Adoption and impact of non-pharmaceutical interventions for COVID-19

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Package

Extract variables of potential interest from linelist

```
extracted_linelist <- suppressMessages(readr::read_csv("raw-data/linelist.csv")) %>%
  dplyr::as_tibble() %>%
  dplyr::select(country, city, province, date_confirmation, travel_history_location) %>%
  dplyr::mutate(import_status = dplyr::if_else(is.na(travel_history_location) |
                                                 travel_history_location == "", "local", "imported"))
```

```
## Warning: 656 parsing failures.
##  row                     col           expected actual                    file
## 5835 data_moderator_initials 1/0/T/F/TRUE/FALSE     SL 'raw-data/linelist.csv'
## 5836 data_moderator_initials 1/0/T/F/TRUE/FALSE     SL 'raw-data/linelist.csv'
## 5837 data_moderator_initials 1/0/T/F/TRUE/FALSE     SL 'raw-data/linelist.csv'
## 5838 data_moderator_initials 1/0/T/F/TRUE/FALSE     SL 'raw-data/linelist.csv'
## 5839 data_moderator_initials 1/0/T/F/TRUE/FALSE     SL 'raw-data/linelist.csv'
## .... ..................... .................. ...... .....................
## See problems(...) for more details.
```

Estimate fraction that are imported

- Based on linelist data alone. Only countries with at least 20 total cases present are shown.

```
## Based on linelist data
prop_cases_imported <- extracted_linelist %>%
  dplyr::count(country, import_status) %>%
  tidyr::spread(key = "import_status", value = "n") %>%
  dplyr::mutate_at(.vars = c("local", "imported"), ~ replace(., is.na(.), 0)) %>%
  dplyr::mutate(linelist_total = imported + local,
                frac_imported = round(imported / linelist_total, 2)) %>%
  dplyr::filter(linelist_total >= 15, !country %in% c("", "China")) %>%
  dplyr::arrange(desc(frac_imported))
```

- Based on linelist data and WH0 sit reps

```
countries <- prop_cases_imported$country
names(countries) <- prop_cases_imported$country

countries["South Korea"] <- "RepublicofKorea"
countries["United Arab Emirates"] <- "UnitedArabEmirates"
countries["United States"] <- "UnitedStatesofAmerica"
```

```
countries["Vietnam"] <- "VietNam"
countries["United Kingdom"] <- "UnitedKingdom"
countries <- countries[!is.na(countries)]

country_cases <- countries %>%
  purrr::map_dfr(~ get_who_cases(., daily = TRUE), .id = "country")

total_cases <- country_cases %>%
  dplyr::count(country, wt = cases) %>%
  dplyr::rename(who_total = n)

prop_cases_imported_who <- prop_cases_imported %>%
  dplyr::full_join(total_cases, by = "country") %>%
  dplyr::mutate(who_frac_imported = round(imported / who_total, 2)) %>%
  dplyr::arrange(desc(who_frac_imported)) %>%
  ## Drop USA and thailand
  dplyr::filter(!country %in% c("United States", "Thailand", "Iran"))
```

- Summarise and report

```
tab_cases_imported <- prop_cases_imported_who %>%
  dplyr::select(Country = country, Cases = who_total, `Fraction imported (linelist only)` = frac_importe
                `Fraction imported (WHO sit reps)` = who_frac_imported)

saveRDS(tab_cases_imported, "output-data/cases_imported.rds")

knitr::kable(tab_cases_imported)
```

Country	Cases	Fraction imported (linelist only)	Fraction imported (WHO sit reps)
Vietnam	17	0.69	0.65
Kuwait	58	1.00	0.64
Bahrain	49	1.00	0.41
Canada	51	0.75	0.29
Singapore	130	0.34	0.25
Australia	62	0.88	0.24
Iraq	44	0.44	0.18
United Arab Emirates	45	0.35	0.16
Malaysia	83	0.65	0.13
India	31	0.14	0.13
Japan	408	0.07	0.13
Netherlands	128	0.67	0.09
United Kingdom	167	0.59	0.06
Spain	374	0.44	0.06
Norway	113	0.25	0.04
Germany	639	0.32	0.03
France	613	0.20	0.01
Italy	4636	0.02	0.00
South Korea	6767	0.02	0.00
Austria	66	0.00	0.00
NA	NA	0.58	NA

Plot cases over time

- Wrangle for countries of interest (with at least 40 cases)

```
cum_cases_in_countries <- readr::read_csv("raw-data/countries_of_interest_counts.csv") %>%
    dplyr::filter(!country %in% c("United States", "Thailand", "Iran"))
```

```
## Parsed with column specification:
## cols(
##   date = col_date(format = ""),
##   country = col_character(),
##   cases = col_double()
## )
```

- Get date of first report

```
first_cases <- cum_cases_in_countries %>%
  dplyr::group_by(country) %>%
  dplyr::filter(cases > 0) %>%
  dplyr::filter(cases == min(cases), date == min(date)) %>%
  dplyr::ungroup() %>%
  dplyr::arrange(date) %>%
  dplyr::select(Country = country, `Date of first case report` = date)

first_cases %>%
  knitr::kable()
```

Country	Date of first case report
Wuhan	2020-01-15
Republic of Korea	2020-01-20
Japan	2020-01-20
Taiwan	2020-01-21
Hong Kong	2020-01-23
Singapore	2020-01-24
Italy	2020-01-31

- Get case counts

```
cases_in_countries <- cum_cases_in_countries %>%
  dplyr::group_by(country) %>%
  ## Cumulative?
  dplyr::mutate(cases = cases - dplyr::lag(cases)) %>%
  dplyr::ungroup()

cases_in_countries <- cases_in_countries %>%
  dplyr::filter(!country %in% "Taiwan") %>%
  dplyr::mutate(
    cases = ifelse(country %in% "Japan",
                   ifelse(date == "2020-02-05", 3,
                          ifelse(date == "2020-02-06", 2, cases)), cases)
  ) %>%
  dplyr::mutate(country = country %>%
                  factor(levels = first_cases$Country))
```

Get interventions

- Plot overall interventions

```
interventions <- readr::read_csv("raw-data/intervention_dates.csv") %>%
  dplyr::select(date = date_intervention, intervention, country, social_distancing) %>%
  dplyr::mutate(date = date %>%
                  stringr::str_replace_all("/", "-")) %>%
  dplyr::mutate(date = as.Date(date)) %>%
  dplyr::mutate(country = country %>%
                  stringr::str_replace_all("south korea", "Republic of Korea") %>%
                  stringr::str_replace_all("Usa", "United States") %>%
                  stringr::str_to_title() %>%
                  stringr::str_replace_all("Usa", "United States") %>%
                  stringr::str_replace_all("Republic Of Korea", "Republic of Korea")) %>%
  dplyr::mutate(intervention = intervention %>%
                  stringr::str_replace_all("_", " ") %>%
                  stringr::str_to_sentence() %>%
                  stringr::str_replace("School restictions", "School restrictions") %>%
                  stringr::str_replace("Communciation distancing", "Communication distancing")) %>%
      dplyr::filter(!country %in% c("United States", "Thailand", "Iran")) %>%
  tidyr::drop_na(intervention)
```

```
## Warning: Missing column names filled in: 'X8' [8]
```

```
## Parsed with column specification:
## cols(
##   date_intervention = col_date(format = ""),
##   intervention = col_character(),
##   social_distancing = col_character(),
##   country = col_character(),
##   notes = col_character(),
##   ref1 = col_character(),
##   ref2 = col_character(),
##   X8 = col_character()
## )
```

```
c_grepl <- purrr::partial(grepl, ignore.case = TRUE)

## Add detail to interventions
interventions <- interventions %>%
  dplyr::mutate(intervention_cat = case_when(
    c_grepl("School", intervention) | c_grepl("University", intervention) ~ "Education",
    c_grepl("Mass gathering", intervention) ~ "Mass gathering",
    c_grepl("Travel", intervention) | c_grepl("flights", intervention) |
      c_grepl("Border", intervention) ~ "Travel",
    c_grepl("Surveillance", intervention) | c_grepl("Contact tracing", interventions) |
      c_grepl("Government on alert", intervention) ~ "Surveillance",
    c_grepl("Quarantine", intervention) ~ "Quarantine",
    c_grepl("information", intervention) | c_grepl("awareness", intervention) |
      c_grepl("annoucement", intervention) | grepl("Communication", intervention) ~ "Information",
    c_grepl("health", intervention) | c_grepl("Enhanced care", intervention) ~ "Healthcare",
    c_grepl("work", intervention) ~ "Workplace",
    c_grepl("Lockdown", intervention) ~ "Lockdown",
    c_grepl("Isolation", intervention) ~ "Isolation",
    TRUE ~ "Other"
```

```
  ),
intervention_scale = case_when(
  c_grepl("awareness", intervention) | c_grepl("advisory", intervention) ~ "Advice",
  c_grepl("ban", intervention) ~ "Restriction",
  c_grepl("closure", intervention) ~ "Closure",
  c_grepl("surveillance", intervention) | c_grepl("isolation", intervention) |
    c_grepl("contact tracing", intervention) ~ "Public health",
  TRUE ~ "Other"
)) %>%
  dplyr::mutate(country = country %>%
                  factor(levels = first_cases$Country))
```

```
## Warning in c_grepl("Surveillance", intervention) | c_grepl("Contact tracing", :
## longer object length is not a multiple of shorter object length
```

```
readr::write_csv(interventions, "output-data/interventions.csv")

summarise_ints <- function(df) {
  df %>%
  dplyr::select(-date) %>%
  dplyr::group_by(country, intervention) %>%
  dplyr::slice(1) %>%
  dplyr::ungroup() %>%
  dplyr::count(intervention) %>%
  tidyr::drop_na(intervention) %>%
  dplyr::arrange(desc(n)) %>%
  dplyr::select(Intervention = intervention,
                `Countries that have implemented` = n)
}


summarise_interventions <- interventions %>%
  summarise_ints()



saveRDS(summarise_interventions, "output-data/intervention_freq.rds")
```

- Summarise interventions by category

```
sum_intervention_cats <- interventions %>%
  dplyr::group_by(intervention_cat, social_distancing) %>%
  dplyr::summarise(interventions = paste(unique(intervention), collapse = ", "))
```

- Social categories

```
sum_intervention_cats %>%
  dplyr::filter(social_distancing %in% "yes") %>%
  dplyr::select(-social_distancing) %>%
  knitr::kable()
```

intervention_cat	interventions
Education	School closure, University closure, School closure (not related to outbreak), Prevention measures school,
Healthcare	Healthcare restrictions
Information	Communication distancing

intervention_cat	interventions
Isolation	Isolation
Lockdown	Lockdown
Mass gathering	Mass gathering advisory, Mass gathering cancellation
Other	Social distancing misc, Reduced shop hours, Social event cancellation
Quarantine	Mandatory quarantine, Quarantine
Surveillance	Quarantine, Mandatory quarantine, Remote working, Contact tracing, Work closure (not related to outb
Travel	Travel advice, Travel restriction
Workplace	Remote working, Work closure (not related to outbreak)

- Non-social categories

```
sum_intervention_cats %>%
  dplyr::filter(social_distancing %in% "no") %>%
  dplyr::select(-social_distancing) %>%
  knitr::kable()
```

intervention_cat	interventions
Healthcare	Health screening, Enhanced care
Information	Public information, Communication general, Raise awareness healthcare staff, Raise awareness public
Other	Containment to mitigation, Supply, Decontamination, Government announcement
Surveillance	Government on alert, Surveillance, Raise awareness healthcare staff, Raise awareness public, Resumption
Travel	Raise awareness flights, Travel ban, Border control, Travel advice, Suspending flights, Travel advisory, T

- Social scales

```
sum_intervention_scales <- interventions %>%
  dplyr::group_by(intervention_scale, social_distancing) %>%
  dplyr::summarise(interventions = paste(unique(intervention), collapse = ", "))

sum_intervention_scales %>%
  dplyr::filter(social_distancing %in% "no") %>%
  dplyr::select(-social_distancing) %>%
  knitr::kable()
```

intervention_scale	interventions
Advice	Raise awareness flights, Raise awareness healthcare staff, Raise awareness public, Travel advisory
Other	Containment to mitigation, Government on alert, Public information, Communication general, Border
Public health	Surveillance, Medical surveillance
Restriction	Travel ban

- Non-social scales

```
sum_intervention_scales %>%
  dplyr::filter(social_distancing %in% "no") %>%
  dplyr::select(-social_distancing) %>%
  knitr::kable()
```

intervention_scale	interventions
Advice	Raise awareness flights, Raise awareness healthcare staff, Raise awareness public, Travel advisory
Other	Containment to mitigation, Government on alert, Public information, Communication general, Border
Public health	Surveillance, Medical surveillance

intervention_scale	interventions
Restriction	Travel ban
Social intervention	s only

```
social_interventions <- interventions %>%
  dplyr::filter(social_distancing %in% "yes") %>%
  summarise_ints() %>%
  dplyr::filter(`Countries that have implemented` > 1)

saveRDS(social_interventions, "output-data/social_interventions.rds")

knitr::kable(social_interventions)
```

Intervention	Countries that have implemented
Quarantine	3
Remote working	3
School closure	3
School closure (not related to outbreak)	3
Lockdown	2
Mandatory quarantine	2
Mass gathering cancellation	2
Social event cancellation	2
University closure	2
Work closure (not related to outbreak)	2

- Non-social interventions

```
non_social_interventions <- interventions %>%
  dplyr::filter(social_distancing %in% "no") %>%
  summarise_ints() %>%
  dplyr::filter(`Countries that have implemented` > 1)

saveRDS(non_social_interventions, "output-data/non_social_interventions.rds")

knitr::kable(non_social_interventions)
```

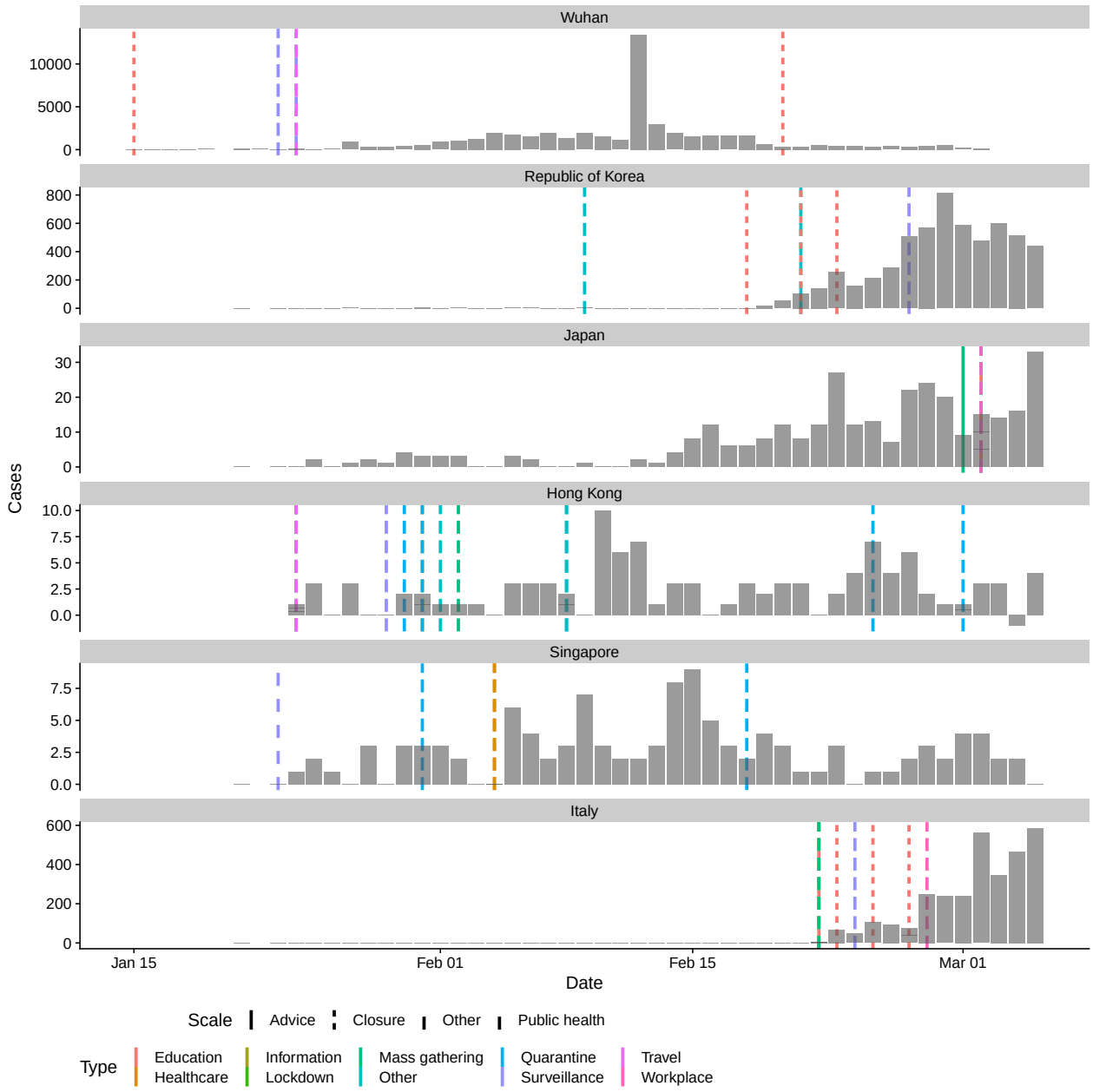
Intervention	Countries that have implemented
Health screening	4
Travel restriction	3

- Plot social interventions

```
plot_interventions <- function(intervention_type , scales = "free_y") {
  plot_df <- cases_in_countries %>%
  dplyr::left_join(interventions %>%
                     dplyr::filter(social_distancing %in% intervention_type),
                   by = c("date", "country")) %>%
  dplyr::group_by(country, date) %>%
  dplyr::mutate(cases = cases / dplyr::n())

  plot_df %>%
```

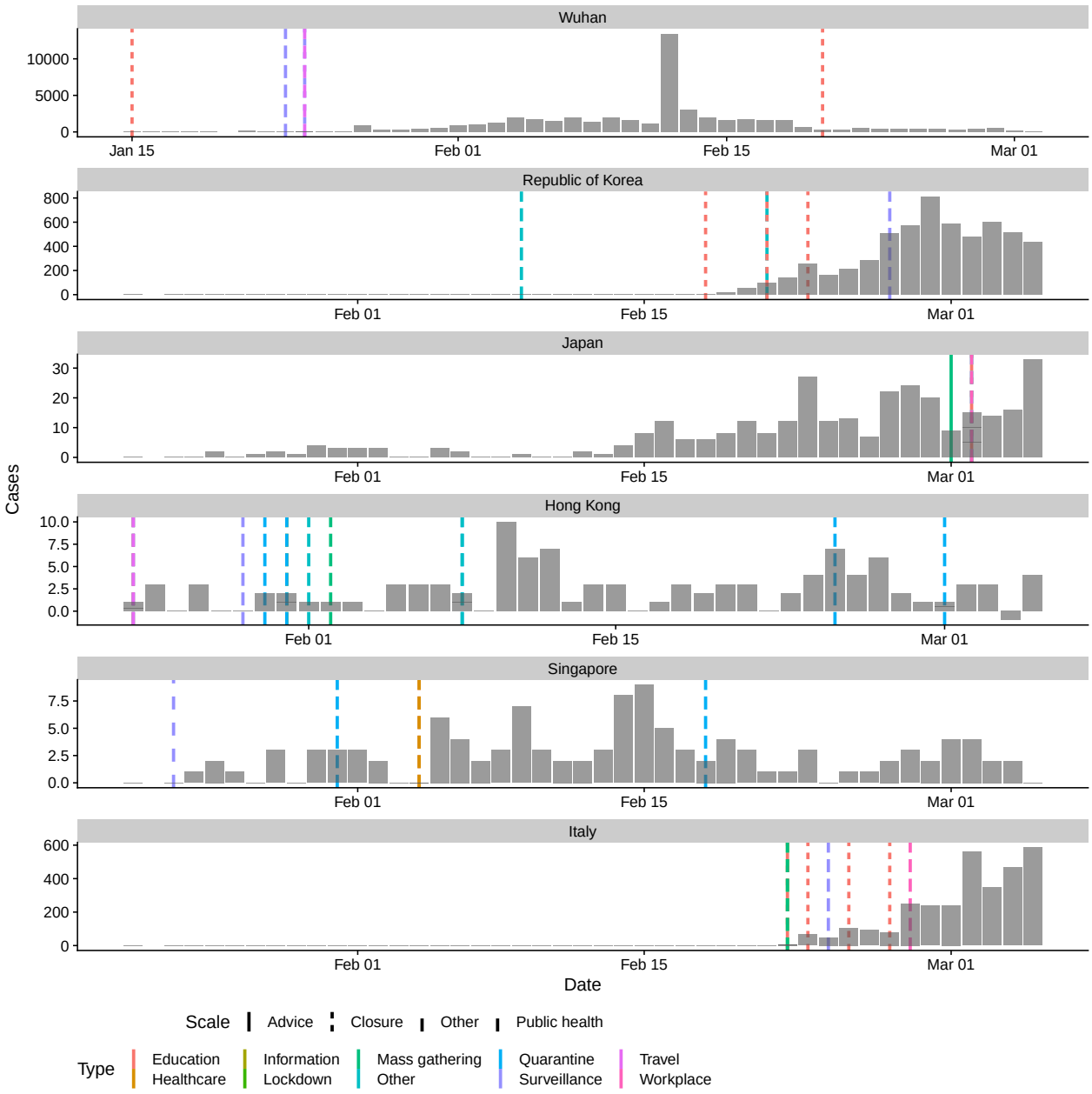
```
  ggplot2::ggplot(ggplot2::aes(x = date, y = cases, col= intervention_cat)) +
  ggplot2::geom_vline(data = tidyr::drop_na(plot_df, intervention_cat),
                      aes(xintercept = date, col = intervention_cat,
                          linetype = intervention_scale),
                      size = 1.2) +
  ggplot2::geom_col(col = NA, alpha = 0.6) +
  ggplot2::scale_fill_brewer(palette = "Dark2", na.value = "grey") +
  ggplot2::facet_wrap(~ country, scales = scales, ncol = 1) +
  cowplot::theme_cowplot() +
  labs(x = "Date", y = "Cases") +
  theme(legend.position = "bottom", legend.box="vertical") +
  labs(col = "Type", fill = NULL, linetype = "Scale")
}


plot_interventions("yes", scales = "free_y")
```

```
## Warning: Removed 8 rows containing missing values (position_stack).
```




```
plot_interventions("yes", scales = "free")
```

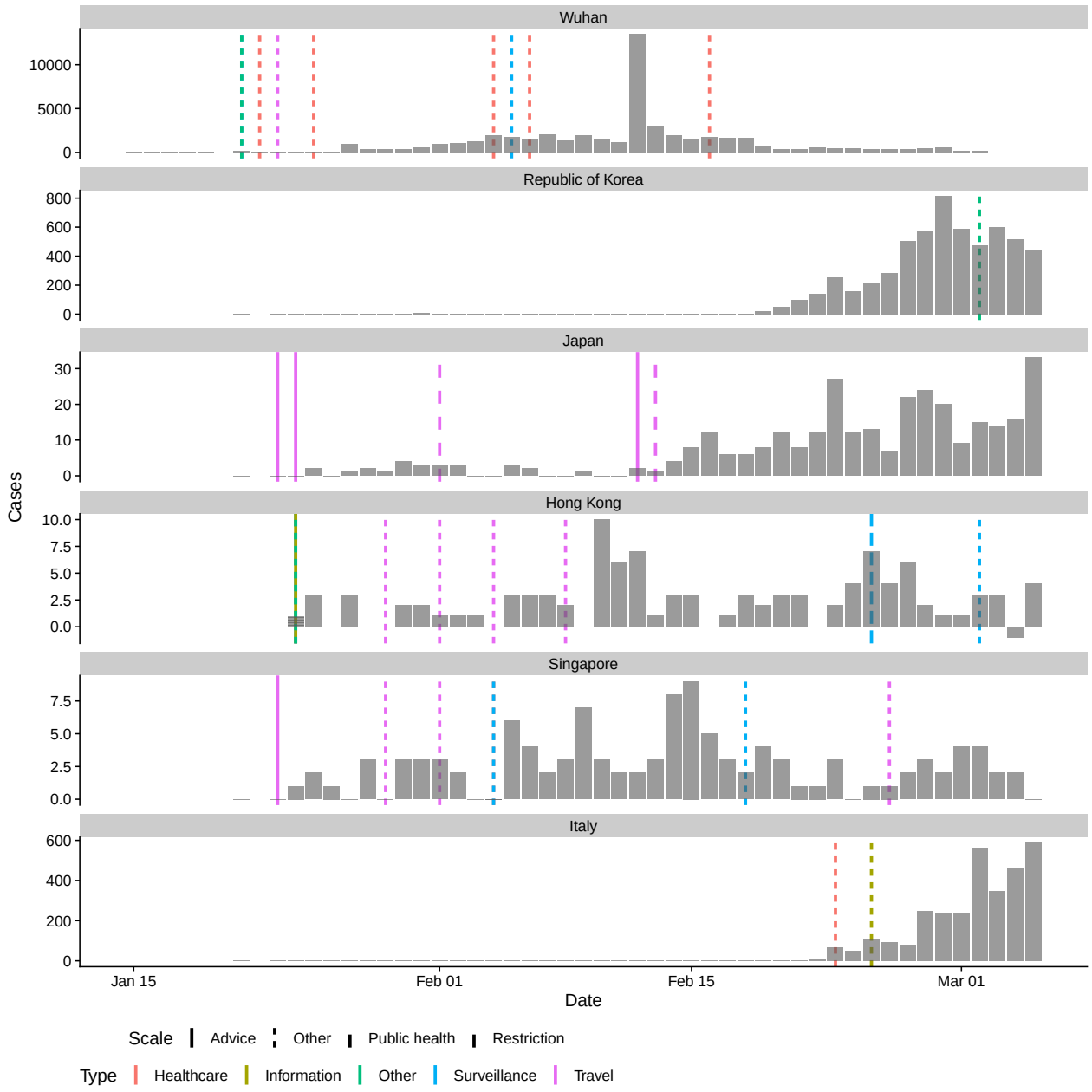
```
## Warning: Removed 8 rows containing missing values (position_stack).
```



- Plot non-social interventions

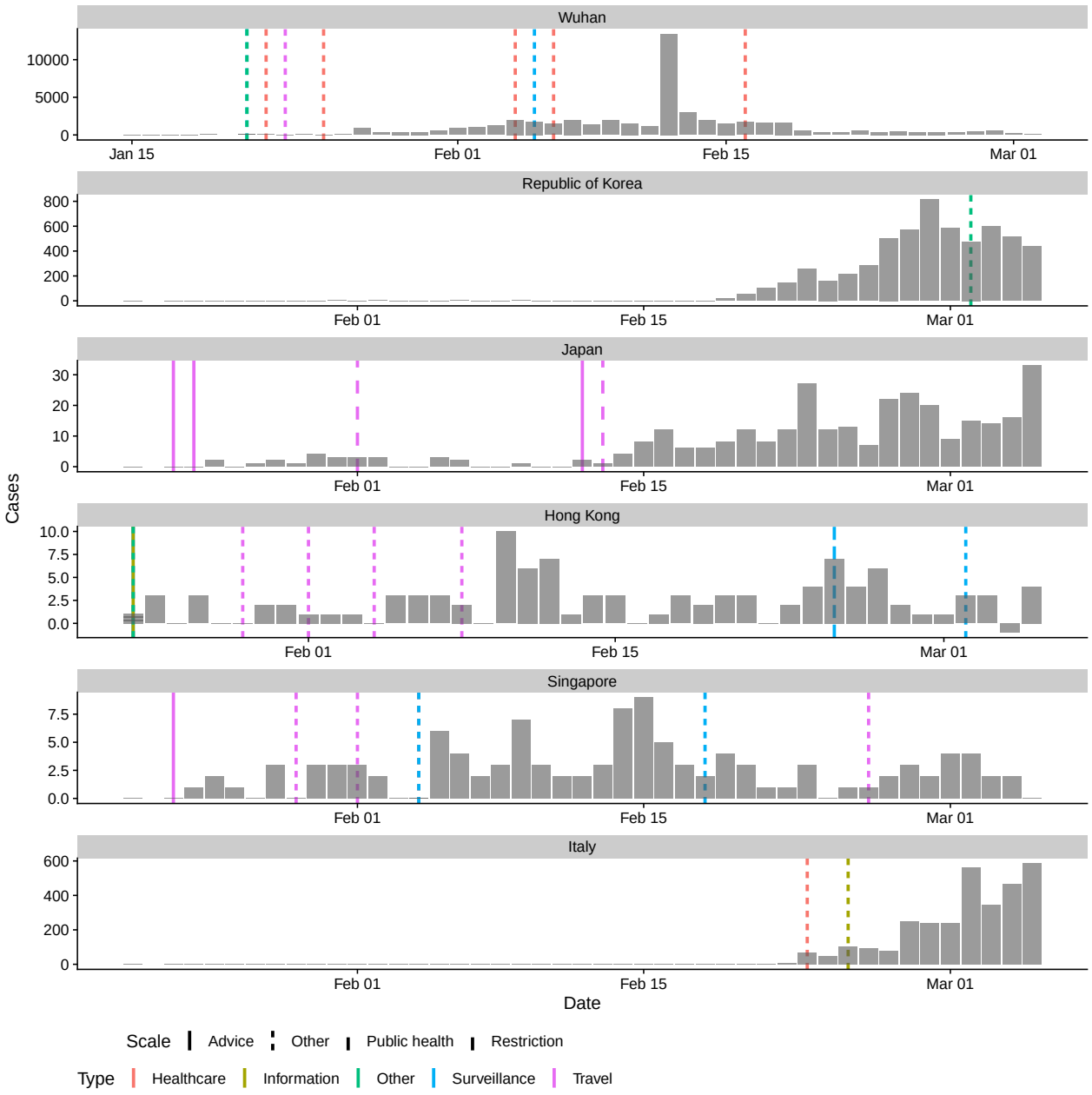
```
plot_interventions("no", scales = "free_y")
```

```
## Warning: Removed 8 rows containing missing values (position_stack).
```




```
plot_interventions("no", scales = "free")
```

```
## Warning: Removed 8 rows containing missing values (position_stack).
```


Wuhan
Republic of Korea
Japan
Hong Kong
Singapore
Italy
Cases
Date
Jan 15
Feb 01
Feb 15
Mar 01
Scale
Advice
Other
Public health
Restriction
Type
Healthcare
Information
Other
Surveillance
Travel