cartesian(expand = FALSE) +
    theme_bw() +
    theme(legend.position = "none",
          plot.caption = element_text(face = "italic",hjust = 0),
          panel.grid.major = element_line(colour = "lightgrey", linetype =
"dashed"),
          plot.title = element_text(size = 10, colour = "#2b2828", hjust =
0),
          plot.subtitle = element_text(size = 8, colour = "#2b2828", hjust =
0),
          axis.text.y = element_text(size = 6, colour = "#2b2828"),
          axis.text.x = element_text(size = 6, colour = "#2b2828", angle =
90, vjust = 0.5),
          axis.title = element_text(size = 8, colour = "#2b2828"))

  ## Figure A4: Point figure with a linear regression line
  # Calculate dependence of respiratory diseases in correlation to smoking
  model = lm(`Resp. diseases per 100.000` ~ `Median age`, data = data_plot)
  p = round(summary(model)$coefficients[,4][2], digits = 3)
  # Correlation between respiratory diseases and age
  p1d <- data_plot %>%
    ggplot(aes(x = `Median age`, y = `Resp. diseases per 100.000`, color =
Country)) +
    geom_point(aes(color = Country, size = `Resp. diseases per 100.000`)) +
```

```r
    geom_text(aes(label = Country, color = `Resp. diseases per 100.000` >
2000), hjust = -0.1, vjust = 1.5) +
    geom_smooth(method = "lm", se = FALSE, color = "gray") +
    annotate("text", x = 40, y = 1200, label = paste0("p-value = ", p), size
= 3) +
    labs(title = paste0("Figure A4: Respiratory diseases in ",
length(data_plot$Country), " european countries"),
         subtitle = paste0("in correlation to age (year ", YEAR, ")"),
         x = "Median Age (in years)", y = "Respiratory diseases (per
100.000)",
         caption = "Data source: https://www.cia.gov/the-world-
factbook/field/median-age/country-comparison/") +
    scale_x_continuous(labels = function(x) paste0(x, 'yrs')) +
    scale_y_continuous(labels = scales::label_comma()) +
    expand_limits(x = c(38.5, 47), y = c(500, 2400)) +
    coord_cartesian(expand = FALSE) +
    theme_bw() +
    theme(legend.position = "none",
          plot.caption = element_text(face = "italic",hjust = 0),
          panel.grid.major = element_line(colour = "lightgrey", linetype =
"dashed"),
          plot.title = element_text(size = 10, colour = "#2b2828", hjust =
0),
          plot.subtitle = element_text(size = 8, colour = "#2b2828", hjust =
0),
          axis.text.y = element_text(size = 6, colour = "#2b2828"),
          axis.text.x = element_text(size = 6, colour = "#2b2828", angle =
90, vjust = 0.5),
          axis.title = element_text(size = 8, colour = "#2b2828"))

  # Combine the plots
  combined_plot <- arrangeGrob(p1a, p1b, p1c, p1d, nrow = 4)

  # Save the combined plot
  ggsave(combined_plot, file = here("figures/", "Plot_A_Combined.png"), width
= 4.5, height = 10)

  # Remove unused data / values from Global Environment
  rm(list = c("combined_plot", "p", "model", "city_pm", "city_value",
"city_resp_diseases", "data_plot_with_city", "data_plot", "p1a", "p1b",
"p1c", "p1d"))
}

# Show figure
knitr::include_graphics(here("figures", "Plot_A_Combined.png"))
```

Figure A1: Respiratory diseases in 13 european countries

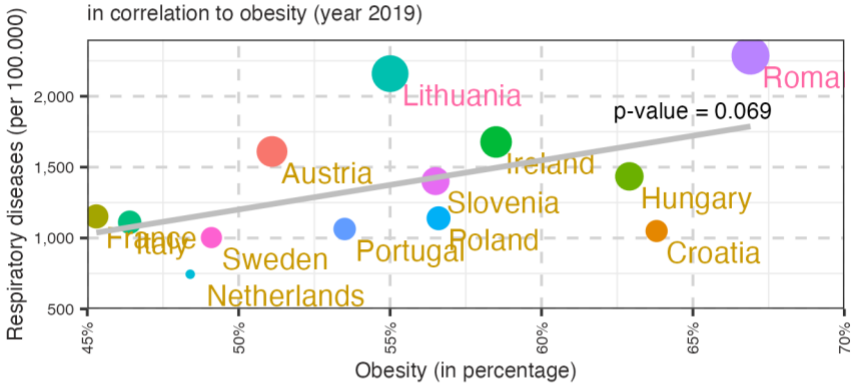
in correlation to air pollution (year 2019), plus prediction of Milano



Data source: OECD health data & https://github.com/dw-data/edjnet-pm2p

Figure A2: Respiratory diseases in 13 european countries

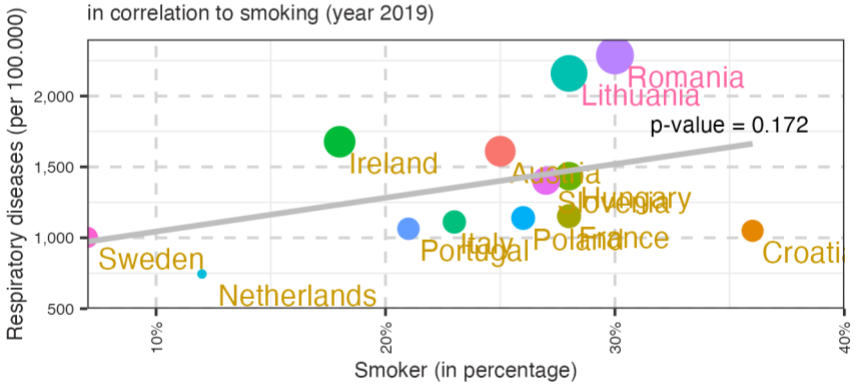
in correlation to obesity (year 2019)



Data source: OECD health data

Figure A3: Respiratory diseases in 13 european countries

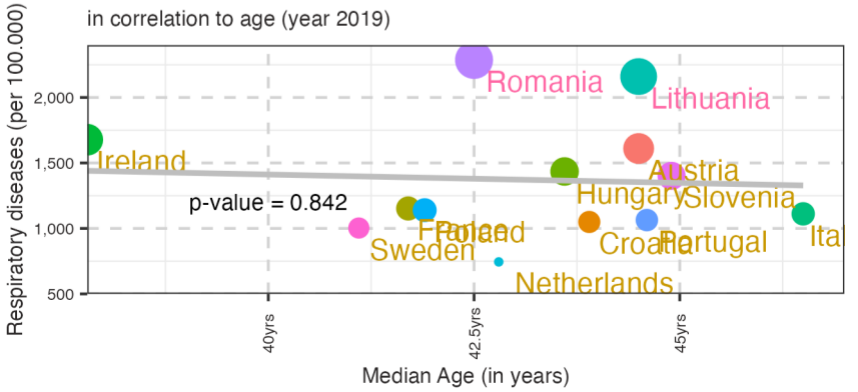
in correlation to smoking (year 2019)



Data source: https://www.statista.com/statistics/433390/individuals-who-cu

Figure A4: Respiratory diseases in 13 european countries

in correlation to age (year 2019)



Data source: https://www.cia.gov/the-world-factbook/field/median-age/cou

Note: *The strongest correlation is been found in the independent variable* `Obesity`*, towards* `Resp. diseases per 100.000`*. This could underscore the significance of obesity in relation to resp. diseases. Milano has a predicted rate of 1688 cases per 100,000, which would be around 23,000 cases for the cities population.*

As the data found is restricted to **13 european countries**, the need for a global comparison is not achievable. Therefore, the following code will request global data on obesity from the `ourworldindata` repository.

In this case, the data does not consist of the percentage of overweight and obesity per country, instead it holds the **deaths related to obesity**.

```
## More data from countries on other continents needed!
{
  # Source: https://ourworldindata.org/obesity
  obesity_world_data_raw <- read_csv(here("raw_data/", "share-of-deaths-
obesity.csv"))
  obesity_world_data_tidy <- obesity_world_data_raw %>%
    filter(Year == YEAR) %>%
    # Drop NA rows
    drop_na(Code) %>%
    # Drop `World`
    filter(str_length(Code) <= 3) %>%
    rename("Country" = Code, "Obesity" = starts_with("Share")) %>%
    select(Country, Obesity)

  # ChatGPT or loading existing data
  if (nchar(OPENAI_API_KEY) == 51) {
    message("API key is valid, requesting data from OpenAI")

    # OpenAI ChatGPT API usage to map continents to countries
    convert_codes <- function(mode, data) {
      output <- vector()
      cat("Converting codes: ")
      for (country in data) {
        if (mode == "Country") {
          request <- create_chat_completion(model = "gpt-3.5-turbo",
openai_api_key = OPENAI_API_KEY, messages = list(
              list("role" = "system", "content" = "You convert a country code
to the english country name. Use `Unknown` for unknown country codes."),
              list("role" = "user", "content" = "Please convert 'DEU'."),
              list("role" = "assistant", "content" = "Germany"),
              list("role" = "user", "content" = "Exactly, like that! Now I
give you another country code."),
              list("role" = "user", "content" = country)))
          output <- append(output, request$choices$message.content)
        }
        if (mode == "Continent") {
          request <- create_chat_completion(model = "gpt-3.5-turbo",
openai_api_key = OPENAI_API_KEY, messages = list(
```

```
              list("role" = "system", "content" = "You convert a country code
to the english continent name it is located on. Use `Unknown` for unknown
country codes or one of these 6 different continent names `Africa`, `Asia`,
`Europe`, `North America`, `South America`, `Oceania`.)"),
              list("role" = "user", "content" = "Please convert 'DEU'."),
              list("role" = "assistant", "content" = "Europe"),
              list("role" = "user", "content" = "Exactly, like that! Now I
give you another country code."),
              list("role" = "user", "content" = country)))
          output <- append(output, request$choices$message.content)
        }
        cat("#")
      }
      return(output)
    }

    # Convert country codes to continents
    continents_world <- convert_codes("Continent", data =
obesity_world_data_tidy$Country)
    saveRDS(continents_world, here("processed_data/", "continents.rds"))

    # Convert country codes to country names
    countries_world <- convert_codes("Country", data =
obesity_world_data_tidy$Country)
    saveRDS(countries_world, here("processed_data/", "countries.rds"))
  } else {
    message("API key is invalid, loading existing data")

    # Load saved data (ChatGPT requests are charged!)
    continents_world <- readRDS(here("processed_data/", "continents.rds"))
    countries_world <- readRDS(here("processed_data/", "countries.rds"))
  }

  # Creating dataset for plotting
  obesity_world_plot <- obesity_world_data_tidy %>%
    mutate(Country = countries_world %>%
      factor()) %>%
    mutate(Continent = continents_world %>%
      factor()) %>%
    filter(Country != "Unknown") %>%
    filter(Continent != "Unknown")

  # Remove unused data / values from Global Environment
  rm(list = c("obesity_world_data_raw", "obesity_world_data_tidy",
"continents_world", "countries_world", "OPENAI_API_KEY", "CITY",
"convert_codes"))

  ## Checking new data
  # Show levels (Continents)
```

```
  obesity_world_plot %>%
    pull(Continent) %>%
    levels()

  # Show count of countries per continent
  obesity_world_plot %>%
    select(Continent) %>%
    summary()

  # Count African countries
  afr_countries <- obesity_world_plot %>%
    filter(Continent == "Africa") %>%
    select(Continent) %>%
    count()

  # Count European countries
  eur_countries <- obesity_world_plot %>%
    filter(Continent == "Europe") %>%
    select(Continent) %>%
    count()
}
```

To display more than 200 different countries in a meaningful way, the data is presented as a table, ordered by continents and highlighting the percentage of obesity in brackets.

```
## Table A1: Table with 6 columns (grouped by continents)
{
  # Show overview over countries with deaths related to obesity
  t1 <- obesity_world_plot %>%
    mutate(Country = if_else(Obesity < 7,  md(paste0(Country, ' (<span
style="color:green">', round(Obesity, digits = 1), '%</span>)')),
                     if_else(Obesity < 15, md(paste0(Country, ' (<span
style="color:#ff8c00">', round(Obesity, digits = 1), '%</span>)')),
                                           md(paste0("**", Country, ' (<span
style="color:red">', round(Obesity, digits = 1), '%</span>)**'))))) %>%
    arrange(Obesity) %>%
    select(Country, Continent) %>%
    pivot_wider(names_from = Continent, values_from = Country) %>%
    gt() %>%
      tab_header(title = "Table A1: Percentage of deaths attributed to
obesity",
                 subtitle = paste0("for ",
length(obesity_world_plot$Country), " countries, grouped by continents (year
", YEAR, ")")) %>%
      tab_source_note(source_note = md("*Data source:
https://ourworldindata.org/obesity*")) %>%
      tab_footnote(footnote = paste0("EUROPE includes ", eur_countries, "
countries (avg. age 42.5yrs), AFRICA includes ", afr_countries, " countries
(avg. age 19.7yrs)"),
                   locations = cells_column_labels(columns = c(Europe,
```

```
Africa))) %>%
      cols_move(columns = Africa, after = Asia) %>%
      cols_move(columns = `North America`, after = Europe) %>%
      cols_move(columns = Oceania, after = `South America`) %>%
      cols_label(Africa = md("**AFRICA**"), Asia = md("**ASIA**"), `North
America` = md("**NORTH AMERICA**"),
                 Europe = md("**EUROPE**"), `South America` = md("**SOUTH
AMERICA**"), Oceania = md("**OCEANIA**")) %>%
      cols_align(align = "left", columns = everything()) %>%
      tab_spanner(label = md("*Focus continents*"), columns = c(Africa,
Europe))

  # Save the table
  gtsave(t1, filename = "Table_A1_Deaths_Obesity.pdf", path =
here("tables/"))
}

# Remove unused data / values from Global Environment
rm(list = c("t1", "eur_countries", "afr_countries"))

# Show PDF
knitr::include_graphics(here("tables", "Table_A1_Deaths_Obesity.pdf"))
```

Table A1: Percentage of deaths attributed to obesity

for 201 countries, grouped by continents (year 2019)

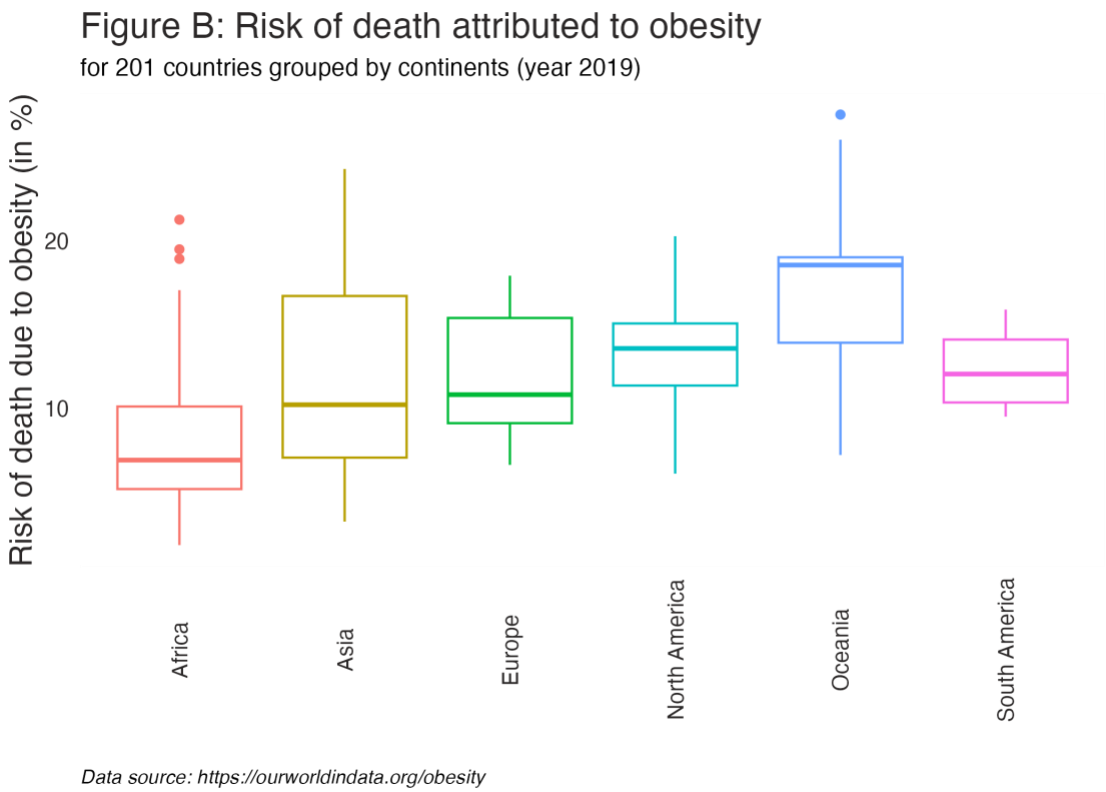
	Focus continents				
ASIA	**AFRICA**[1]	**EUROPE**[1]	**NORTH AMERICA**	**SOUTH AMERICA**	**OCEANIA**
Timor-Leste (3.2%), Japan (3.9%), Nepal (4.4%), Cambodia (4.4%), Bangladesh (4.7%), Vietnam (5.5%), India (5.7%), South Korea (5.8%), China (6.4%), Myanmar (6.6%), Maldives (6.6%), Bhutan (6.8%), Singapore (7.1%), Laos (7.5%), Taiwan (7.8%), Pakistan (8%), Thailand (8.1%), Yemen (8.3%), Brunei (8.3%), Indonesia (8.4%), Cyprus (8.9%), Tajikistan (9.3%), Philippines (9.5%), Malaysia (9.7%), Israel (10.7%), Sri Lanka (10.8%), Afghanistan (12.3%), Kyrgyzstan (12.9%), Mongolia (13.1%), **Armenia (15.4%)**, **Iran (15.4%)**, **Kazakhstan (15.9%)**, **Syria (16.5%)**, **Palestine (16.5%)**,	Somalia (1.8%), Central African Republic (2.8%), Burundi (3.1%), Chad (3.4%), Niger (3.8%), Ethiopia (3.8%), Sierra Leone (4.3%), Mozambique (4.4%), Democratic Republic of the Congo (4.9%), Mali (4.9%), Burkina Faso (4.9%), Nigeria (5.1%), Eritrea (5.1%), Guinea (5.2%), Angola (5.2%), Rwanda (5.4%), Uganda (5.4%), Malawi (5.5%), South Sudan (5.5%), Djibouti (5.5%), Togo (6.1%), Kenya (6.2%), Madagascar (6.2%), Ivory Coast (6.2%), Zimbabwe (6.4%), Comoros (6.4%), Zambia (6.8%), Benin (7%), Tanzania (7.1%), Liberia (7.1%), Senegal (7.2%), Gambia (7.7%), Lesotho (8.7%), Andorra (9%), Cameroon	Norway (6.6%), Netherlands (7.3%), Denmark (7.3%), Belgium (7.4%), France (7.5%), Switzerland (8.3%), San Marino (8.3%), Luxembourg (8.4%), Portugal (8.7%), Ireland (9.1%), United Kingdom (9.1%), Sweden (9.2%), Monaco (9.2%), Malta (9.5%), Iceland (9.5%), Spain (9.6%), Finland (9.6%), Italy (9.7%), Austria (10.4%), Greece (10.6%), Germany (10.8%), Slovenia (12.1%), Albania (12.9%), Poland (13.8%), Lithuania (14.4%), Croatia (14.4%), Czech Republic (14.8%), Bosnia and Herzegovina	Haiti (6.1%), Guatemala (9.2%), Greenland (9.5%), Canada (10%), Honduras (10.8%), Cuba (11.2%), Costa Rica (11.3%), Panama (11.5%), Dominican Republic (12.7%), United States (13%), Saint Lucia (13.3%), Bermuda (13.4%), El Salvador (13.5%), Antigua and Barbuda (13.6%), Barbados (13.8%), Grenada (13.9%), Saint Kitts and Nevis (14.1%), Nicaragua (14.7%), Saint Vincent and the Grenadines (14.7%), Dominica	Peru (9.5%), Uruguay (9.5%), Colombia (10.2%), Argentina (10.4%), Bolivia (11.8%), Brazil (12%), Chile (12.1%), Venezuela (13.7%), Suriname (14.1%), Paraguay (14.2%), Ecuador (14.3%), **Guyana (15.9%)**	Papua New Guinea (7.2%), New Zealand (10.3%), Australia (10.7%), Solomon Islands (13.1%), Vanuatu (13.6%), Marshall Islands (14.3%), **Tuvalu (16.1%)**, **Kiribati (16.5%)**, **Tonga (17.7%)**, **Palau (18.6%)**, **Tokelau (18.6%)**, **Northern Mariana Islands (18.6%)**, **Micronesia, Federated States of (18.7%)**, **Guam (18.8%)**, **Samoa (19.3%)**, **Nauru (19.9%)**, **Niue (21.6%)**, **Cook Islands**

Data source: https://ourworldindata.org/obesity

Note: *At the bottom of the table the countries with the highest rates of deaths related to obesity can be found.*

To summarize this observation per continent, a boxplot is used. The boxplot shows the median of the deaths attributed to obesity per continent.

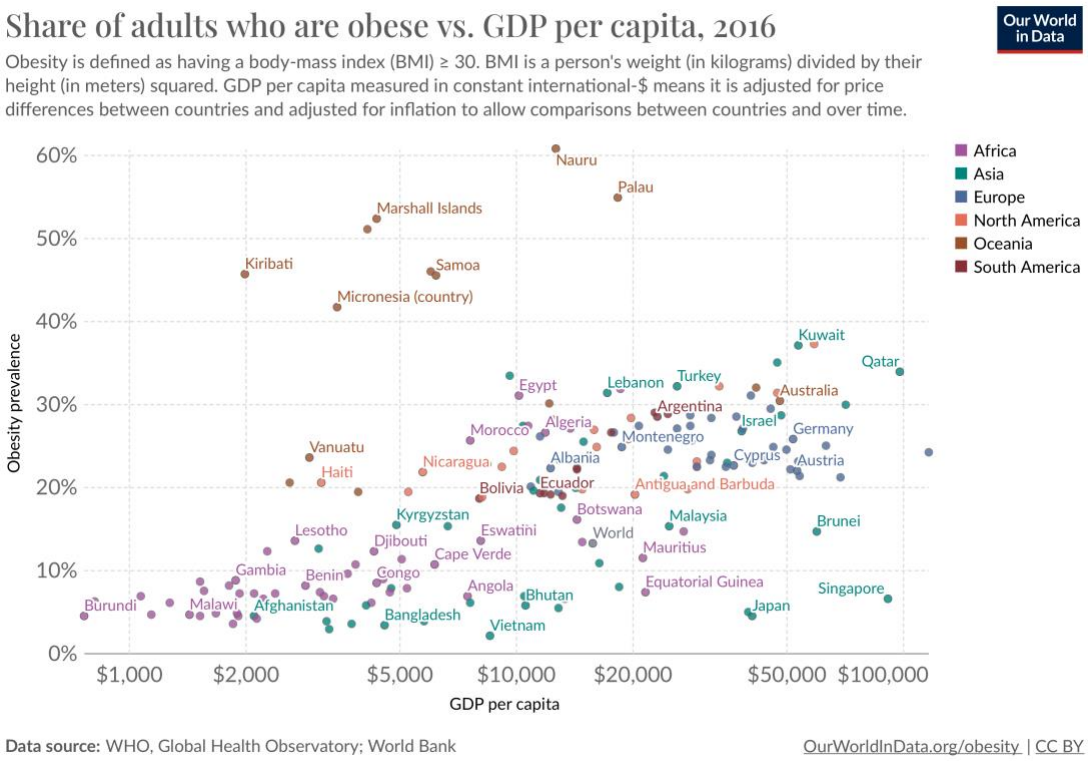
```r
## Figure B: Boxplot, grouped by continents
{
  # Rename `obesity` to `Risk of death`
  obesity_world_plot <- obesity_world_plot %>%
    rename("Risk of death" = "Obesity")

  # Show deaths attributed to obesity worldwide
  p2 <- obesity_world_plot %>%
    ggplot(aes(x = Continent, y = `Risk of death`)) +
    geom_boxplot(aes(color = Continent)) +
    labs(title = "Figure B: Risk of death attributed to obesity",
         subtitle = paste0("for ", length(obesity_world_plot$Country), "
countries grouped by continents (year ", YEAR, ")"),
         x = "", y = "Risk of death due to obesity (in %)",
         caption = "Data source: https://ourworldindata.org/obesity") +
    theme_bw() +
    theme(legend.position = "none",
          plot.caption = element_text(face = "italic", hjust = 0),
          plot.background = element_blank(), panel.grid.major =
element_blank(),
          panel.grid.minor = element_blank(), panel.border = element_blank(),
          plot.title = element_text(size = 16, colour = "#2b2828", hjust =
0),
          axis.ticks.x = element_blank(), axis.ticks.y = element_blank(),
          axis.text.x = element_text(size = 10, colour = "#2b2828", angle =
90, vjust = 0.5),
          axis.text.y = element_text(size = 10, colour = "#2b2828"),
          axis.title = element_text(size = 14, hjust = 0.5, colour =
"#2b2828"))

  # Save the table
  ggsave(p2, file = here("figures/", "Plot_B_Deaths_Obesity.png"), width = 7,
height = 5)
}

# Show figure
knitr::include_graphics(here("figures", "Plot_B_Deaths_Obesity.png"))
```



Data source: https://ourworldindata.org/obesity

```
# Remove unused data / values from Global Environment
rm("p2")
```

Note: *Africa has the lowest median, while Oceania has the highest. Europa also shows many countries with a high rate of health issues related to obesity.*



This figure from **Our World in Data** shows the relationship between obesity and GDP. It indicates that *the higher the GDP, the higher the obesity rate*.

As second table is created for grouping countries not by continent but by risk factor as also the median age in three groups.

```
## Table A2: Table grouped by risks and age groups
{
  # Add avg. age per country
  obesity_world_plot2 <- left_join(obesity_world_plot, age_data_tidy, by =
"Country")

  # Convert variable `Risk of death` values from numeric to categorical
  obesity_world_plot2 <- obesity_world_plot2 %>%
    mutate(`Risk of death` = cut(`Risk of death`, breaks = c(0, 7, 15, 100),
labels = c("Low", "Medium", "High"), include.lowest = TRUE)) %>%
    mutate(`Median age` = cut(`Median age`, breaks = c(0, 25, 40, 100),
labels = c("Young", "Middle", "Old"), include.lowest = TRUE)) %>%
    rename("Age" = "Median age") %>%
    drop_na(Age)

  # Calculate highest risk group
  len_list <- obesity_world_plot2 %>%
    filter(`Risk of death` == "High" & Age == "Old") %>%
    count()
```

```r
  # Show overview of risk of death related to obesity and age group
  t2 <- obesity_world_plot2 %>%
    arrange(`Risk of death`) %>%
    mutate(Country = if_else(`Risk of death` == "Low",  md(paste0('<span
style="color:green">', Country, ' </span>')),
                      if_else(`Risk of death` == "Medium", md(paste0('<span
style="color:#ff8c00">', Country, '</span>')),
                      if_else(Age == "Old", md(paste0('**<span
style="color:darkred">', Country, '</span>**')),
                                                    md(paste0('**<span
style="color:red">', Country, '</span>**'))))),
           Age = toupper(Age)) %>%
    select(Country, `Risk of death`, Age) %>%
    pivot_wider(names_from = `Risk of death`, values_from = Country) %>%
    gt() %>%
      tab_header(title = "Table A2: Risk of death due to obesity",
                 subtitle = paste0("for ",
length(obesity_world_plot2$Country), " countries, grouped by risk and age
(year ", YEAR, ")")) %>%
      tab_source_note(source_note = md("*Data sources:
https://ourworldindata.org/obesity*,
https://en.wikipedia.org/wiki/List_of_countries_by_median_age")) %>%
      tab_footnote(footnote = paste0("Legend: `YOUNG` ≙ under 25yrs avg. age;
`MIDDLE` ≙ 25 - 40yrs avg. age; `OLD` ≙ over 40yrs avg. age."),
                   locations = cells_column_labels(columns = Age)) %>%
      tab_footnote(footnote = paste0("Subgroup of high risk & and high avg.
age includes ", len_list, " countries."),
                   locations = cells_column_labels(columns = High)) %>%
      cols_move(columns = Low, after = Age) %>%
      cols_label(Age = md("**AGE**"), Low = md("*LOW RISK*"), Medium =
md("*MEDIUM RISK*"), High = md("*HIGH RISK*")) %>%
      cols_align(align = "left", columns = everything()) %>%
      tab_spanner(label = md("*Focus countries*"), columns = High)

  # Save the table
  gtsave(t2, filename = "Table_A2_Deaths_Risk.pdf", path = here("tables/"))
}

# Remove unused data / values from Global Environment
rm(list = c("t2", "obesity_world_plot", "obesity_world_plot2",
"age_data_tidy", "YEAR", "len_list"))

# Show PDF
knitr::include_graphics(here("tables", "Table_A2_Deaths_Risk.pdf"))
```

Table A2: Risk of death due to obesity

for 186 countries, grouped by risk and age (year 2019)

			Focus countries
AGE[1]	*LOW RISK*	*MEDIUM RISK*	*HIGH RISK*[2]
YOUNG	Angola , Burkina Faso , Burundi , Central African Republic , Chad , Comoros , Djibouti , Timor-Leste , Eritrea , Ethiopia , Guinea , Haiti , Kenya , Madagascar , Malawi , Mali , Mozambique , Niger , Nigeria , Rwanda , Sierra Leone , Somalia , South Sudan , Togo , Uganda , Zambia , Zimbabwe	Afghanistan, Benin, Cameroon, Equatorial Guinea, Eswatini, Gabon, Ghana, Guatemala, Honduras, Laos, Lesotho, Liberia, Marshall Islands, Mauritania, Namibia, Pakistan, Papua New Guinea, Philippines, Senegal, Solomon Islands, Sudan, Tanzania, Vanuatu, Yemen	**Belize**, **Egypt**, **Iraq**, **Jordan**, **Syria**, **Tonga**
MIDDLE	Bangladesh , Bhutan , Cambodia , China , India , Maldives , Nepal , Norway , Vietnam	Albania, Antigua and Barbuda, Argentina, Australia, Barbados, Bolivia, Botswana, Brazil, Brunei, Chile, Colombia, Costa Rica, Cyprus, Dominica, Dominican Republic, Ecuador, El Salvador, Greenland, Grenada, Iceland, Indonesia, Ireland, Israel, Kyrgyzstan, Luxembourg, Malaysia, Mongolia, New Zealand, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Singapore, South Africa, Sri Lanka, Suriname, Tajikistan, Thailand, United States, Uruguay, Venezuela	**Algeria**, **Armenia**, **Azerbaijan**, **Bahrain**, **Cook Islands**, **Fiji**, **Georgia**, **Guam**, **Guyana**, **Iran**, **Jamaica**, **Kazakhstan**, **Kiribati**, **Kuwait**, **Lebanon**, **Libya**, **Mauritius**, **Mexico**, **Micronesia, Federated States of**, **Moldova**, **Montenegro**, **Morocco**, **Nauru**, **North Macedonia**, **Northern Mariana Islands**, **Oman**, **Palau**, **Qatar**, **Samoa**, **Saudi Arabia**, **Trinidad and Tobago**, **Tunisia**, **Turkmenistan**, **Tuvalu**, **United Arab Emirates**, **Uzbekistan**
OLD	Japan	Andorra, Austria, Belgium, Bermuda, Bosnia and Herzegovina, Canada, Croatia, Cuba, Denmark, Finland, France, Germany, Greece, Italy, Lithuania, Malta, Monaco,	**Belarus**, **Bulgaria**, **Estonia**, **Hungary**, **Latvia**, **Puerto Rico**, **Romania**, **Russia**, **Serbia**, **Slovakia**, **Ukraine**

Data sources: https://ourworldindata.org/obesity, https://en.wikipedia.org/wiki/List_of_countries_by_median_age

Note: *Here we see that the countries with the highest risk of death due to obesity and a high median age. Many of them in Europe.*

4 Discussion and analysis

The data analysis shows a strong correlation ($p = 0.07$) between the appearance of overweight / obesity and the risk of developing a respiratory disease. In clinical experience of Physiotherapists, obesity is known as a critical factor in health outcomes of patients. The abdominal fat, is suspected to negatively affect the mobility and function of the lungs in the upper torso Rauch, E. (2015). European countries have a high prevalence of obesity, consequently reducing obesity would serve as an initial step towards the diminution of prevalence rates of resp. diseases.

The data also shows moderate correlation between smoking and resp. diseases ($p = 0.17$). This is not surprising, as smoking is known to be a risk factor for a long time and there are many initiatives to reduce smoking and to prevent younger people from starting to consume tobacco.

On the other hand, air pollution and the median age of a country both do not seem to impact the risk of developing a resp. disease. Particular the air pollution was under suspicion to be a high risk factor, but the data does not show a significant correlation.

5 Conclusion and Recommendations

As the data shows, obesity leads to a high risk to develop a resp. disease. Countries with a higher median age (confounder / mediator) are often found in Europe. Physiotherapy is an important pillar in the health system not only to treat resp. diseases directly (awareness of breathing movements, postures that make breathing easier, stretching positions or mucolytic exercises), but also to prevent or cure obesity through physical exercise and diet education. Rauch, E. (2015) posits that accumulations of visceral adipose tissue influence the respiratory mechanics.

Considering that the factors `air pollution`, `smoking` and `median age` seemingly exert an insubstantial impact on the risk of developing a resp. disease, and given that these can not be directly influenced by physiotherapeutic measures, it is reasonable to omit them from this conclusion.

Why do factors like *air pollution* and *smoking* not seem to have a strong impact, as obesity have? Why does obesity have such a strong impact on the risk of developing a respiratory disease. Can the research of F. X. Mayr, Rauch, E. (2015) referred to his foundational work, provide valid explanations for this phenomenon? Will there be a rise in obesity and also in the prevalence of resp. diseases in Counties which are still developing, like on the African continent?

6 Reflective practice

Description: My experience of working on the project was showing different phases of the working process. In the beginning I was very motivated to do the coding. I used a R script file to try out different data wrangling, analysis and visualisation methods for the presentation and report and I was very curious about the data and how I can enrich the OECD data with data from other sources. This changed over time with more data and aspects needed to be covered. The participation in the discussion boards gave me further insights, but due to lack of time I was not able to participate in all of the discussions.

Feelings: At some point with rising complexity, finding the red thread, I was a bit overwhelmed. I found it hard to express my thoughts in a structured way, taking also into account that English is not my native language.

Evaluation: I really enjoyed to work with R code, RStudio and plotting libraries such as *ggplot2*. Also to use ChatGPT for the first time in R for normalizing purposes was a rewarding experience. The finalization of the project was a bit draining, as it already reached a higher complexity.

Analysis: My time management was good, as after taking my long leave in my expiring job, I kept the working hours I had before to finish the assessment in good time. With my previous coding experience I found my self in a good learning position to reach a higher level of understanding in R and data science at all.

Conclusion: Keeping a journal of my steps and thoughts would have helped me to reach a better understanding of the data and the research question.

Action plan: I need to keep the overview of my research question and the data which is used. Also I need to be more structured in my approach and follow a red thread.

References

Daniels, J. P., 2023. Colombia introduces junk food tax. THE LANCET, (Accessed: 24.11.2023).

Hawkings, A., 2023. China supplies data to WHO about clusters of respiratory illness. The Guardian, (Accessed: 27.11.2023).

Jura, M. & Kozak, L. P., 2016. Obesity and related consequences to ageing. National Library of Medicine, (Accessed: 24.11.2023).

Rauch, E., 2015. Lehrbuch der diagnostik und therapie nach f. X. Mayr, pp. 73. Karl F. Haug Verlag, Stuttgart.

World Health Organization, 2023. Obesity. National Library of Medicine, (Accessed: 27.11.2023).

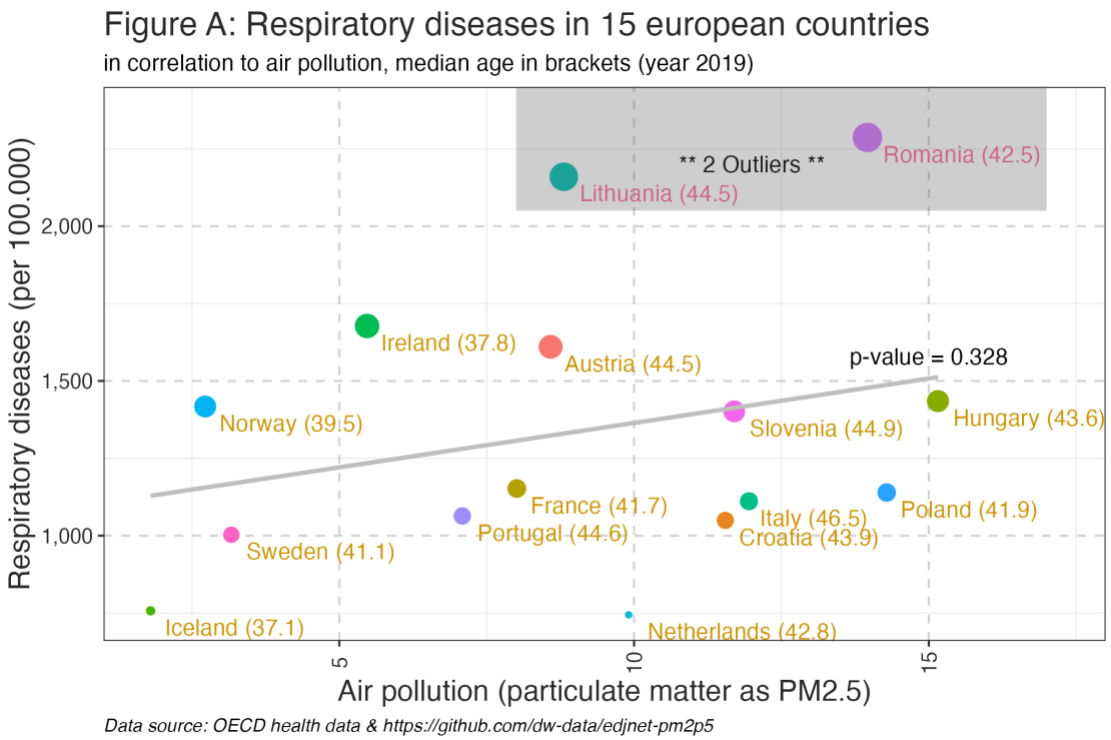
Soft copies:

Daniels, J. P., 2023

Jura, M. & Kozak, L. P., 2016

WHO, 2023

Figures from the management presentation:



PM2.5

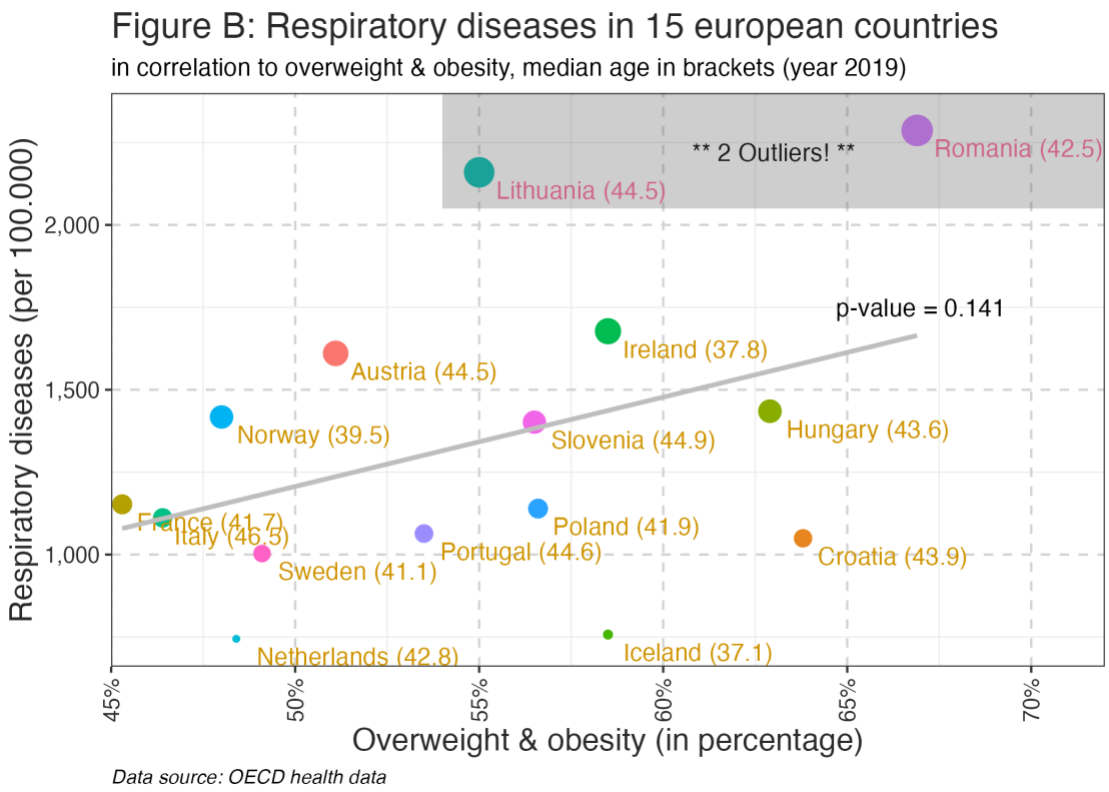
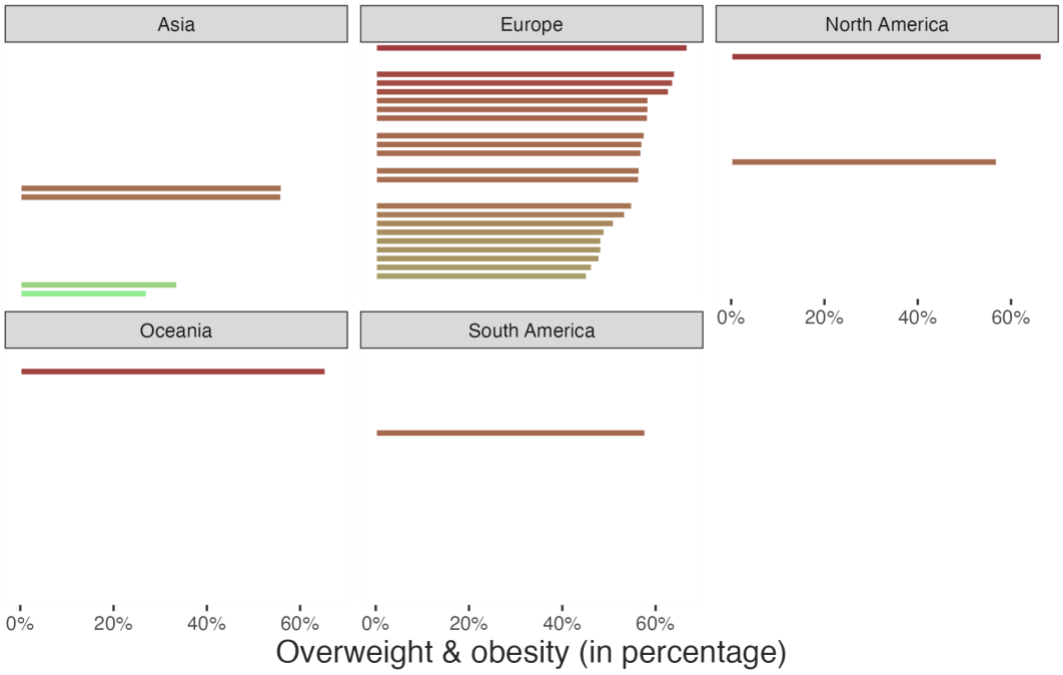


Figure B: Respiratory diseases in 15 european countries
in correlation to overweight & obesity, median age in brackets (year 2019)
** 2 Outliers! **
Romania (42.5)
Lithuania (44.5)
p-value = 0.141
Ireland (37.8)
Austria (44.5)
Norway (39.5)
Slovenia (44.9)
Hungary (43.6)
France (41.7)
Italy (46.5)
Poland (41.9)
Portugal (44.6)
Croatia (43.9)
Sweden (41.1)
Netherlands (42.8)
Iceland (37.1)
Respiratory diseases (per 100.000)
2,000
1,500
1,000
45%
50%
55%
60%
65%
70%
Overweight & obesity (in percentage)
Data source: OECD health data

Obesity

Figure C1: Overweight & obesity

for 29 countries, grouped by continents (year 2019)

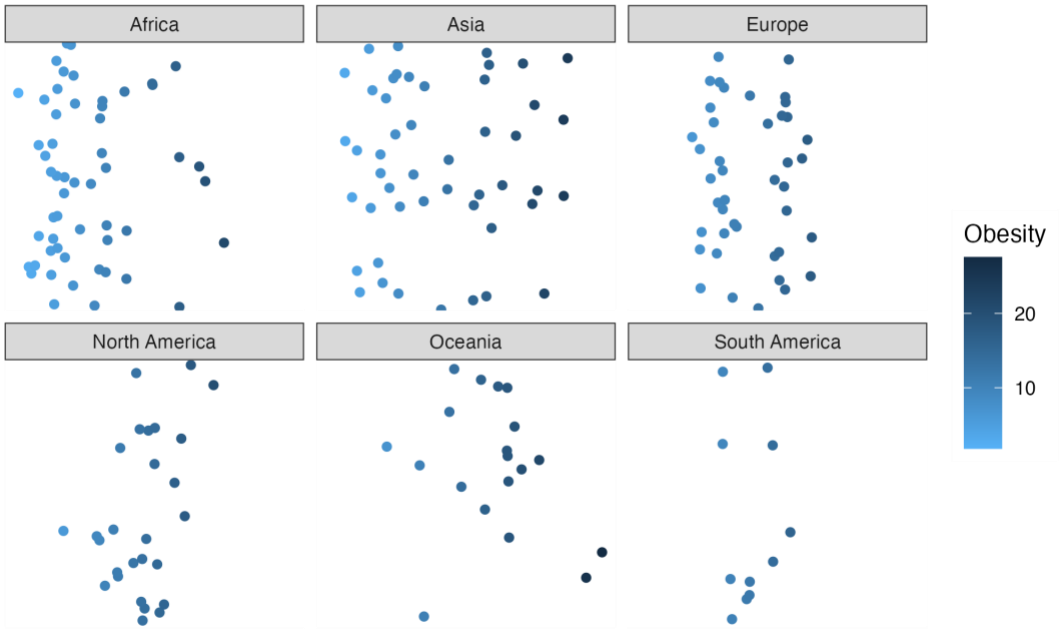


Data source: OECD health data

Obesity continental

Figure C2: Percentage of deaths attributed to obesity

for 201 countries grouped by continents (year 2019)



Data source: https://ourworldindata.org/obesity

Deaths continental

Datathon Assessment Guidelines

Datathon Assessment Guidelines

Session Info

Debug variable and output of used libraries.

```
# Knitted with RStudio (2023.09.1+494 "Desert Sunflower" for macOS)
# For word counting the code and it's output can be neglected,
# setting the `debug_var` variable to `TRUE`.
sessionInfo()

## R version 4.1.2 (2021-11-01)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS Big Sur 10.16
##
## Matrix products: default
## BLAS:
/Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRblas.0.dylib
## LAPACK:
/Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] here_1.0.1      janitor_2.2.0   webshot2_0.1.1  gt_0.10.0
##  [5] gridExtra_2.3   openai_0.4.1    lubridate_1.9.3 forcats_1.0.0
##  [9] stringr_1.5.0   dplyr_1.1.3     purrr_1.0.2     readr_2.1.4
## [13] tidyr_1.3.0     tibble_3.2.1    ggplot2_3.4.3   tidyverse_2.0.0
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.8        lattice_0.20-45   png_0.1-7         ps_1.6.0
##  [5] rprojroot_2.0.2   digest_0.6.29     utf8_1.2.2        R6_2.5.1
##  [9] repr_1.1.6        evaluate_0.22     pillar_1.9.0      rlang_1.1.1
## [13] rstudioapi_0.15.0 Matrix_1.3-4      rmarkdown_2.25
textshaping_0.3.6
## [17] labeling_0.4.2    splines_4.1.2     bit_4.0.4         munsell_0.5.0
## [21] compiler_4.1.2    xfun_0.40         systemfonts_1.0.4 pkgconfig_2.0.3
## [25] base64enc_0.1-3   mgcv_1.8-38       htmltools_0.5.7   websocket_1.4.1
## [29] tidyselect_1.2.0  fansi_1.0.2       crayon_1.4.2      tzdb_0.2.0
## [33] withr_2.5.0       later_1.3.0       commonmark_1.9.0  grid_4.1.2
## [37] nlme_3.1-153      jsonlite_1.8.7    gtable_0.3.0      lifecycle_1.0.3
## [41] pacman_0.5.1      magrittr_2.0.3    scales_1.2.1      cli_3.6.1
## [45] stringi_1.7.6     vroom_1.6.3       farver_2.1.0      fs_1.6.3
## [49] promises_1.2.0.1  snakecase_0.11.1  skimr_2.1.5       xml2_1.3.3
## [53] ragg_1.2.5        generics_0.1.2    vctrs_0.6.3       tools_4.1.2
## [57] bit64_4.0.5       glue_1.6.2        markdown_1.11     hms_1.1.3
## [61] processx_3.8.2    parallel_4.1.2    fastmap_1.1.0     yaml_2.2.2
```

```
## [65] timechange_0.2.0  chromote_0.1.2    colorspace_2.0-2  knitr_1.44
## [69] sass_0.4.7
```