# STOR 664 — Part 1 Combined EDA (Pokémon)

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2025-11-15

```
# 1)  distribution statistics (with box plots)

#Missing values
core_wo_t2_gen <- select(pokemon, -type_2, -generation_id)
n_sparse <- sum(!complete.cases(core_wo_t2_gen))
cat("Number of rows with at least one N.A.(not counting type_2 or generation_id):", n_sparse, "\n")
```

```
## Number of rows with at least one N.A.(not counting type_2 or generation_id): 711
```

```
empty_type2         <- sum(is.na(pokemon$type_2))
empty_generation_id <- sum(is.na(pokemon$generation_id))
unique_generation_id <- sort(unique(pokemon$generation_id))
cat("Number of rows with missing type_2:", empty_type2, "\n")
```

```
## Number of rows with missing type_2: 439
```

```
cat("Number of rows with missing generation_id:", empty_generation_id, "\n")
```

```
## Number of rows with missing generation_id: 147
```

```
cat("Unique generation IDs:", paste(unique_generation_id, collapse = ", "), "\n")
```

```
## Unique generation IDs: 1, 2, 3, 4, 5, 6, 7
```

```
gen_tab  <- as.data.frame(table(pokemon$generation_id, useNA = "ifany"))
names(gen_tab) <- c("generation_id","count")
type_tab <- as.data.frame(table(pokemon$type_1,       useNA = "ifany"))
names(type_tab) <- c("type_1","count")
save_tbl(gen_tab,  "tables/count_by_generation.csv")
```

| generation_id | count |
|---|---|
| 1 | 151 |
| 2 | 100 |
| 3 | 135 |
| 4 | 107 |
| 5 | 156 |

| generation_id | count |
|---|---|
| 6 | 72 |
| 7 | 81 |
| NA | 147 |

```
save_tbl(type_tab, "tables/count_by_type1.csv")
```

| type_1 | count |
|---|---|
| bug | 79 |
| dark | 37 |
| dragon | 39 |
| electric | 61 |
| fairy | 19 |
| fighting | 31 |
| fire | 59 |
| flying | 4 |
| ghost | 40 |
| grass | 84 |
| ground | 36 |
| ice | 29 |
| normal | 111 |
| poison | 35 |
| psychic | 64 |
| rock | 65 |
| steel | 30 |
| water | 126 |

```
knitr::kable(gen_tab,  caption = "Counts of Pokémon by generation_id")
```

Table 3: Counts of Pokémon by generation_id

| generation_id | count |
|---|---|
| 1 | 151 |
| 2 | 100 |
| 3 | 135 |
| 4 | 107 |
| 5 | 156 |
| 6 | 72 |
| 7 | 81 |
| NA | 147 |

```
knitr::kable(type_tab, caption = "Counts of Pokémon by type_1")
```

Table 4: Counts of Pokémon by type_1

| type_1 | count |
|---|---|
| bug | 79 |
| dark | 37 |
| dragon | 39 |
| electric | 61 |
| fairy | 19 |
| fighting | 31 |
| fire | 59 |
| flying | 4 |
| ghost | 40 |
| grass | 84 |
| ground | 36 |
| ice | 29 |
| normal | 111 |
| poison | 35 |
| psychic | 64 |
| rock | 65 |
| steel | 30 |
| water | 126 |

```r
# Conditional distribution P(type_2 | type_1) + X² ----
pokemon_types <- pokemon |> filter(!is.na(type_2))

type_pair_counts <- pokemon_types |>
  count(type_1, type_2, name = "n") |>
  group_by(type_1) |>
  mutate(row_total = sum(n), prop = n / row_total) |>
  arrange(type_1, desc(prop)) |>
  ungroup()
save_tbl(type_pair_counts, "tables/type1_type2_joint_counts_proportions.csv")
```

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| bug | flying | 14 | 61 | 0.230 |
| bug | poison | 12 | 61 | 0.197 |
| bug | steel | 7 | 61 | 0.115 |
| bug | grass | 6 | 61 | 0.098 |
| bug | electric | 5 | 61 | 0.082 |
| bug | fighting | 4 | 61 | 0.066 |
| bug | rock | 3 | 61 | 0.049 |
| bug | water | 3 | 61 | 0.049 |
| bug | fairy | 2 | 61 | 0.033 |
| bug | fire | 2 | 61 | 0.033 |
| bug | ground | 2 | 61 | 0.033 |
| bug | ghost | 1 | 61 | 0.016 |
| dark | flying | 5 | 25 | 0.200 |
| dark | dragon | 4 | 25 | 0.160 |
| dark | fire | 3 | 25 | 0.120 |
| dark | normal | 3 | 25 | 0.120 |
| dark | fighting | 2 | 25 | 0.080 |

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| dark | ghost | 2 | 25 | 0.080 |
| dark | ice | 2 | 25 | 0.080 |
| dark | psychic | 2 | 25 | 0.080 |
| dark | steel | 2 | 25 | 0.080 |
| dragon | ground | 8 | 27 | 0.296 |
| dragon | flying | 6 | 27 | 0.222 |
| dragon | psychic | 4 | 27 | 0.148 |
| dragon | fighting | 3 | 27 | 0.111 |
| dragon | ice | 3 | 27 | 0.111 |
| dragon | electric | 1 | 27 | 0.037 |
| dragon | fairy | 1 | 27 | 0.037 |
| dragon | fire | 1 | 27 | 0.037 |
| electric | flying | 6 | 21 | 0.286 |
| electric | steel | 4 | 21 | 0.190 |
| electric | fairy | 2 | 21 | 0.095 |
| electric | normal | 2 | 21 | 0.095 |
| electric | dragon | 1 | 21 | 0.048 |
| electric | fire | 1 | 21 | 0.048 |
| electric | ghost | 1 | 21 | 0.048 |
| electric | grass | 1 | 21 | 0.048 |
| electric | ice | 1 | 21 | 0.048 |
| electric | psychic | 1 | 21 | 0.048 |
| electric | water | 1 | 21 | 0.048 |
| fairy | flying | 2 | 2 | 1.000 |
| fighting | psychic | 3 | 9 | 0.333 |
| fighting | steel | 2 | 9 | 0.222 |
| fighting | dark | 1 | 9 | 0.111 |
| fighting | flying | 1 | 9 | 0.111 |
| fighting | ghost | 1 | 9 | 0.111 |
| fighting | ice | 1 | 9 | 0.111 |
| fire | fighting | 7 | 28 | 0.250 |
| fire | flying | 7 | 28 | 0.250 |
| fire | ground | 3 | 28 | 0.107 |
| fire | dragon | 2 | 28 | 0.071 |
| fire | normal | 2 | 28 | 0.071 |
| fire | psychic | 2 | 28 | 0.071 |
| fire | dark | 1 | 28 | 0.036 |
| fire | ghost | 1 | 28 | 0.036 |
| fire | rock | 1 | 28 | 0.036 |
| fire | steel | 1 | 28 | 0.036 |
| fire | water | 1 | 28 | 0.036 |
| flying | dragon | 2 | 2 | 1.000 |
| ghost | grass | 11 | 30 | 0.367 |
| ghost | fairy | 4 | 30 | 0.133 |
| ghost | poison | 4 | 30 | 0.133 |
| ghost | fire | 3 | 30 | 0.100 |
| ghost | flying | 3 | 30 | 0.100 |
| ghost | dragon | 2 | 30 | 0.067 |
| ghost | ground | 2 | 30 | 0.067 |
| ghost | dark | 1 | 30 | 0.033 |
| grass | poison | 15 | 45 | 0.333 |
| grass | flying | 7 | 45 | 0.156 |

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| grass | fairy | 5 | 45 | 0.111 |
| grass | dark | 3 | 45 | 0.067 |
| grass | fighting | 3 | 45 | 0.067 |
| grass | ice | 3 | 45 | 0.067 |
| grass | steel | 3 | 45 | 0.067 |
| grass | dragon | 2 | 45 | 0.044 |
| grass | psychic | 2 | 45 | 0.044 |
| grass | ghost | 1 | 45 | 0.022 |
| grass | ground | 1 | 45 | 0.022 |
| ground | flying | 4 | 21 | 0.190 |
| ground | dark | 3 | 21 | 0.143 |
| ground | rock | 3 | 21 | 0.143 |
| ground | steel | 3 | 21 | 0.143 |
| ground | dragon | 2 | 21 | 0.095 |
| ground | ghost | 2 | 21 | 0.095 |
| ground | psychic | 2 | 21 | 0.095 |
| ground | electric | 1 | 21 | 0.048 |
| ground | fire | 1 | 21 | 0.048 |
| ice | ground | 3 | 14 | 0.214 |
| ice | water | 3 | 14 | 0.214 |
| ice | flying | 2 | 14 | 0.143 |
| ice | psychic | 2 | 14 | 0.143 |
| ice | steel | 2 | 14 | 0.143 |
| ice | fairy | 1 | 14 | 0.071 |
| ice | ghost | 1 | 14 | 0.071 |
| normal | flying | 27 | 44 | 0.614 |
| normal | fairy | 5 | 44 | 0.114 |
| normal | fighting | 4 | 44 | 0.091 |
| normal | psychic | 3 | 44 | 0.068 |
| normal | grass | 2 | 44 | 0.045 |
| normal | dragon | 1 | 44 | 0.023 |
| normal | ground | 1 | 44 | 0.023 |
| normal | water | 1 | 44 | 0.023 |
| poison | dark | 5 | 20 | 0.250 |
| poison | fire | 3 | 20 | 0.150 |
| poison | flying | 3 | 20 | 0.150 |
| poison | water | 3 | 20 | 0.150 |
| poison | fighting | 2 | 20 | 0.100 |
| poison | ground | 2 | 20 | 0.100 |
| poison | bug | 1 | 20 | 0.050 |
| poison | dragon | 1 | 20 | 0.050 |
| psychic | fairy | 7 | 23 | 0.304 |
| psychic | flying | 7 | 23 | 0.304 |
| psychic | fighting | 3 | 23 | 0.130 |
| psychic | ghost | 2 | 23 | 0.087 |
| psychic | dark | 1 | 23 | 0.043 |
| psychic | fire | 1 | 23 | 0.043 |
| psychic | grass | 1 | 23 | 0.043 |
| psychic | steel | 1 | 23 | 0.043 |
| rock | flying | 18 | 53 | 0.340 |
| rock | ground | 6 | 53 | 0.113 |
| rock | water | 6 | 53 | 0.113 |

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| rock | electric | 3 | 53 | 0.057 |
| rock | fairy | 3 | 53 | 0.057 |
| rock | steel | 3 | 53 | 0.057 |
| rock | bug | 2 | 53 | 0.038 |
| rock | dark | 2 | 53 | 0.038 |
| rock | dragon | 2 | 53 | 0.038 |
| rock | grass | 2 | 53 | 0.038 |
| rock | ice | 2 | 53 | 0.038 |
| rock | psychic | 2 | 53 | 0.038 |
| rock | fighting | 1 | 53 | 0.019 |
| rock | poison | 1 | 53 | 0.019 |
| steel | psychic | 7 | 25 | 0.280 |
| steel | fairy | 5 | 25 | 0.200 |
| steel | ghost | 4 | 25 | 0.160 |
| steel | rock | 3 | 25 | 0.120 |
| steel | flying | 2 | 25 | 0.080 |
| steel | ground | 2 | 25 | 0.080 |
| steel | dragon | 1 | 25 | 0.040 |
| steel | fighting | 1 | 25 | 0.040 |
| water | ground | 10 | 60 | 0.167 |
| water | dark | 8 | 60 | 0.133 |
| water | flying | 7 | 60 | 0.117 |
| water | psychic | 6 | 60 | 0.100 |
| water | fairy | 4 | 60 | 0.067 |
| water | rock | 4 | 60 | 0.067 |
| water | fighting | 3 | 60 | 0.050 |
| water | grass | 3 | 60 | 0.050 |
| water | ice | 3 | 60 | 0.050 |
| water | poison | 3 | 60 | 0.050 |
| water | bug | 2 | 60 | 0.033 |
| water | dragon | 2 | 60 | 0.033 |
| water | electric | 2 | 60 | 0.033 |
| water | ghost | 2 | 60 | 0.033 |
| water | steel | 1 | 60 | 0.017 |

```
knitr::kable(head(type_pair_counts, 30), digits = 3,
             caption = "P(type_2 | type_1): top 30 rows.")  # as in your Table 3
```

Table 6: P(type_2 | type_1): top 30 rows.

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| bug | flying | 14 | 61 | 0.230 |
| bug | poison | 12 | 61 | 0.197 |
| bug | steel | 7 | 61 | 0.115 |
| bug | grass | 6 | 61 | 0.098 |
| bug | electric | 5 | 61 | 0.082 |
| bug | fighting | 4 | 61 | 0.066 |
| bug | rock | 3 | 61 | 0.049 |
| bug | water | 3 | 61 | 0.049 |
| bug | fairy | 2 | 61 | 0.033 |

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| bug | fire | 2 | 61 | 0.033 |
| bug | ground | 2 | 61 | 0.033 |
| bug | ghost | 1 | 61 | 0.016 |
| dark | flying | 5 | 25 | 0.200 |
| dark | dragon | 4 | 25 | 0.160 |
| dark | fire | 3 | 25 | 0.120 |
| dark | normal | 3 | 25 | 0.120 |
| dark | fighting | 2 | 25 | 0.080 |
| dark | ghost | 2 | 25 | 0.080 |
| dark | ice | 2 | 25 | 0.080 |
| dark | psychic | 2 | 25 | 0.080 |
| dark | steel | 2 | 25 | 0.080 |
| dragon | ground | 8 | 27 | 0.296 |
| dragon | flying | 6 | 27 | 0.222 |
| dragon | psychic | 4 | 27 | 0.148 |
| dragon | fighting | 3 | 27 | 0.111 |
| dragon | ice | 3 | 27 | 0.111 |
| dragon | electric | 1 | 27 | 0.037 |
| dragon | fairy | 1 | 27 | 0.037 |
| dragon | fire | 1 | 27 | 0.037 |
| electric | flying | 6 | 21 | 0.286 |

```
type2_pref <- type_pair_counts |>
  group_by(type_1) |>
  slice_max(prop, n = 1, with_ties = TRUE) |>
  arrange(type_1, desc(prop)) |>
  ungroup()
save_tbl(type2_pref, "tables/type2_preference_by_type1.csv")
```

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| bug | flying | 14 | 61 | 0.230 |
| dark | flying | 5 | 25 | 0.200 |
| dragon | ground | 8 | 27 | 0.296 |
| electric | flying | 6 | 21 | 0.286 |
| fairy | flying | 2 | 2 | 1.000 |
| fighting | psychic | 3 | 9 | 0.333 |
| fire | fighting | 7 | 28 | 0.250 |
| fire | flying | 7 | 28 | 0.250 |
| flying | dragon | 2 | 2 | 1.000 |
| ghost | grass | 11 | 30 | 0.367 |
| grass | poison | 15 | 45 | 0.333 |
| ground | flying | 4 | 21 | 0.190 |
| ice | ground | 3 | 14 | 0.214 |
| ice | water | 3 | 14 | 0.214 |
| normal | flying | 27 | 44 | 0.614 |
| poison | dark | 5 | 20 | 0.250 |
| psychic | fairy | 7 | 23 | 0.304 |
| psychic | flying | 7 | 23 | 0.304 |
| rock | flying | 18 | 53 | 0.340 |
| steel | psychic | 7 | 25 | 0.280 |

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| water | ground | 10 | 60 | 0.167 |

```
knitr::kable(type2_pref, digits = 3,
             caption = "Most frequent secondary type(s) for each primary type.")
```

Table 8: Most frequent secondary type(s) for each primary type.

| type_1 | type_2 | n | row_total | prop |
|---|---|---|---|---|
| bug | flying | 14 | 61 | 0.230 |
| dark | flying | 5 | 25 | 0.200 |
| dragon | ground | 8 | 27 | 0.296 |
| electric | flying | 6 | 21 | 0.286 |
| fairy | flying | 2 | 2 | 1.000 |
| fighting | psychic | 3 | 9 | 0.333 |
| fire | fighting | 7 | 28 | 0.250 |
| fire | flying | 7 | 28 | 0.250 |
| flying | dragon | 2 | 2 | 1.000 |
| ghost | grass | 11 | 30 | 0.367 |
| grass | poison | 15 | 45 | 0.333 |
| ground | flying | 4 | 21 | 0.190 |
| ice | ground | 3 | 14 | 0.214 |
| ice | water | 3 | 14 | 0.214 |
| normal | flying | 27 | 44 | 0.614 |
| poison | dark | 5 | 20 | 0.250 |
| psychic | fairy | 7 | 23 | 0.304 |
| psychic | flying | 7 | 23 | 0.304 |
| rock | flying | 18 | 53 | 0.340 |
| steel | psychic | 7 | 25 | 0.280 |
| water | ground | 10 | 60 | 0.167 |

```
tab_t1_t2 <- table(type_1 = pokemon_types$type_1, type_2 = pokemon_types$type_2)
chi_res <- chisq.test(tab_t1_t2)                    # you printed the warning; keep behavior
```

```
## Warning in stats::chisq.test(x, y, ...): Chi-squared approximation may be
## incorrect
```

```
chi_tbl <- tibble(statistic = as.numeric(chi_res$statistic),
                  df        = as.integer(chi_res$parameter),
                  p_value   = as.numeric(chi_res$p.value))
save_tbl(chi_tbl, "tables/chisq_type1_type2_independence.csv")
```

| statistic | df | p_value |
|---|---|---|
| 698.644 | 289 | 0 |

```
chi_res                                    # prints Pearson X² (X²=698.64, df=289, p<2.2e-16). :
```

```
##
##  Pearson's Chi-squared test
##
## data:  tab_t1_t2
## X-squared = 698.64, df = 289, p-value < 2.2e-16
```

```
# By generation_id: distribution tables with boxplots
pokemon <- pokemon |>
  mutate(generation_id_f = forcats::fct_na_value_to_level(as.factor(generation_id), level = "Unknown"))
stat_vars <- c("hp","attack","defense","special_attack","special_defense","speed")

gen_stats_all <- pokemon |>
  group_by(generation_id_f) |>
  summarise(
    n = n(),
    across(all_of(stat_vars),
           list(mean = ~mean(.x, na.rm = TRUE),
                sd   = ~sd(.x,   na.rm = TRUE)), .names = "{.col}_{.fn}")
  ) |>
  arrange(generation_id_f)
save_tbl(gen_stats_all, "tables/gen_stats_by_generation_all_stats.csv", digits = 1)
```

| generation | n | hp_mean | hp_sd | attack_mean | attack_sd | defense_mean | defense_sd | special_attack_mean | special_attack_sd | special_defense_mean | special_defense_sd | speed_mean | speed_sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 151 | 64.2 | 28.6 | 72.9 | 26.8 | 68.2 | 26.9 | 67.1 | 28.5 | 66.1 | 24.2 | 69.1 | 27.0 |
| 2 | 100 | 71.0 | 31.2 | 68.3 | 28.4 | 69.7 | 35.2 | 64.5 | 25.6 | 72.3 | 31.5 | 61.4 | 27.2 |
| 3 | 135 | 65.7 | 25.2 | 73.1 | 30.4 | 69.0 | 31.1 | 67.9 | 28.3 | 66.5 | 28.5 | 61.6 | 26.9 |
| 4 | 107 | 73.1 | 24.7 | 80.2 | 30.9 | 75.2 | 30.7 | 73.3 | 31.2 | 74.5 | 27.8 | 69.5 | 27.6 |
| 5 | 156 | 70.3 | 21.6 | 81.0 | 29.4 | 71.2 | 23.0 | 69.2 | 29.8 | 67.3 | 21.9 | 66.6 | 28.2 |
| 6 | 72 | 68.9 | 21.7 | 72.5 | 25.6 | 75.2 | 31.7 | 72.5 | 28.0 | 74.7 | 30.8 | 65.7 | 25.9 |
| 7 | 81 | 70.7 | 28.2 | 83.2 | 32.6 | 77.0 | 29.9 | 73.5 | 33.4 | 74.8 | 29.3 | 64.5 | 29.1 |
| Unknown | 147 | 70.1 | 25.1 | 98.9 | 37.5 | 87.7 | 34.4 | 92.0 | 42.0 | 84.6 | 26.2 | 87.3 | 31.4 |

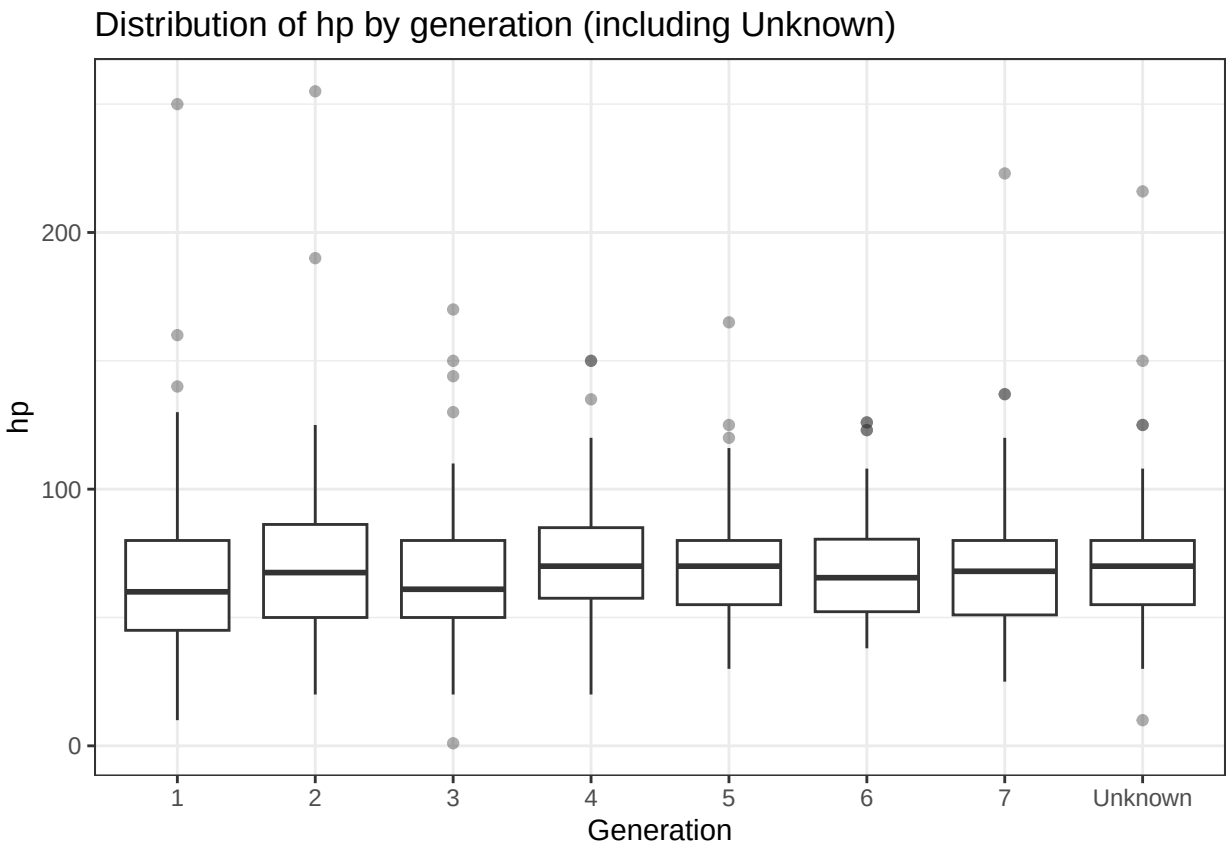
```
knitr::kable(gen_stats_all, digits = 1,
             caption = "Means and SDs of stats by generation (including Unknown).")  # your Table 6
```

Table 11: Means and SDs of stats by generation (including Unknown).

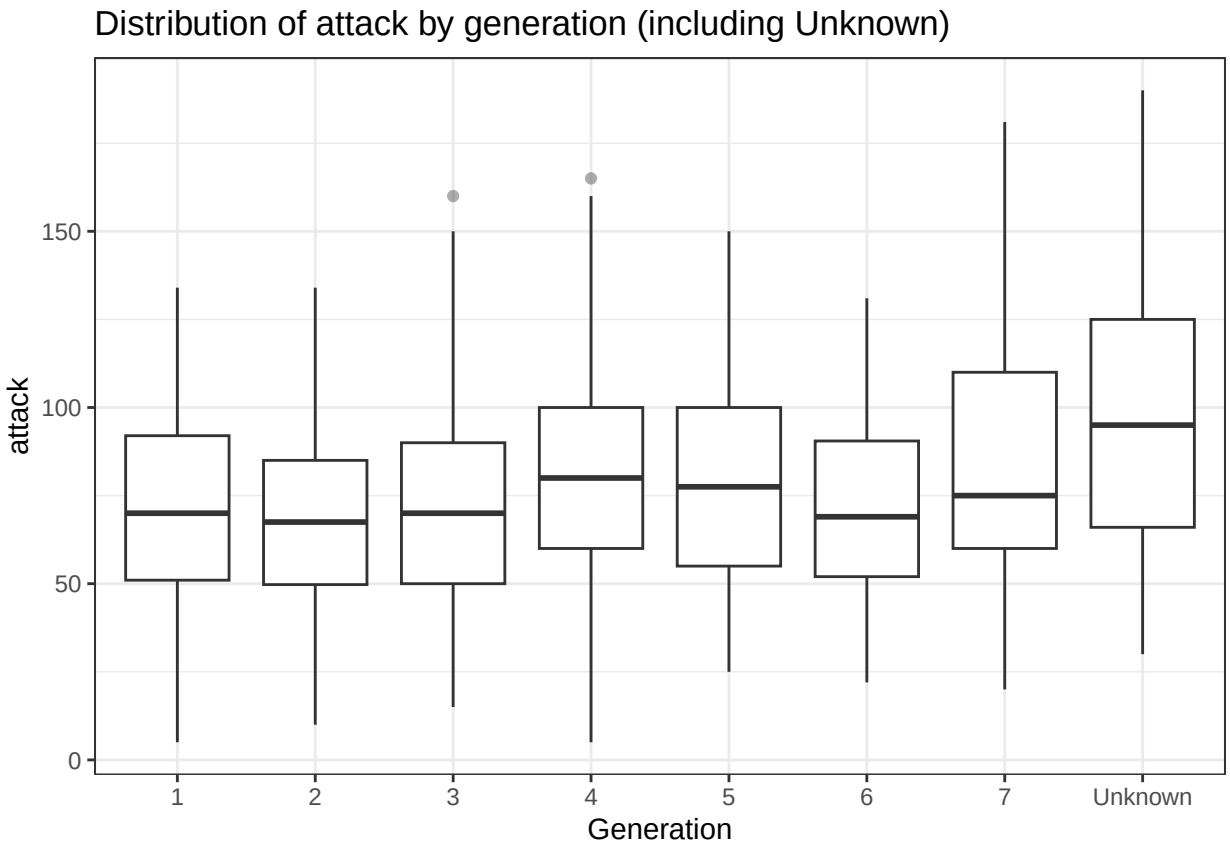
| generation | n | hp_mean | hp_sd | attack_mean | attack_sd | defense_mean | defense_sd | special_attack_mean | special_attack_sd | special_defense_mean | special_defense_sd | speed_mean | speed_sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 151 | 64.2 | 28.6 | 72.9 | 26.8 | 68.2 | 26.9 | 67.1 | 28.5 | 66.1 | 24.2 | 69.1 | 27.0 |
| 2 | 100 | 71.0 | 31.2 | 68.3 | 28.4 | 69.7 | 35.2 | 64.5 | 25.6 | 72.3 | 31.5 | 61.4 | 27.2 |
| 3 | 135 | 65.7 | 25.2 | 73.1 | 30.4 | 69.0 | 31.1 | 67.9 | 28.3 | 66.5 | 28.5 | 61.6 | 26.9 |
| 4 | 107 | 73.1 | 24.7 | 80.2 | 30.9 | 75.2 | 30.7 | 73.3 | 31.2 | 74.5 | 27.8 | 69.5 | 27.6 |
| 5 | 156 | 70.3 | 21.6 | 81.0 | 29.4 | 71.2 | 23.0 | 69.2 | 29.8 | 67.3 | 21.9 | 66.6 | 28.2 |
| 6 | 72 | 68.9 | 21.7 | 72.5 | 25.6 | 75.2 | 31.7 | 72.5 | 28.0 | 74.7 | 30.8 | 65.7 | 25.9 |
| 7 | 81 | 70.7 | 28.2 | 83.2 | 32.6 | 77.0 | 29.9 | 73.5 | 33.4 | 74.8 | 29.3 | 64.5 | 29.1 |
| Unknown | 147 | 70.1 | 25.1 | 98.9 | 37.5 | 87.7 | 34.4 | 92.0 | 42.0 | 84.6 | 26.2 | 87.3 | 31.4 |

```
for (s in stat_vars) {
  p <- ggplot(pokemon, aes(x = generation_id_f, y = .data[[s]])) +
    geom_boxplot(outlier.alpha = 0.4) +
    labs(title = paste("Distribution of", s, "by generation (including Unknown)"),
         x = "Generation", y = s) + theme_bw()
  save_plot(p, paste0("figures/box_", s, "_by_generation.png")) ; print(p)
}
```

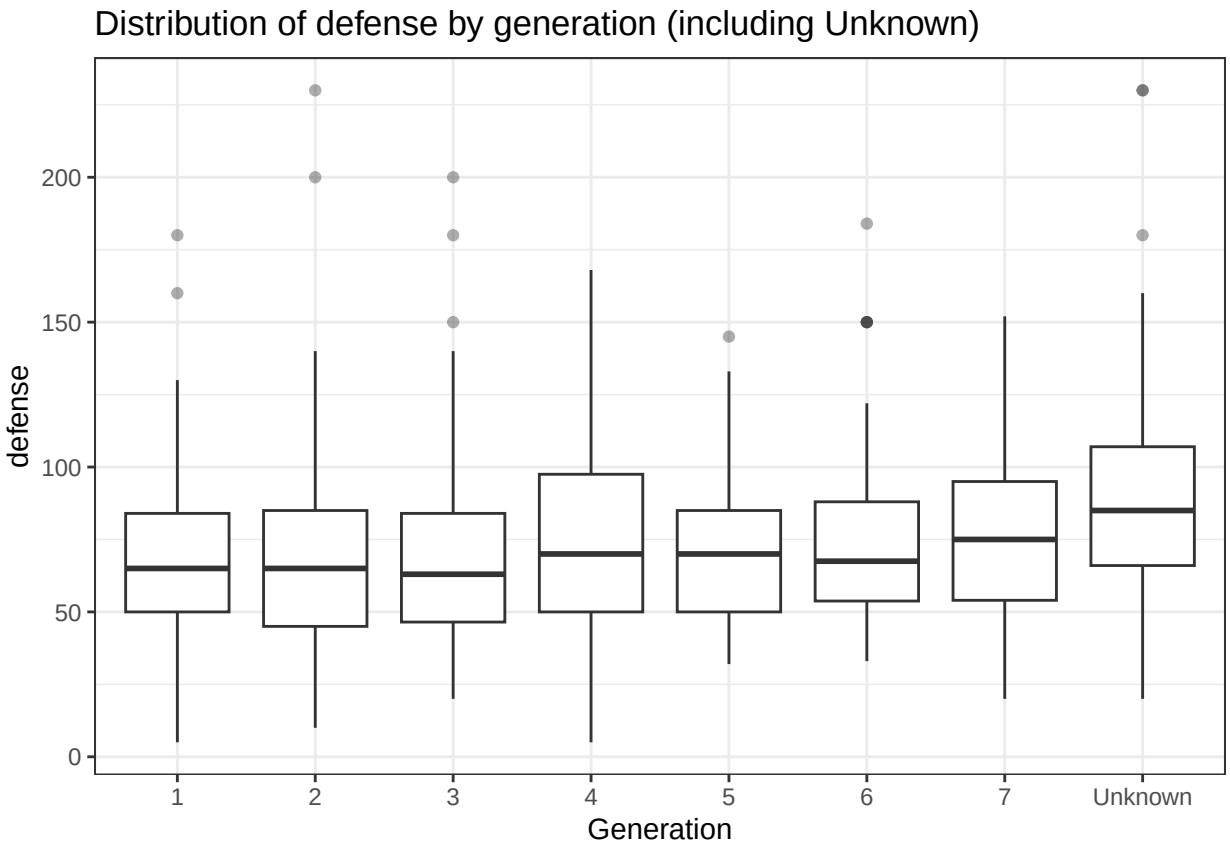
```
## Saved: figures/box_hp_by_generation.png
```



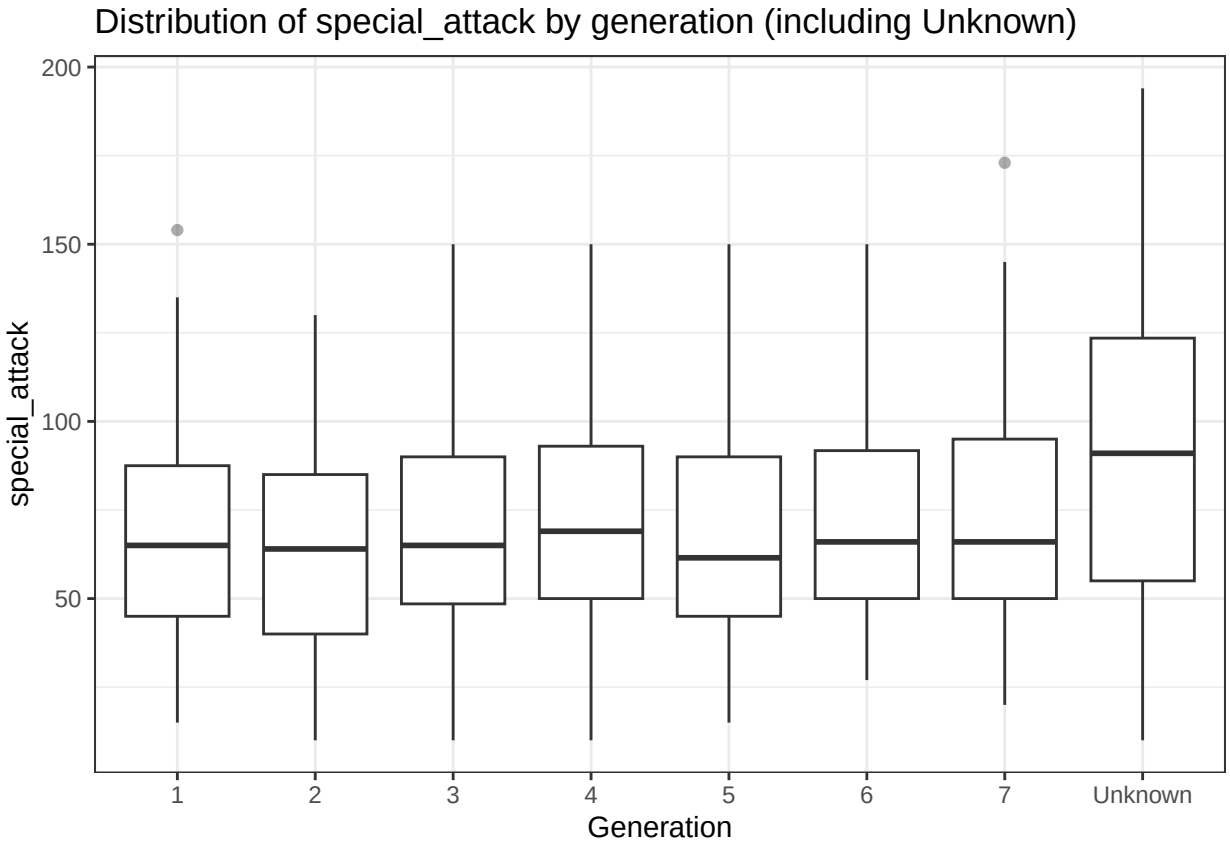

```
## Saved: figures/box_attack_by_generation.png
```



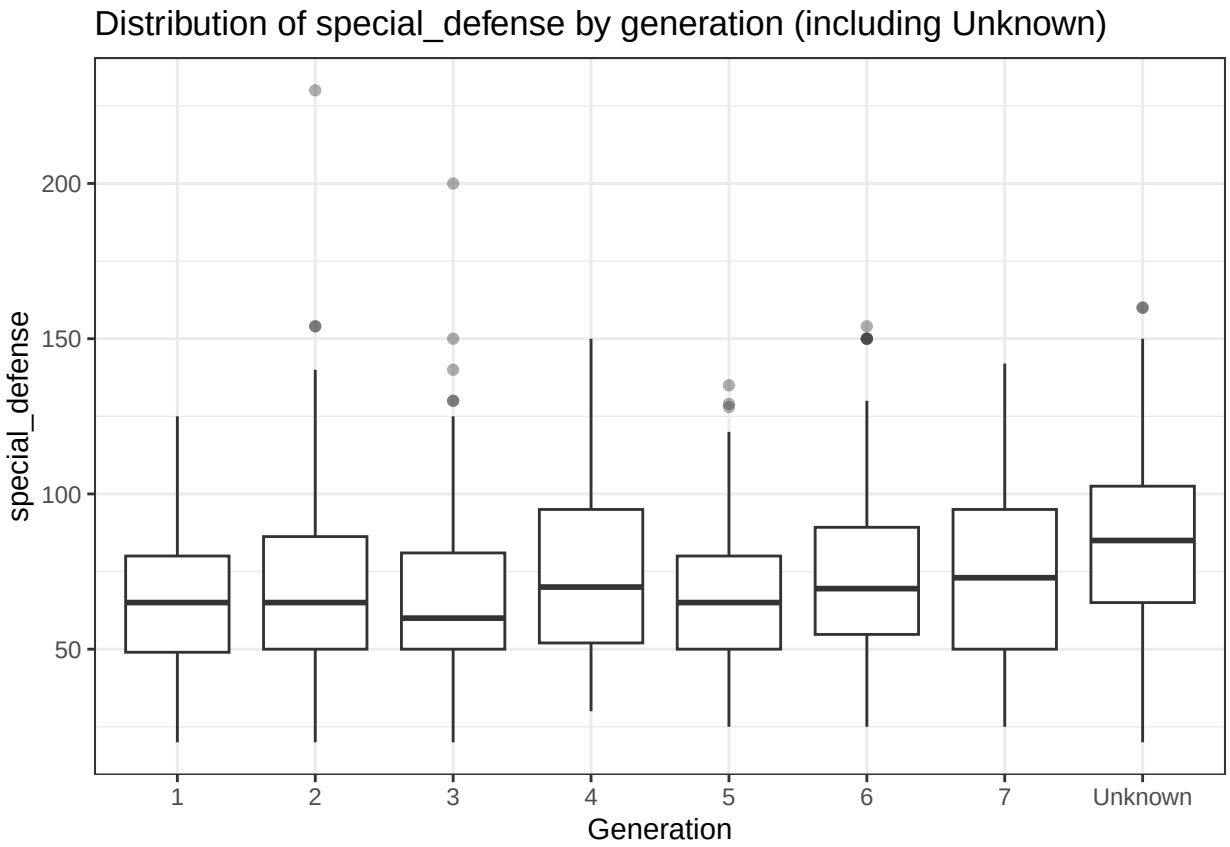

```
## Saved: figures/box_defense_by_generation.png
```



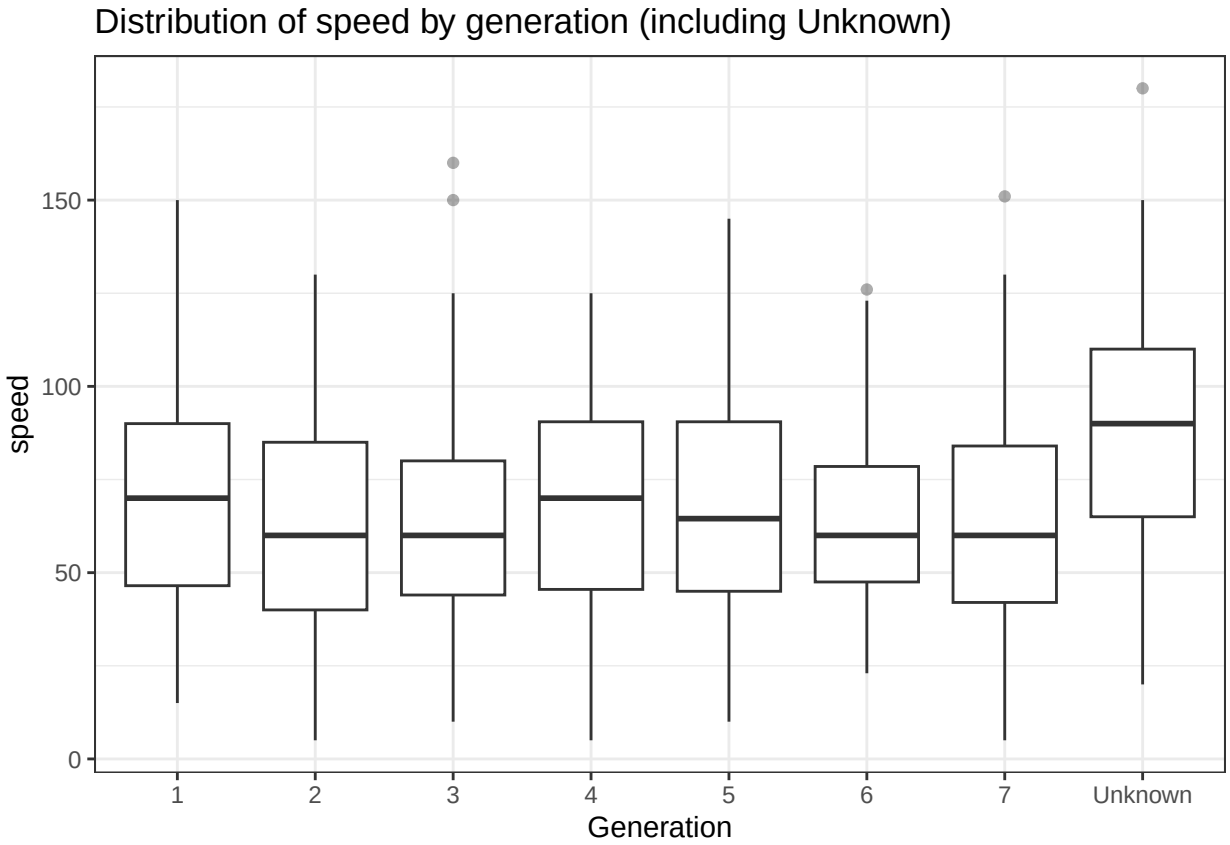

```
## Saved: figures/box_special_attack_by_generation.png
```




```
## Saved: figures/box_special_defense_by_generation.png
```




```
## Saved: figures/box_speed_by_generation.png
```




```
# By type1: distribution tables with boxplots
pokemon <- pokemon |>
  mutate(type_1_f = forcats::fct_infreq(as.factor(type_1)))

type1_stats <- pokemon |>
  group_by(type_1_f) |>
  summarise(
    n = n(),
    across(all_of(stat_vars),
           list(mean = ~mean(.x, na.rm = TRUE),
                sd   = ~sd(.x,   na.rm = TRUE)), .names = "{.col}_{.fn}")
  ) |>
  arrange(desc(n))
save_tbl(type1_stats, "tables/type1_stats_all_stats.csv", digits = 1)
```

| type_1_f | n | hp_mean | hp_sd | attack_mean | attack_sd | defense_mean | defense_sd | special_attack_mean | special_attack_sd | special_defense_mean | special_defense_sd | speed_mean | speed_sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| water | 126 | 71.1 | 26.4 | 74.7 | 29.0 | 73.5 | 28.1 | 75.6 | 30.3 | 72.4 | 29.6 | 65.7 | 24.8 |
| normal | 111 | 77.3 | 34.8 | 75.9 | 30.0 | 60.5 | 23.5 | 57.5 | 25.1 | 64.4 | 25.2 | 70.3 | 27.7 |
| grass | 84 | 66.7 | 18.9 | 75.2 | 29.3 | 71.7 | 25.0 | 76.2 | 27.0 | 70.7 | 22.1 | 60.3 | 27.9 |
| bug | 79 | 57.7 | 17.3 | 72.5 | 37.2 | 72.1 | 34.1 | 57.7 | 31.0 | 64.4 | 31.0 | 63.3 | 34.0 |
| rock | 65 | 65.3 | 19.4 | 90.0 | 31.9 | 94.3 | 34.4 | 66.2 | 28.0 | 75.3 | 30.2 | 64.3 | 33.2 |
| psychic | 64 | 72.6 | 29.8 | 72.5 | 42.0 | 69.9 | 29.1 | 98.0 | 39.1 | 87.0 | 31.1 | 80.9 | 36.3 |
| electric | 61 | 55.8 | 18.3 | 68.1 | 22.4 | 61.2 | 23.7 | 83.0 | 32.6 | 69.1 | 21.4 | 87.2 | 24.0 |
| fire | 59 | 69.7 | 18.8 | 84.3 | 27.5 | 69.3 | 25.0 | 87.6 | 29.0 | 71.9 | 22.0 | 73.5 | 24.8 |

| type_1 | n | hp_mean | hp_sd | attack_mean | attack_sd | defense_mean | defense_sd | special_attack_mean | special_attack_sd | special_defense_mean | special_defense_sd | speed_mean | speed_sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ghost | 40 | 64.2 | 28.7 | 76.3 | 28.5 | 82.0 | 29.6 | 77.3 | 30.8 | 78.7 | 25.5 | 65.7 | 29.1 |
| dragon | 39 | 84.5 | 32.0 | 108.7 | 32.4 | 89.3 | 25.0 | 93.4 | 39.8 | 88.3 | 28.4 | 82.9 | 22.8 |
| dark | 37 | 69.7 | 33.2 | 84.7 | 26.3 | 67.6 | 24.5 | 71.4 | 32.8 | 67.8 | 24.1 | 76.6 | 26.8 |
| ground | 36 | 71.6 | 27.5 | 96.2 | 32.2 | 82.6 | 33.5 | 55.3 | 26.8 | 62.9 | 20.7 | 64.6 | 27.9 |
| poison | 35 | 67.2 | 19.6 | 73.5 | 19.8 | 69.3 | 24.4 | 62.5 | 21.7 | 65.9 | 23.6 | 64.2 | 25.7 |
| fighting | 31 | 71.6 | 25.7 | 99.1 | 28.0 | 67.2 | 18.2 | 53.8 | 27.3 | 64.9 | 21.9 | 67.6 | 26.9 |
| steel | 30 | 67.3 | 16.6 | 93.1 | 28.8 | 124.8 | 42.7 | 73.0 | 34.3 | 83.6 | 29.0 | 56.1 | 24.6 |
| ice | 29 | 70.5 | 20.8 | 73.1 | 27.3 | 73.4 | 32.5 | 72.3 | 29.1 | 74.7 | 35.0 | 64.6 | 24.2 |
| fairy | 19 | 72.9 | 22.9 | 61.2 | 28.1 | 67.1 | 18.7 | 81.2 | 28.9 | 88.3 | 30.2 | 53.6 | 26.6 |
| flying | 4 | 70.8 | 20.7 | 78.8 | 37.5 | 66.2 | 21.4 | 94.2 | 34.8 | 72.5 | 22.2 | 102.5 | 32.1 |

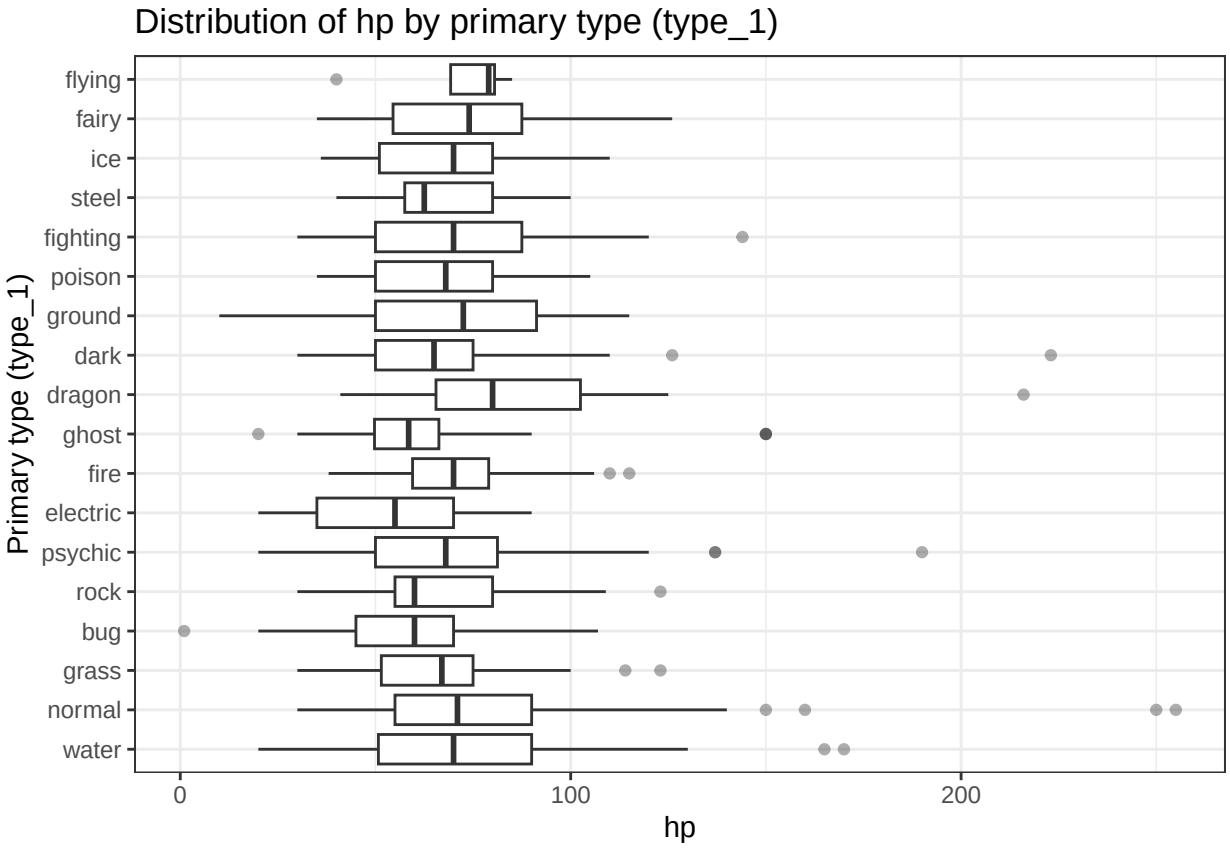
```
knitr::kable(type1_stats, digits = 1,
             caption = "Means and SDs of stats by primary type (type_1).")  # your Table 7
```

Table 13: Means and SDs of stats by primary type (type_1).

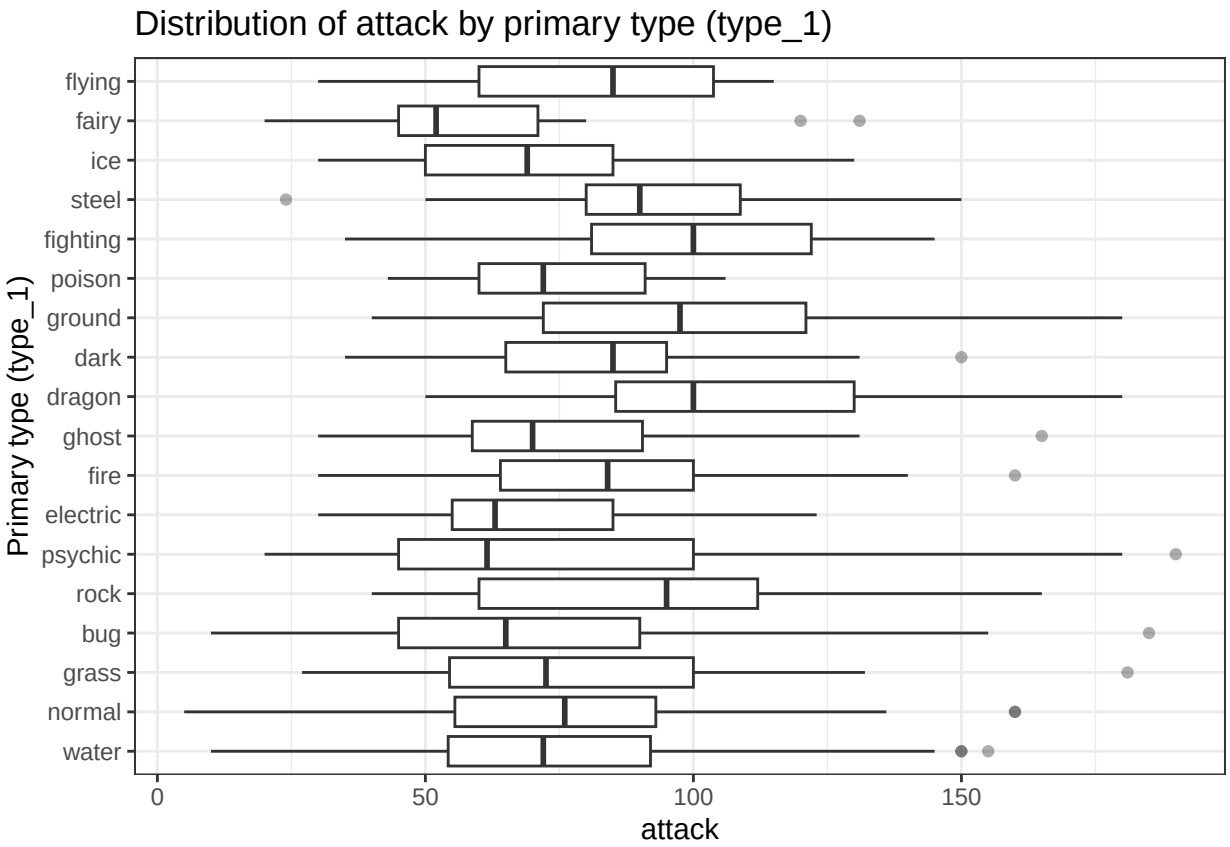
| type_1 | n | hp_mean | hp_sd | attack_mean | attack_sd | defense_mean | defense_sd | special_attack_mean | special_attack_sd | special_defense_mean | special_defense_sd | speed_mean | speed_sd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| water | 126 | 71.1 | 26.4 | 74.7 | 29.0 | 73.5 | 28.1 | 75.6 | 30.3 | 72.4 | 29.6 | 65.7 | 24.8 |
| normal | 111 | 77.3 | 34.8 | 75.9 | 30.0 | 60.5 | 23.5 | 57.5 | 25.1 | 64.4 | 25.2 | 70.3 | 27.7 |
| grass | 84 | 66.7 | 18.9 | 75.2 | 29.3 | 71.7 | 25.0 | 76.2 | 27.0 | 70.7 | 22.1 | 60.3 | 27.9 |
| bug | 79 | 57.7 | 17.3 | 72.5 | 37.2 | 72.1 | 34.1 | 57.7 | 31.0 | 64.4 | 31.0 | 63.3 | 34.0 |
| rock | 65 | 65.3 | 19.4 | 90.0 | 31.9 | 94.3 | 34.4 | 66.2 | 28.0 | 75.3 | 30.2 | 64.3 | 33.2 |
| psychic | 64 | 72.6 | 29.8 | 72.5 | 42.0 | 69.9 | 29.1 | 98.0 | 39.1 | 87.0 | 31.1 | 80.9 | 36.3 |
| electric | 61 | 55.8 | 18.3 | 68.1 | 22.4 | 61.2 | 23.7 | 83.0 | 32.6 | 69.1 | 21.4 | 87.2 | 24.0 |
| fire | 59 | 69.7 | 18.8 | 84.3 | 27.5 | 69.3 | 25.0 | 87.6 | 29.0 | 71.9 | 22.0 | 73.5 | 24.8 |
| ghost | 40 | 64.2 | 28.7 | 76.3 | 28.5 | 82.0 | 29.6 | 77.3 | 30.8 | 78.7 | 25.5 | 65.7 | 29.1 |
| dragon | 39 | 84.5 | 32.0 | 108.7 | 32.4 | 89.3 | 25.0 | 93.4 | 39.8 | 88.3 | 28.4 | 82.9 | 22.8 |
| dark | 37 | 69.7 | 33.2 | 84.7 | 26.3 | 67.6 | 24.5 | 71.4 | 32.8 | 67.8 | 24.1 | 76.6 | 26.8 |
| ground | 36 | 71.6 | 27.5 | 96.2 | 32.2 | 82.6 | 33.5 | 55.3 | 26.8 | 62.9 | 20.7 | 64.6 | 27.9 |
| poison | 35 | 67.2 | 19.6 | 73.5 | 19.8 | 69.3 | 24.4 | 62.5 | 21.7 | 65.9 | 23.6 | 64.2 | 25.7 |
| fighting | 31 | 71.6 | 25.7 | 99.1 | 28.0 | 67.2 | 18.2 | 53.8 | 27.3 | 64.9 | 21.9 | 67.6 | 26.9 |
| steel | 30 | 67.3 | 16.6 | 93.1 | 28.8 | 124.8 | 42.7 | 73.0 | 34.3 | 83.6 | 29.0 | 56.1 | 24.6 |
| ice | 29 | 70.5 | 20.8 | 73.1 | 27.3 | 73.4 | 32.5 | 72.3 | 29.1 | 74.7 | 35.0 | 64.6 | 24.2 |
| fairy | 19 | 72.9 | 22.9 | 61.2 | 28.1 | 67.1 | 18.7 | 81.2 | 28.9 | 88.3 | 30.2 | 53.6 | 26.6 |
| flying | 4 | 70.8 | 20.7 | 78.8 | 37.5 | 66.2 | 21.4 | 94.2 | 34.8 | 72.5 | 22.2 | 102.5 | 32.1 |

```
for (s in stat_vars) {
  p <- ggplot(pokemon, aes(x = type_1_f, y = .data[[s]])) +
    geom_boxplot(outlier.alpha = 0.4) +
    coord_flip() +
    labs(title = paste("Distribution of", s, "by primary type (type_1)"),
         x = "Primary type (type_1)", y = s) + theme_bw()
  save_plot(p, paste0("figures/box_", s, "_by_type1.png"), w = 7.5, h = 6) ; print(p)
}
```

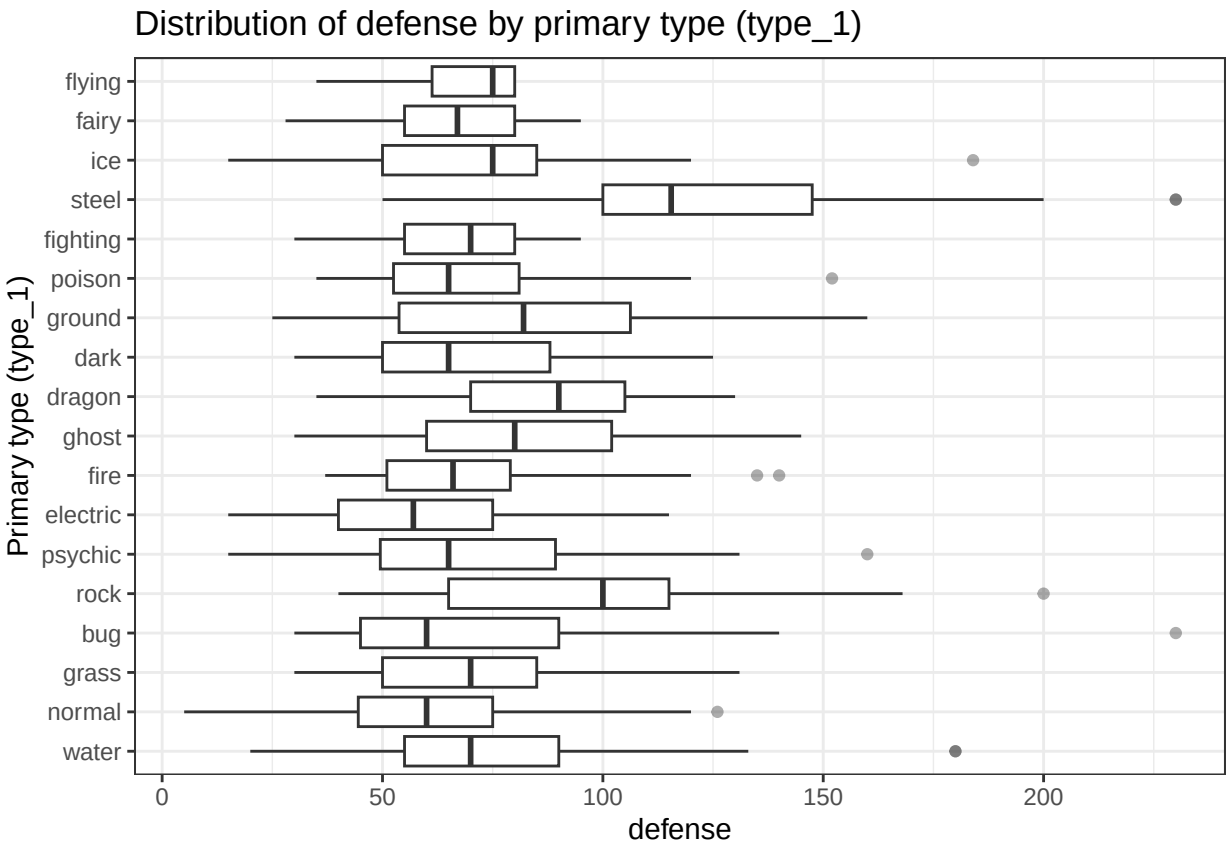
```
## Saved: figures/box_hp_by_type1.png
```



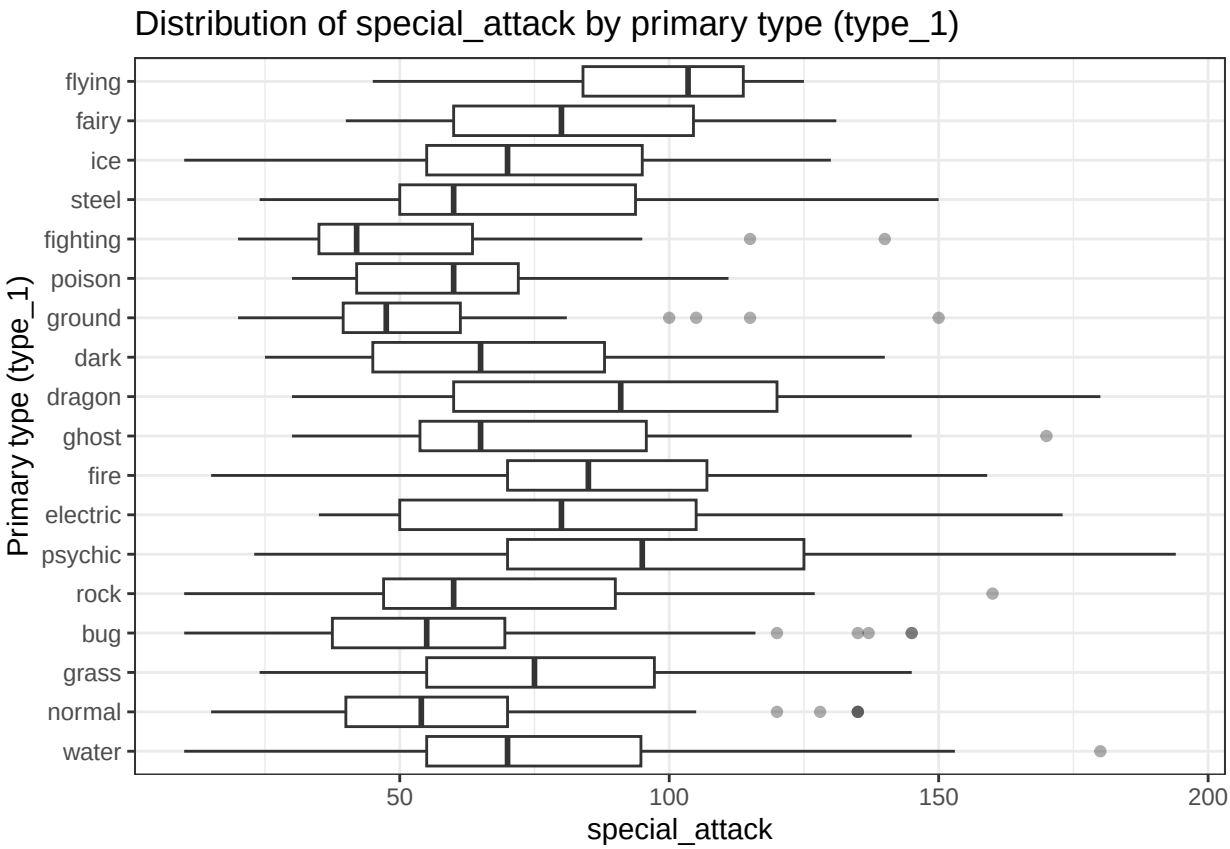

```
## Saved: figures/box_attack_by_type1.png
```



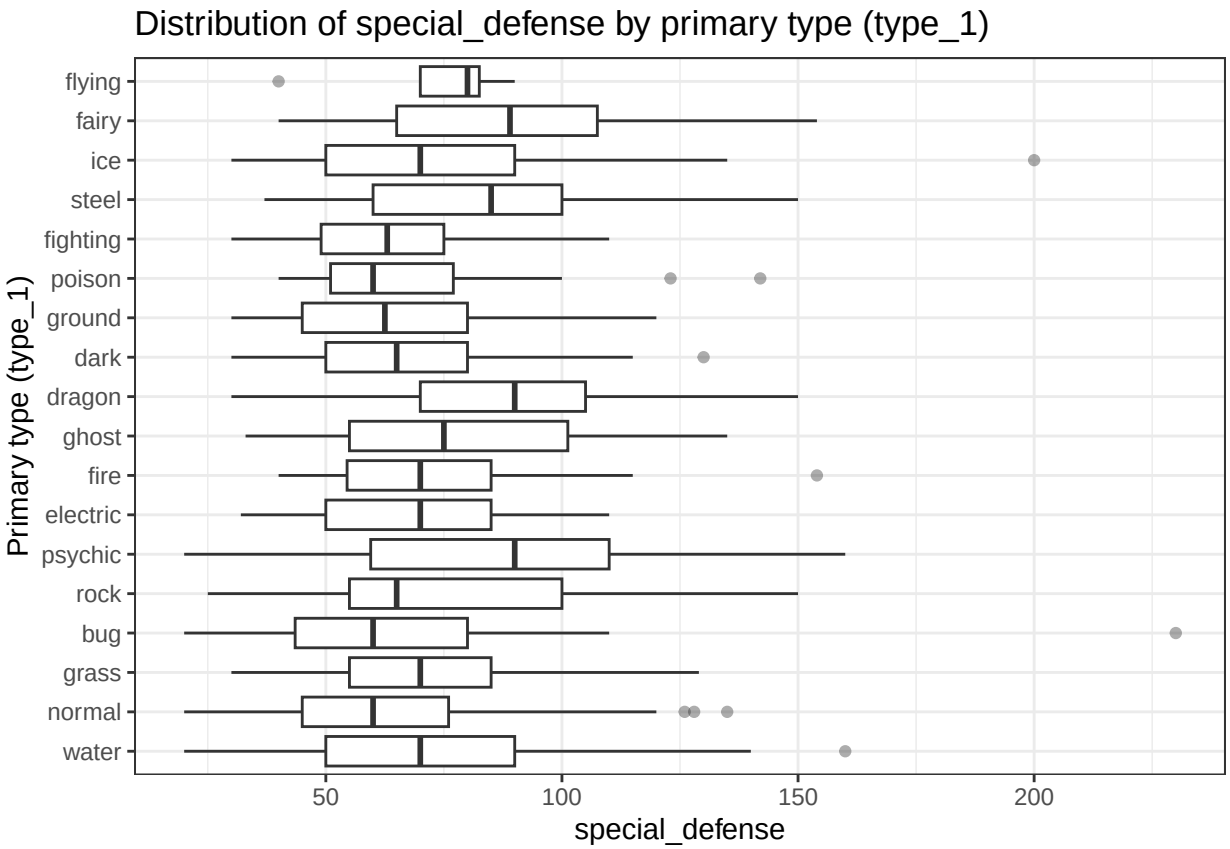

```
## Saved: figures/box_defense_by_type1.png
```



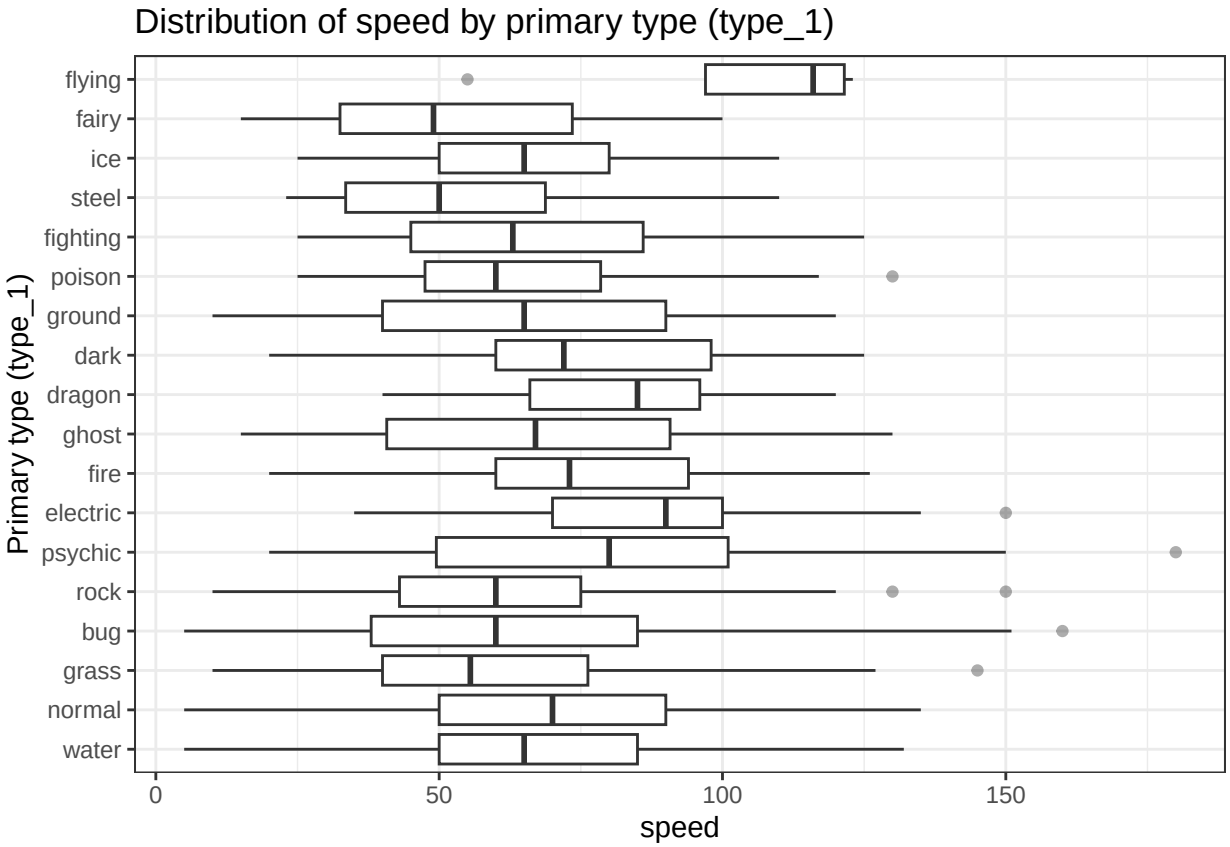

```
## Saved: figures/box_special_attack_by_type1.png
```




```
## Saved: figures/box_special_defense_by_type1.png
```




```
## Saved: figures/box_speed_by_type1.png
```




```
# NA counts across ALL columns (1-row audit table)
na_counts <- pokemon |> summarise(across(everything(), ~sum(is.na(.))))
save_tbl(na_counts, "tables/na_counts_all_columns.csv")            # see pp. 1-2. :contentReference[oai
```

| pokemon | height | weight | base_experience | type_1 | type_2 | attack | defense | special_attack | special_defense | speed | egg_group_1 | egg_group_2 | growth_rate | female_rate | is_legendary | is_mythical | hatch_counter | has_gender_differences | forms_switchable | pokedex_number | generation | type_1_id | f |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 439 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 711 | 147 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

```
# Type_1 counts
type1_counts <- pokemon |> count(type_1) |> arrange(desc(n))
save_tbl(type1_counts, "tables/type1_counts_kareena.csv")
```

| type_1 | n |
|---|---|
| water | 126 |
| normal | 111 |
| grass | 84 |
| bug | 79 |
| rock | 65 |
| psychic | 64 |
| electric | 61 |
| fire | 59 |
| ghost | 40 |
| dragon | 39 |

| type_1 | n |
|---|---|
| dark | 37 |
| ground | 36 |
| poison | 35 |
| fighting | 31 |
| steel | 30 |
| ice | 29 |
| fairy | 19 |
| flying | 4 |

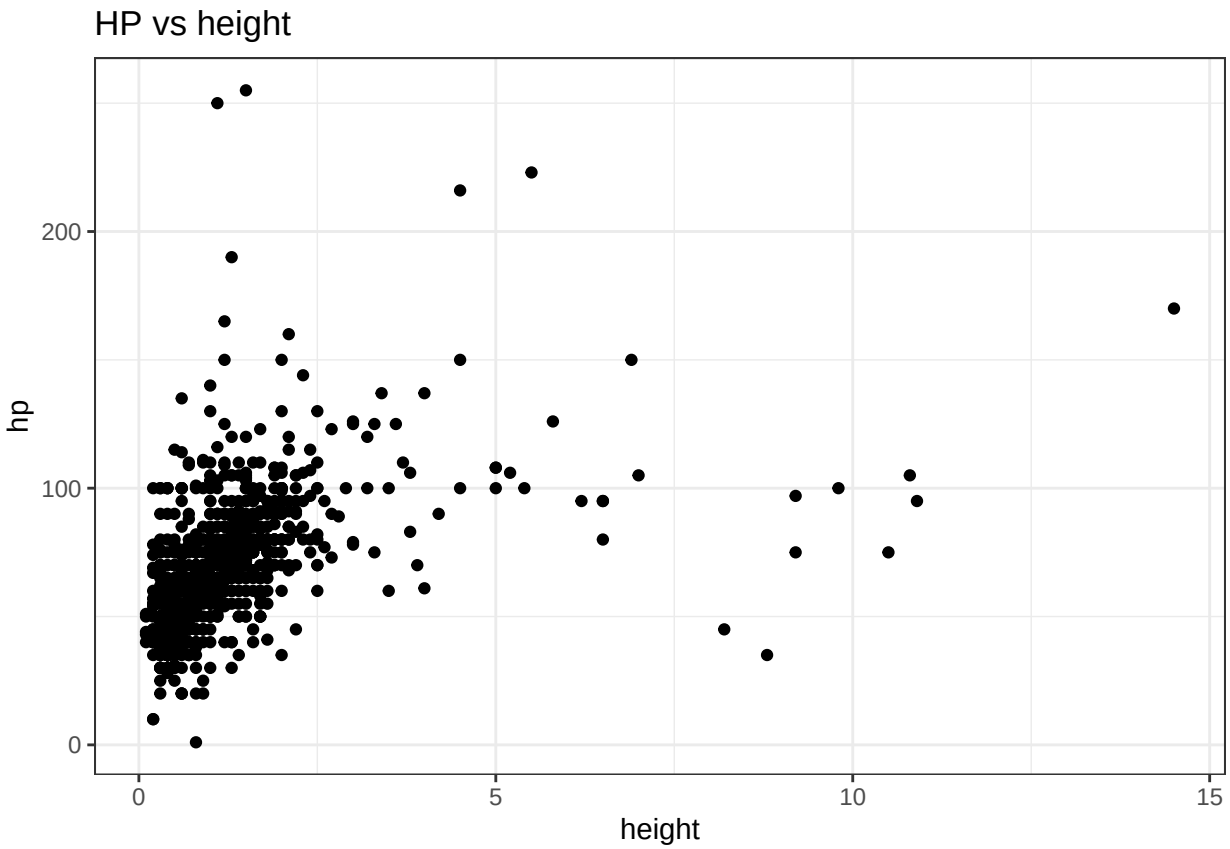
```
knitr::kable(type1_counts, caption = "Counts of primary types (type_1).")
```

Table 16: Counts of primary types (type_1).

| type_1 | n |
|---|---|
| water | 126 |
| normal | 111 |
| grass | 84 |
| bug | 79 |
| rock | 65 |
| psychic | 64 |
| electric | 61 |
| fire | 59 |
| ghost | 40 |
| dragon | 39 |
| dark | 37 |
| ground | 36 |
| poison | 35 |
| fighting | 31 |
| steel | 30 |
| ice | 29 |
| fairy | 19 |
| flying | 4 |

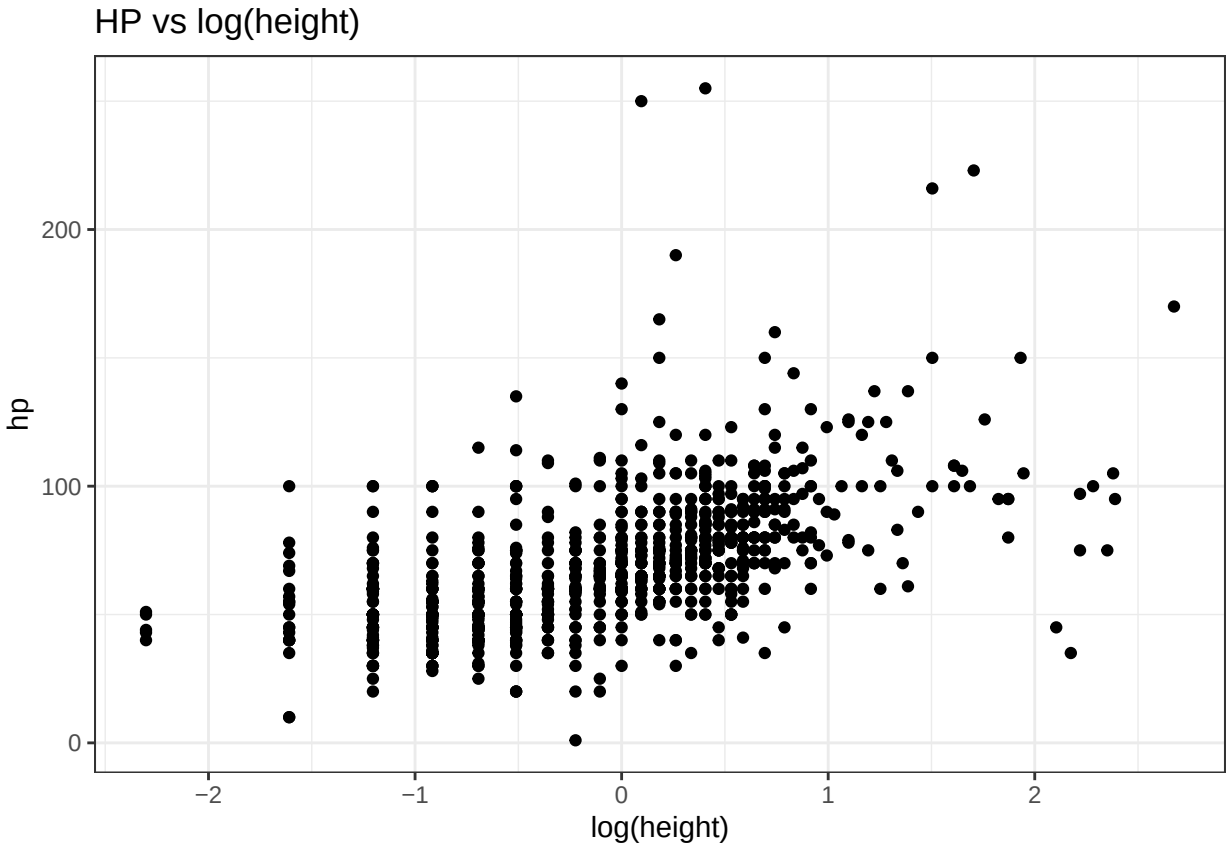
```
# Size → HP (raw vs log)
p_hp_h  <- ggplot(pokemon, aes(height, hp))      + geom_point() + theme_bw() + labs(title="HP vs height
p_hp_lh <- ggplot(pokemon, aes(log(height), hp)) + geom_point() + theme_bw() + labs(title="HP vs log(he
p_hp_w  <- ggplot(pokemon, aes(weight, hp))      + geom_point() + theme_bw() + labs(title="HP vs weight
p_hp_lw <- ggplot(pokemon, aes(log(weight), hp)) + geom_point() + theme_bw() + labs(title="HP vs log(we
save_plot(p_hp_h,  "figures/k_hp_vs_height.png")
```

```
## Saved: figures/k_hp_vs_height.png
```



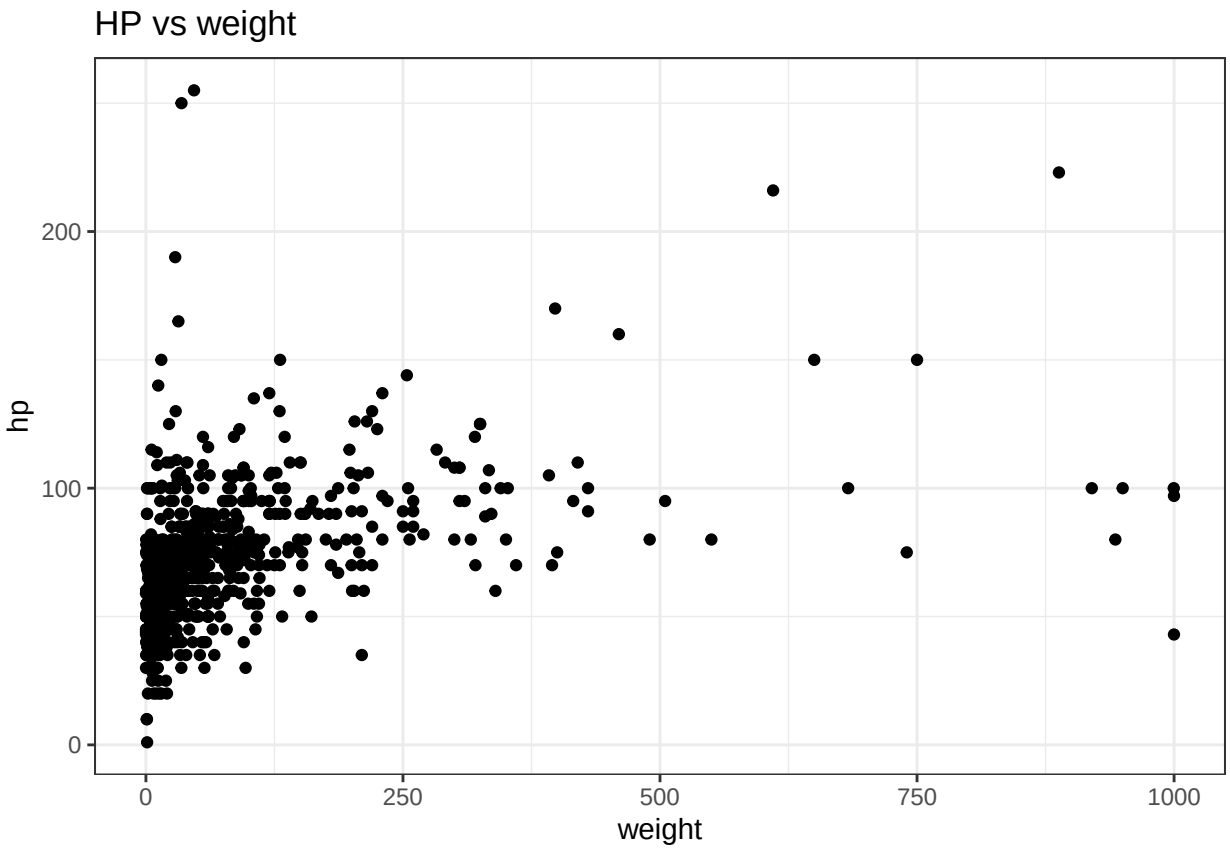

```
save_plot(p_hp_lh, "figures/k_hp_vs_logheight.png")
```

```
## Saved: figures/k_hp_vs_logheight.png
```



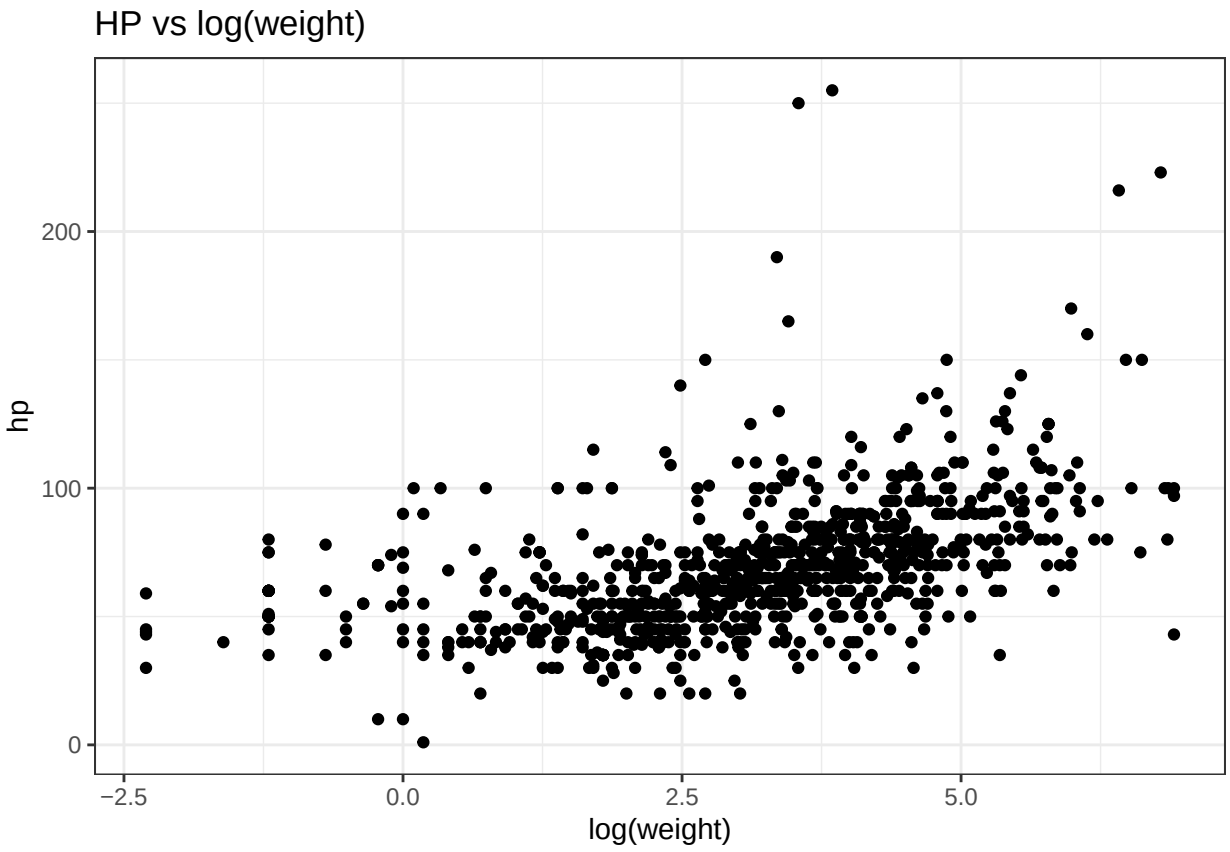

```
save_plot(p_hp_w,  "figures/k_hp_vs_weight.png")
```

```
## Saved: figures/k_hp_vs_weight.png
```

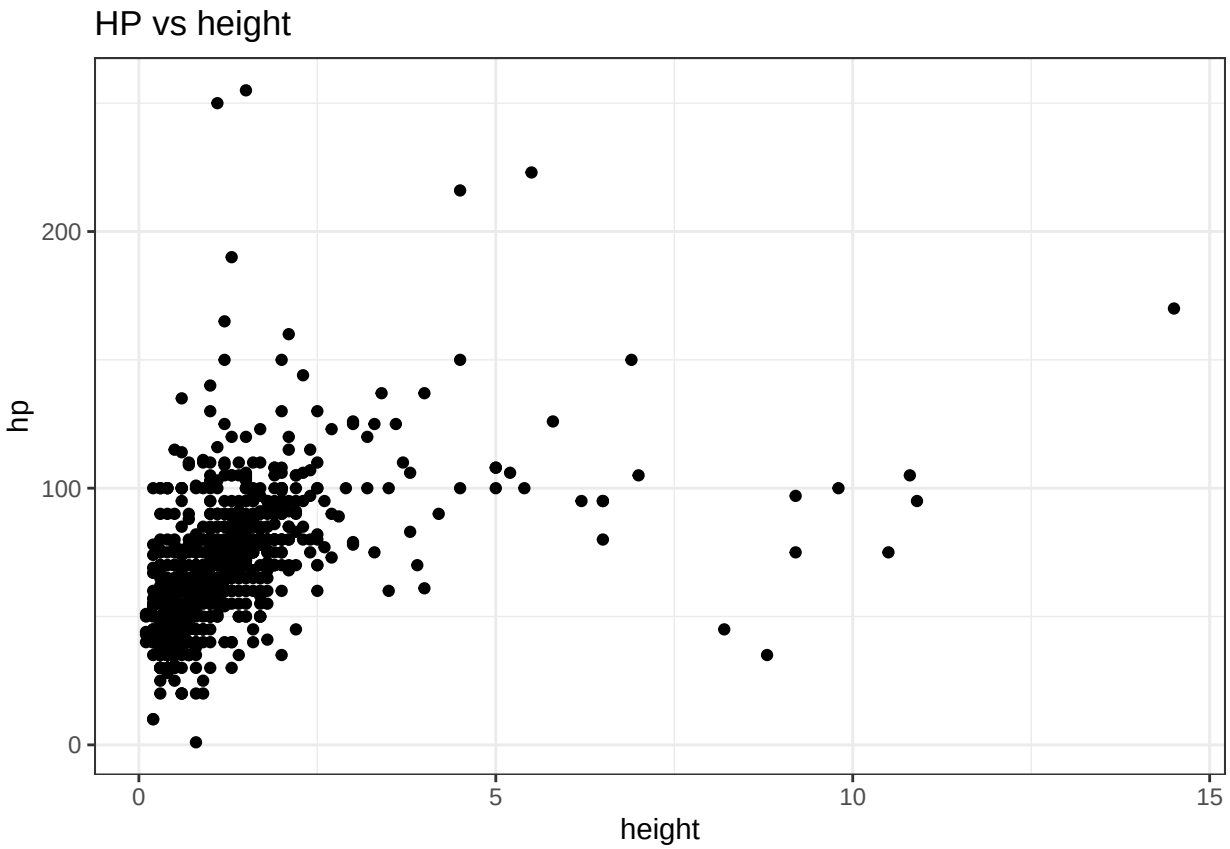


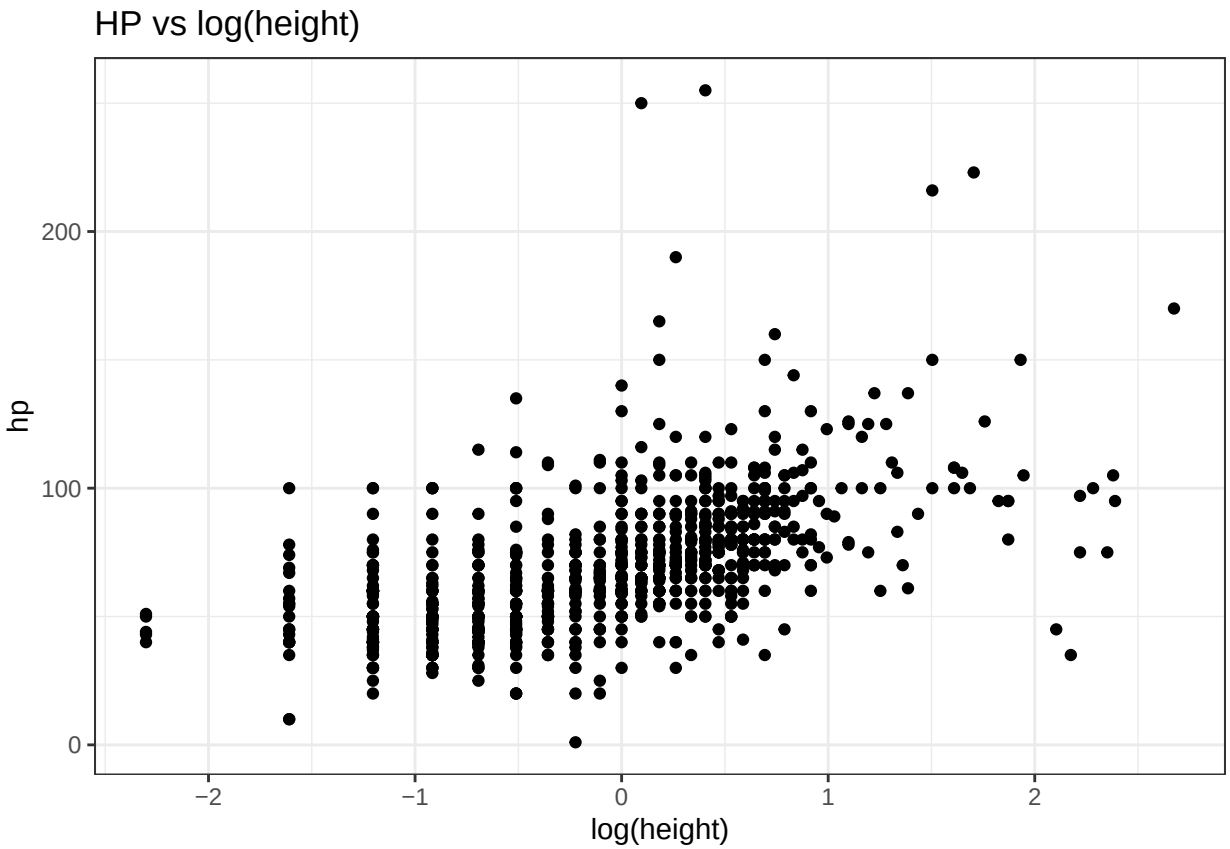

```
save_plot(p_hp_lw, "figures/k_hp_vs_logweight.png")
```

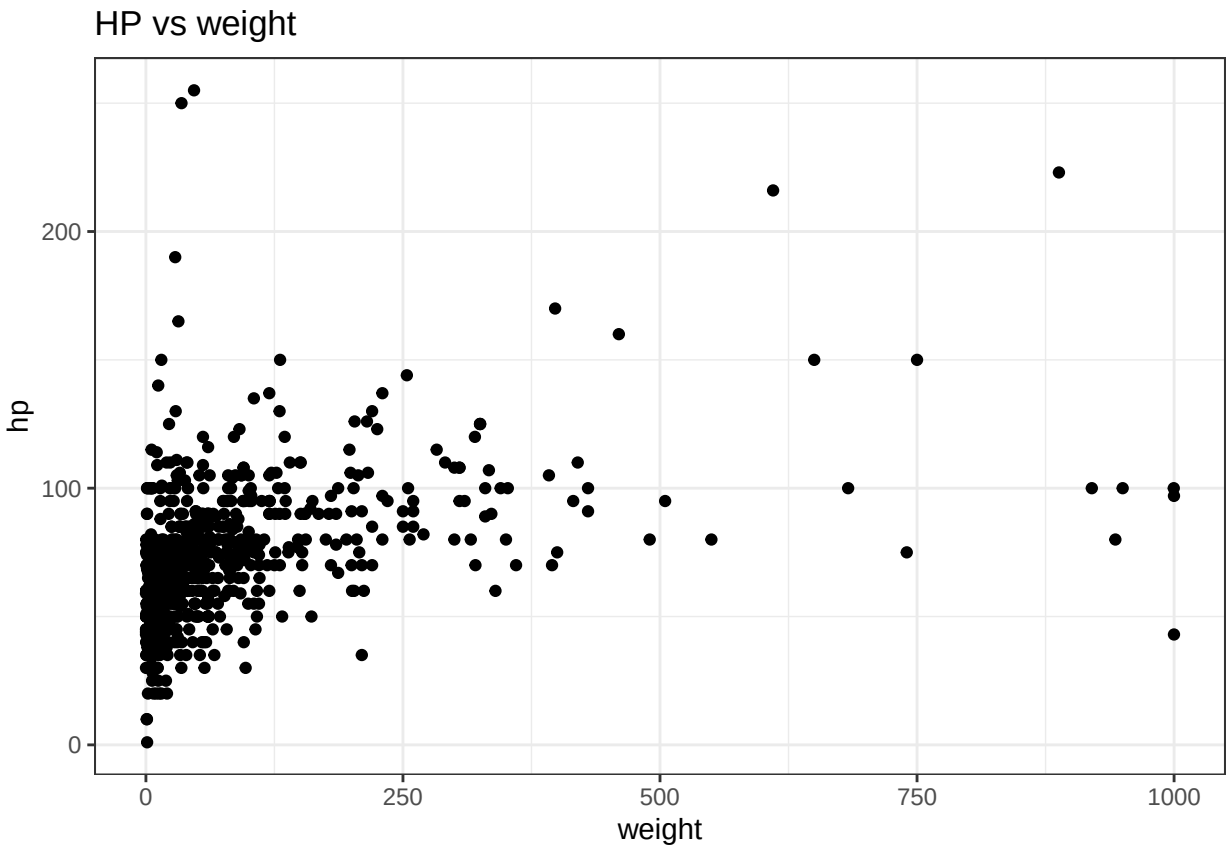
```
## Saved: figures/k_hp_vs_logweight.png
```

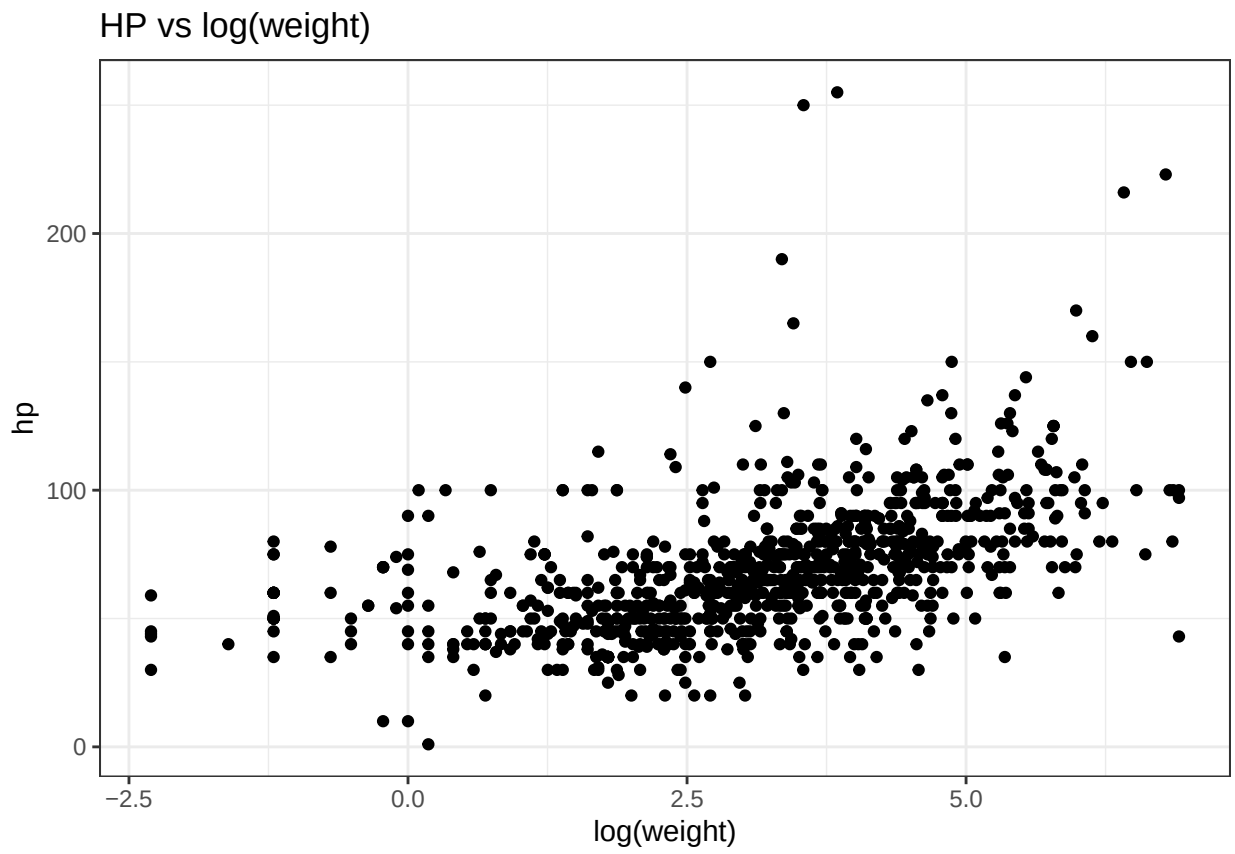



```
p_hp_h; p_hp_lh; p_hp_w; p_hp_lw                                    # pp. 3-5. :contentReference[
```


HP vs height
hp
200
100
0
0
5
10
15
height

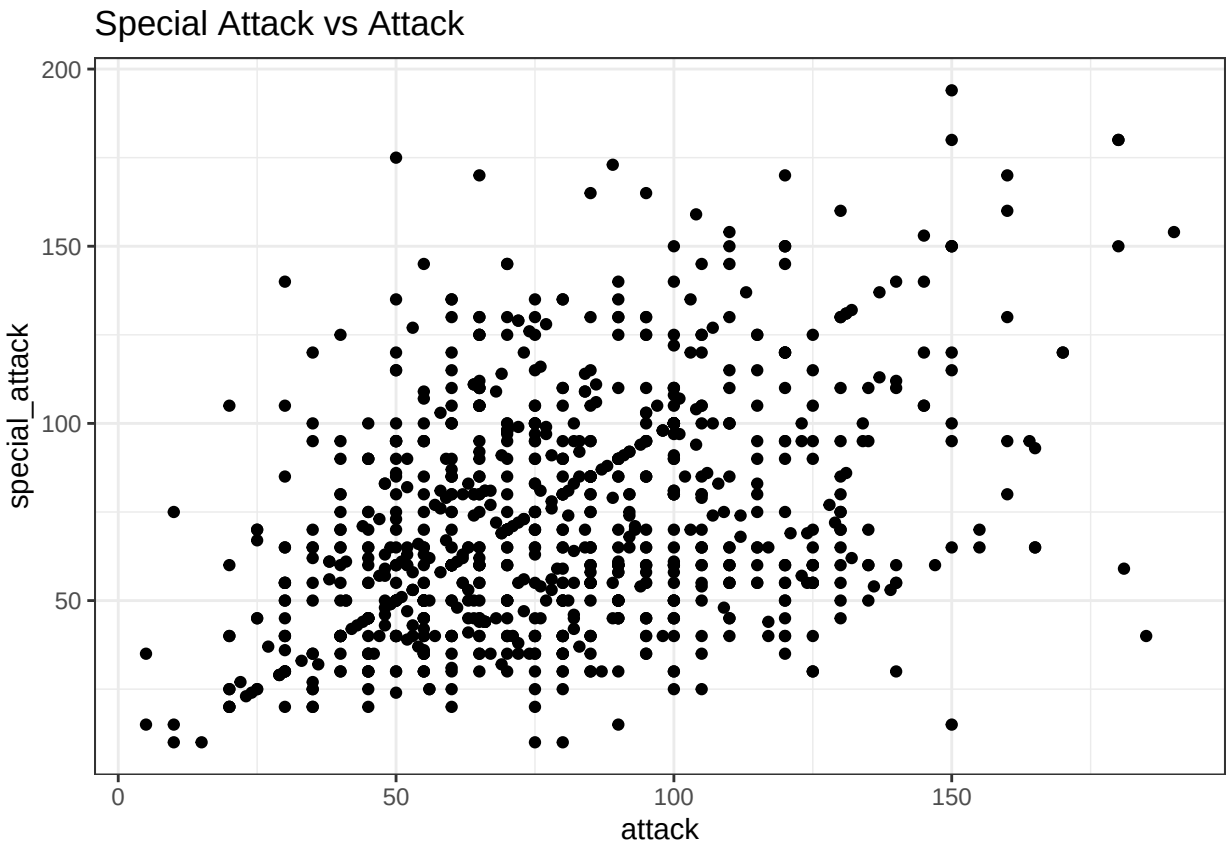

HP vs log(height)
hp
200
100
0
−2
−1
0
1
2
log(height)


HP vs weight
hp
200
100
0
0
250
500
750
1000
weight



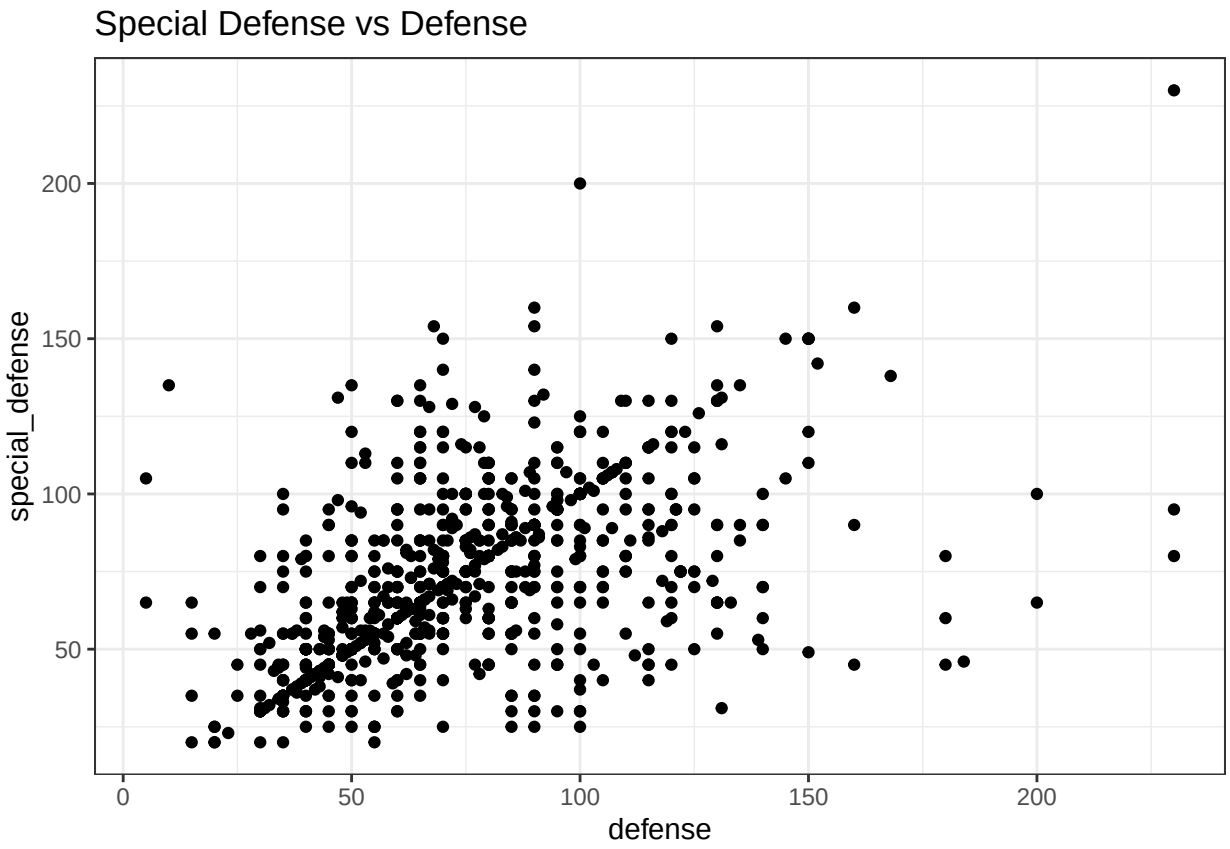

```
# Attack vs Special Attack; Defense vs Special Defense + identical-value counts
p_atk_spa <- ggplot(pokemon, aes(attack, special_attack))  + geom_point() + theme_bw() + labs(title="Sp
p_def_spd <- ggplot(pokemon, aes(defense, special_defense)) + geom_point() + theme_bw() + labs(title="S
save_plot(p_atk_spa, "figures/k_special_attack_vs_attack.png")
```

```
## Saved: figures/k_special_attack_vs_attack.png
```




```
save_plot(p_def_spd, "figures/k_special_defense_vs_defense.png")
```

```
## Saved: figures/k_special_defense_vs_defense.png
```




```
eq_counts <- tibble(
  attack_eq_spatk  = sum(pokemon$attack  == pokemon$special_attack,  na.rm = TRUE),
  defense_eq_spdef = sum(pokemon$defense == pokemon$special_defense, na.rm = TRUE),
  both_equal       = sum((pokemon$attack  == pokemon$special_attack) &
                         (pokemon$defense == pokemon$special_defense), na.rm = TRUE)
)
save_tbl(eq_counts, "tables/k_equal_stat_counts.csv")                    # p. 6. :contentReference[o
```

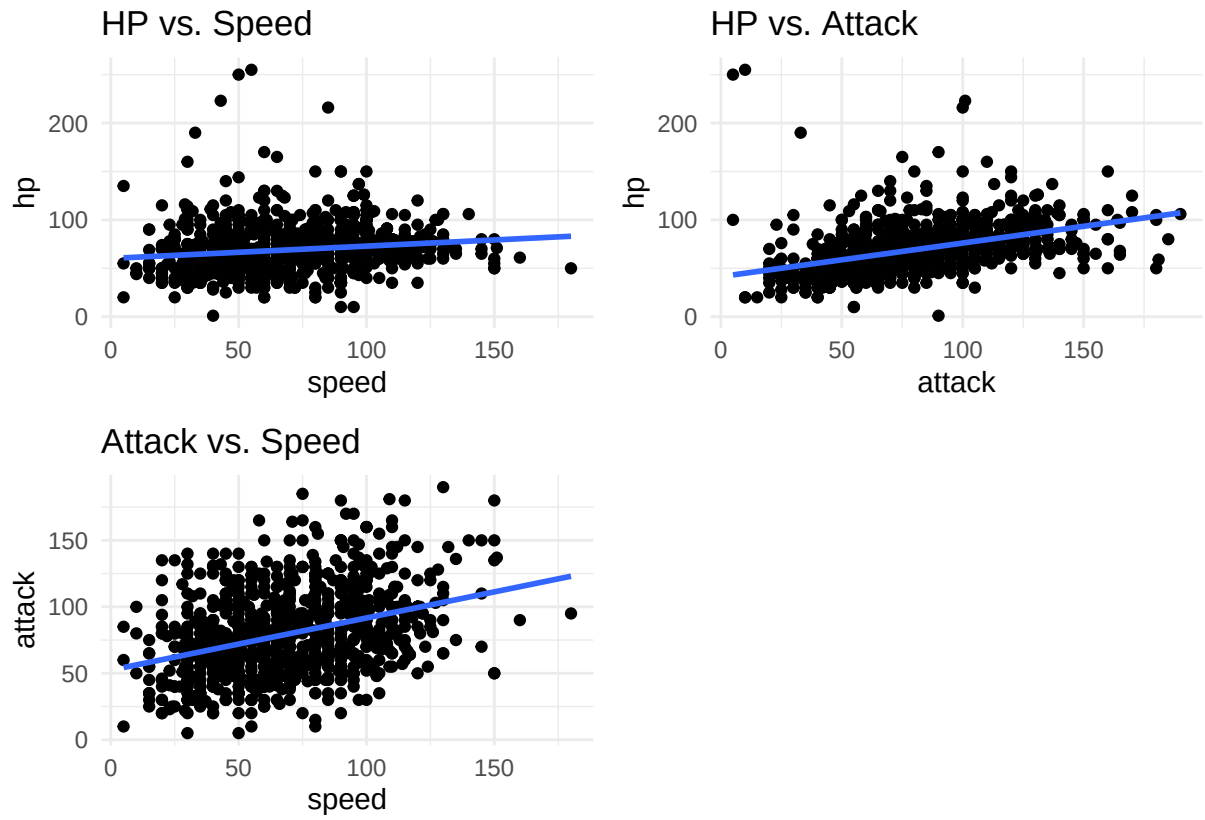
| attack_eq_spatk | defense_eq_spdef | both_equal |
|---|---|---|
| 157 | 321 | 116 |

```
# Hypothesis triptych + simple correlations
p1 <- ggplot(pokemon, aes(speed, hp))     + geom_point() + geom_smooth(method='lm', se=FALSE) + theme_mi
p2 <- ggplot(pokemon, aes(attack, hp))    + geom_point() + geom_smooth(method='lm', se=FALSE) + theme_mi
p3 <- ggplot(pokemon, aes(speed, attack)) + geom_point() + geom_smooth(method='lm', se=FALSE) + theme_mi
g_triptych <- p1 + p2 + p3 + patchwork::plot_layout(ncol=2)
ggsave("figures/k_hypothesis_triptych.png", plot = g_triptych, width = 9, height = 6, dpi = 150)
```

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

```
g_triptych                                                    # pp. 13-14. :contentRe
```

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




```
corrs_simple <- pokemon |>
  summarise(`cor(speed, hp)` = cor(speed, hp),
            `cor(speed, attack)` = cor(speed, attack),
            `cor(attack, hp)` = cor(attack, hp))
save_tbl(corrs_simple, "tables/k_simple_correlations.csv")                # p. 9. :contentReferenc
```

| cor(speed, hp) | cor(speed, attack) | cor(attack, hp) |
|---|---|---|
| 0.143 | 0.359 | 0.427 |

```
# egg_group_1 counts
egg1_counts <- pokemon |> count(egg_group_1) |> arrange(desc(n))
save_tbl(egg1_counts, "tables/k_egg_group1_counts.csv")
```

| egg_group_1 | n |
|---|---|
| ground | 218 |
| no-eggs | 118 |
| monster | 94 |
| water1 | 84 |
| bug | 80 |
| mineral | 67 |
| indeterminate | 64 |
| flying | 59 |
| humanshape | 40 |
| fairy | 38 |
| plant | 35 |
| water2 | 21 |
| water3 | 16 |
| dragon | 14 |
| ditto | 1 |

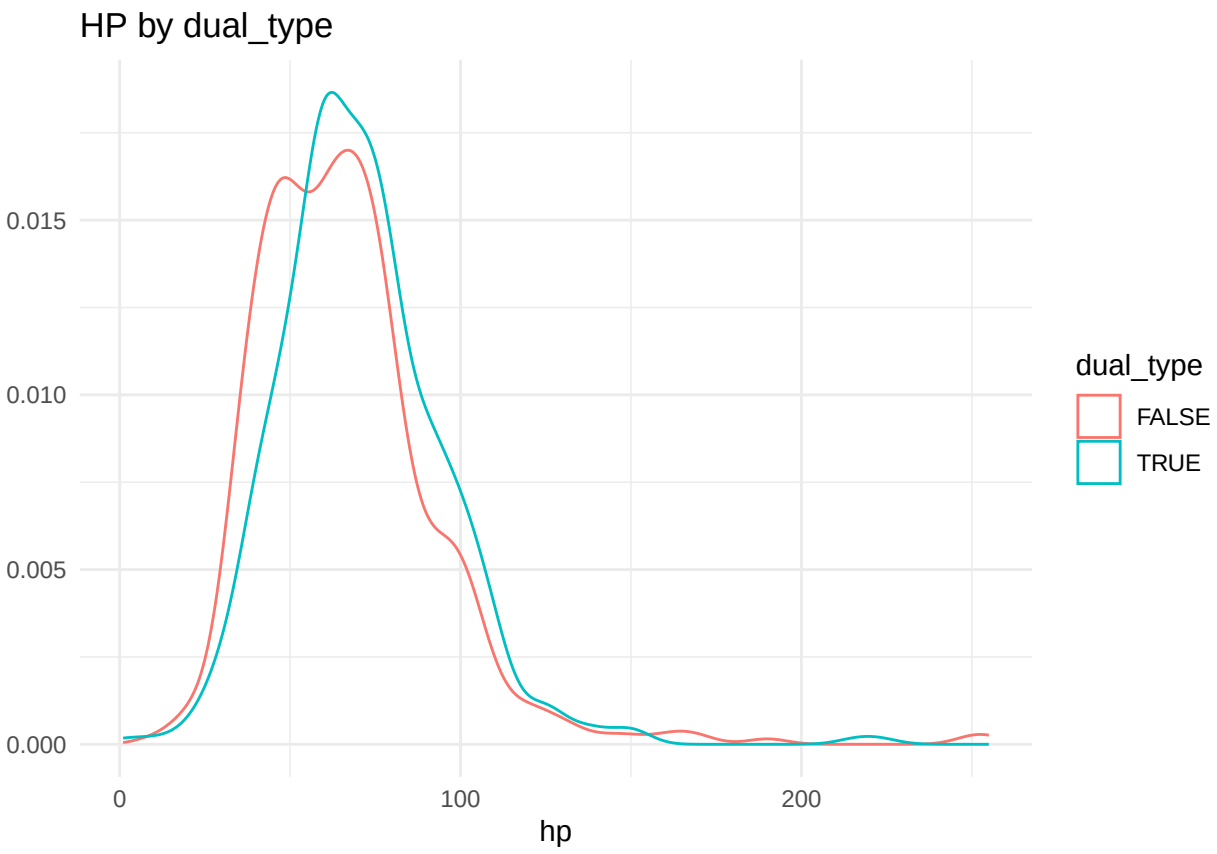
```
knitr::kable(egg1_counts, caption = "Counts of egg_group_1")                    # p. 9. :contentReferenc
```

Table 20: Counts of egg_group_1

| egg_group_1 | n |
|---|---|
| ground | 218 |
| no-eggs | 118 |
| monster | 94 |
| water1 | 84 |
| bug | 80 |
| mineral | 67 |
| indeterminate | 64 |
| flying | 59 |
| humanshape | 40 |
| fairy | 38 |
| plant | 35 |
| water2 | 21 |
| water3 | 16 |
| dragon | 14 |
| ditto | 1 |

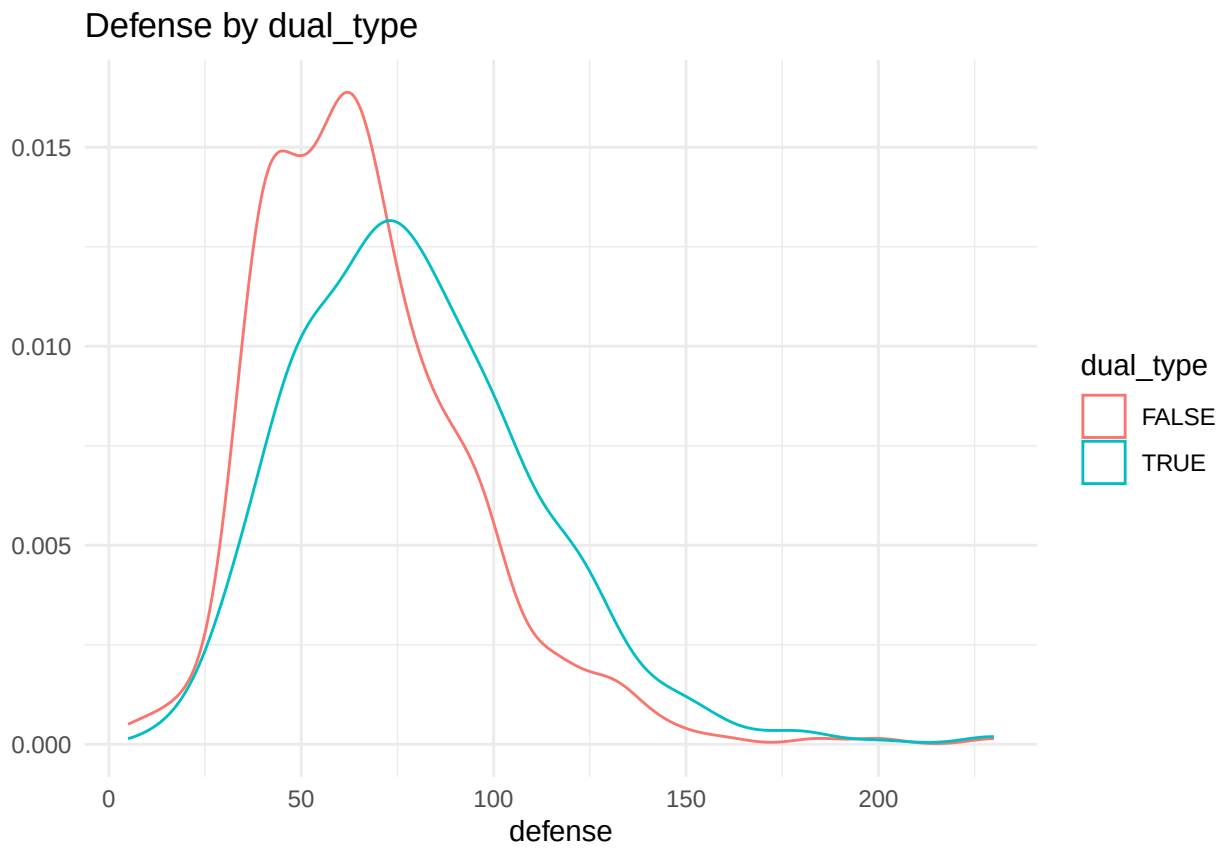
```
# Dual-type densities
p_den_hp  <- ggplot(pokemon, aes(hp,              color = dual_type)) + geom_density() + theme_minimal()
p_den_def <- ggplot(pokemon, aes(defense,         color = dual_type)) + geom_density() + theme_minimal()
p_den_exp <- ggplot(pokemon, aes(base_experience,color = dual_type)) + geom_density() + theme_minimal()
save_plot(p_den_hp,  "figures/k_density_hp_by_dualtype.png")
```

```
## Saved: figures/k_density_hp_by_dualtype.png
```



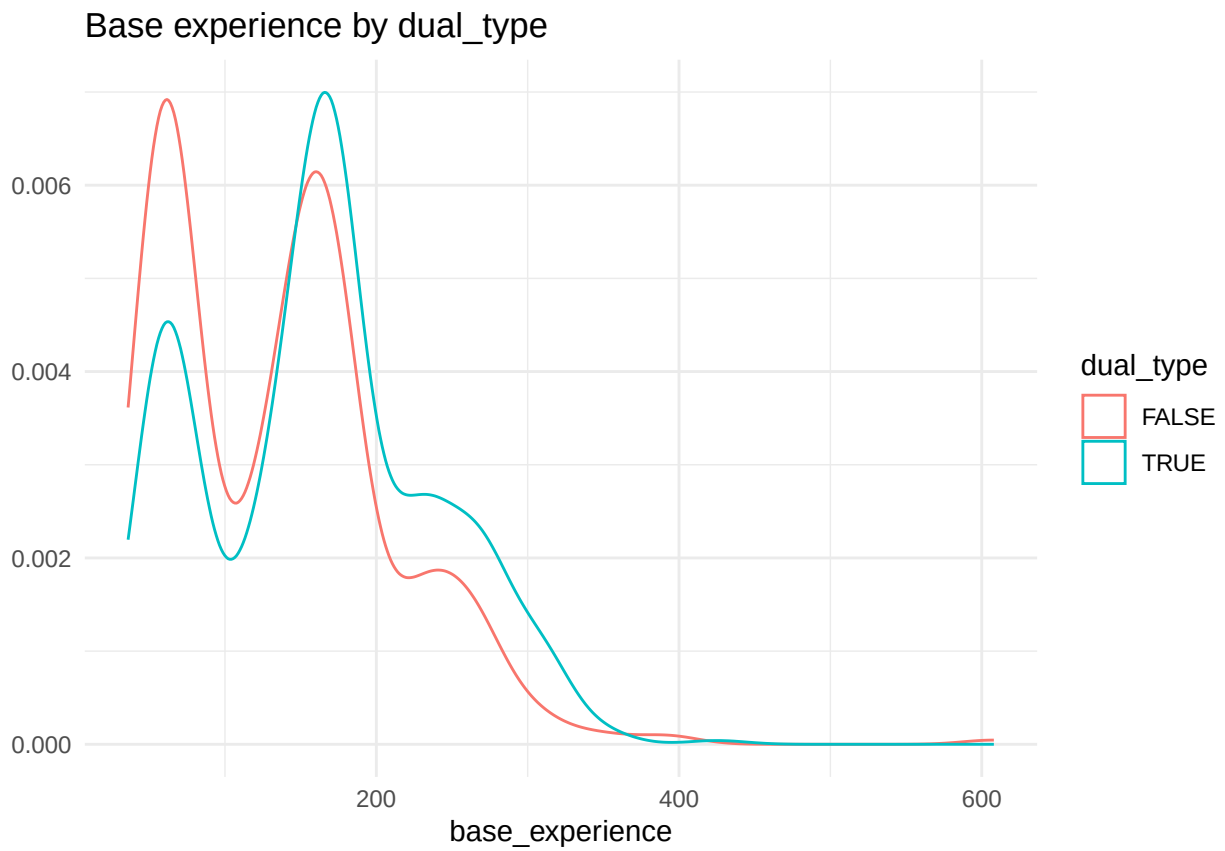

```
save_plot(p_den_def, "figures/k_density_defense_by_dualtype.png")
```

```
## Saved: figures/k_density_defense_by_dualtype.png
```




```
save_plot(p_den_exp, "figures/k_density_baseexp_by_dualtype.png")                # pp. 10-11. :contentRef
```

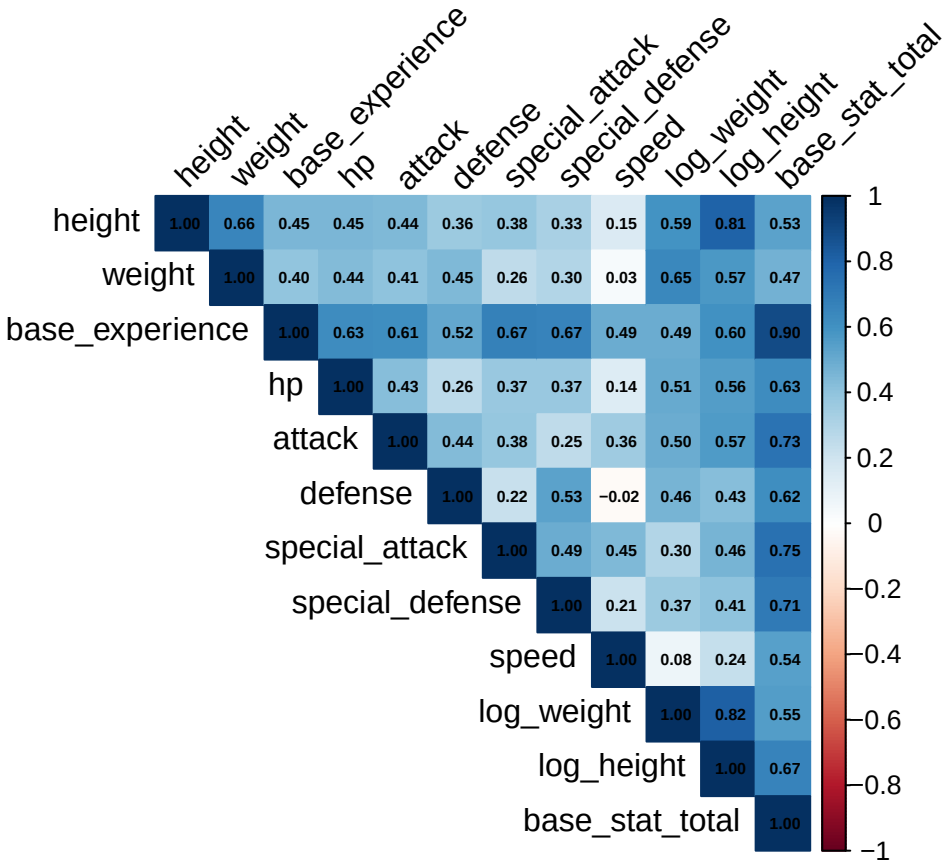
```
## Saved: figures/k_density_baseexp_by_dualtype.png
```




```
dual_means_atk <- pokemon |> group_by(dual_type) |> summarise(`mean(attack)` = mean(attack, na.rm=TRUE)
save_tbl(dual_means_atk, "tables/k_dual_type_mean_attack.csv")
```

| dual_type | mean(attack) |
|---|---|
| FALSE | 74.415 |
| TRUE | 83.825 |

```
# Correlation heatmap (Kareena used corrplot on numeric cols excl. generation_id)
num_keep <- pokemon |> select(where(is.numeric)) |> select(!generation_id)
M <- cor(num_keep, use = "pairwise.complete.obs")
corrplot::corrplot(M, method = "color", type = "upper", addCoef.col = "black", tl.col = "black",
                   number.cex = 0.5, tl.srt = 45)
```

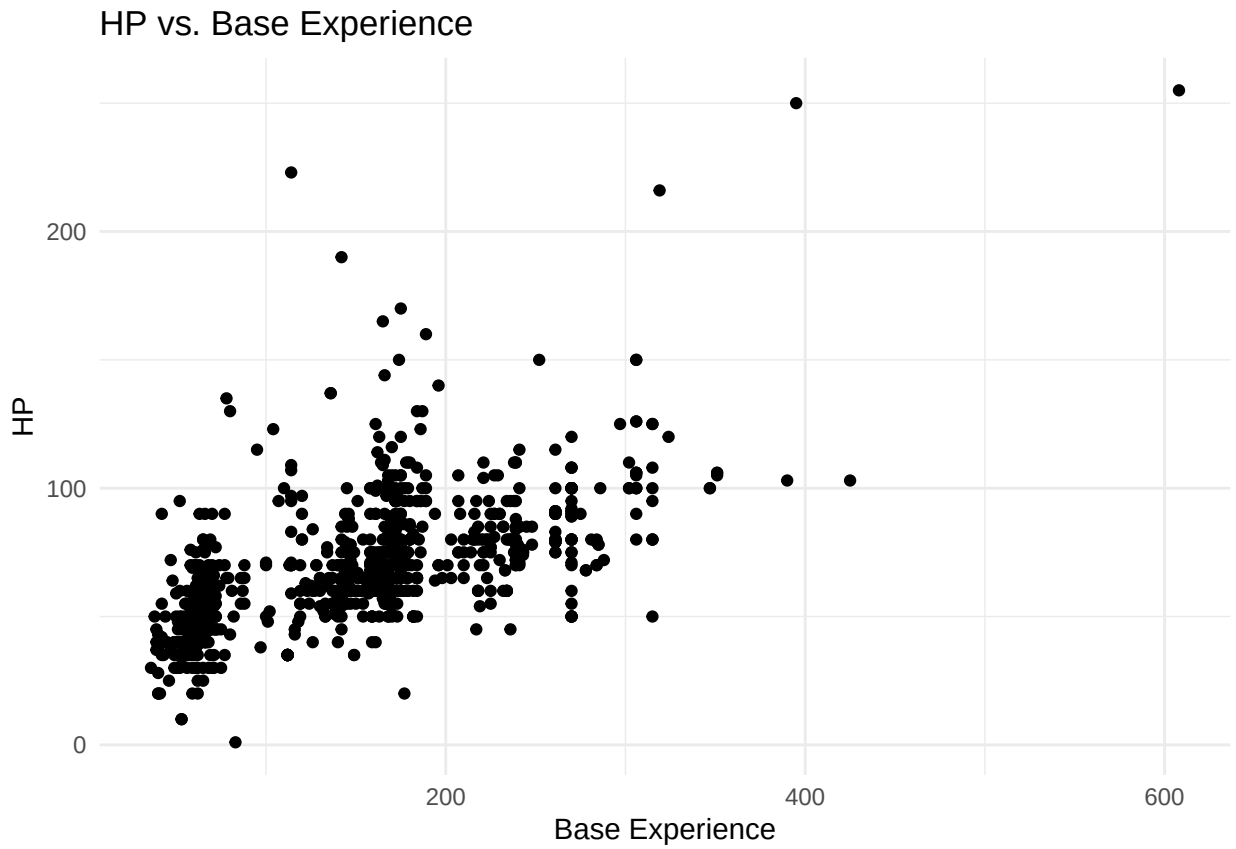



```
  png("figures/k_corrplot_matrix.png", width = 1200, height = 1200, res = 140)
  corrplot::corrplot(M, method = "color", type = "upper", addCoef.col = "black", tl.col = "black",
                     number.cex = 0.5, tl.srt = 45)
  dev.off()
```

```
## pdf
##   2
```

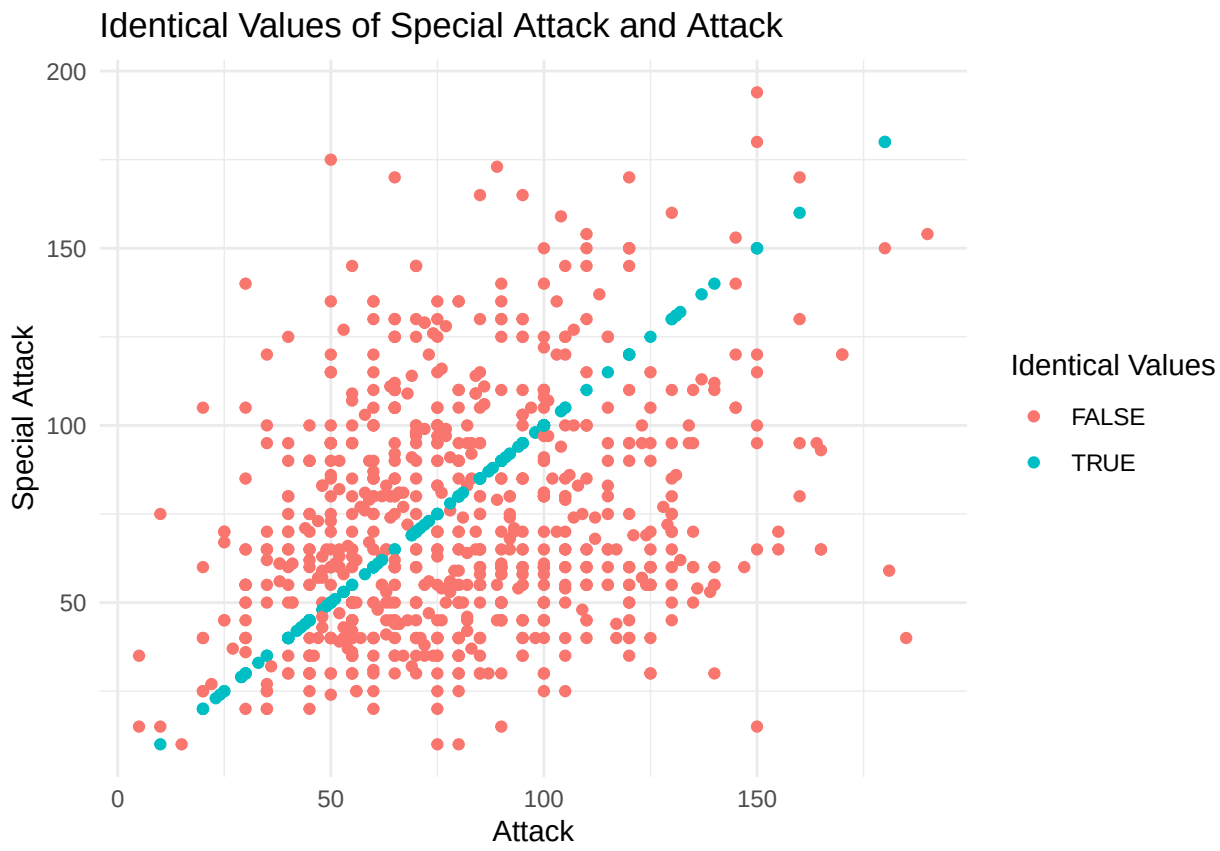
```
# HP vs Base Experience + identical-value highlights (Kareena)
p_hp_exp <- ggplot(pokemon, aes(base_experience, hp)) + geom_point() + theme_minimal() +
  labs(title = "HP vs. Base Experience", x = "Base Experience", y = "HP")
save_plot(p_hp_exp, "figures/k_hp_vs_base_experience.png")
```

```
## Saved: figures/k_hp_vs_base_experience.png
```



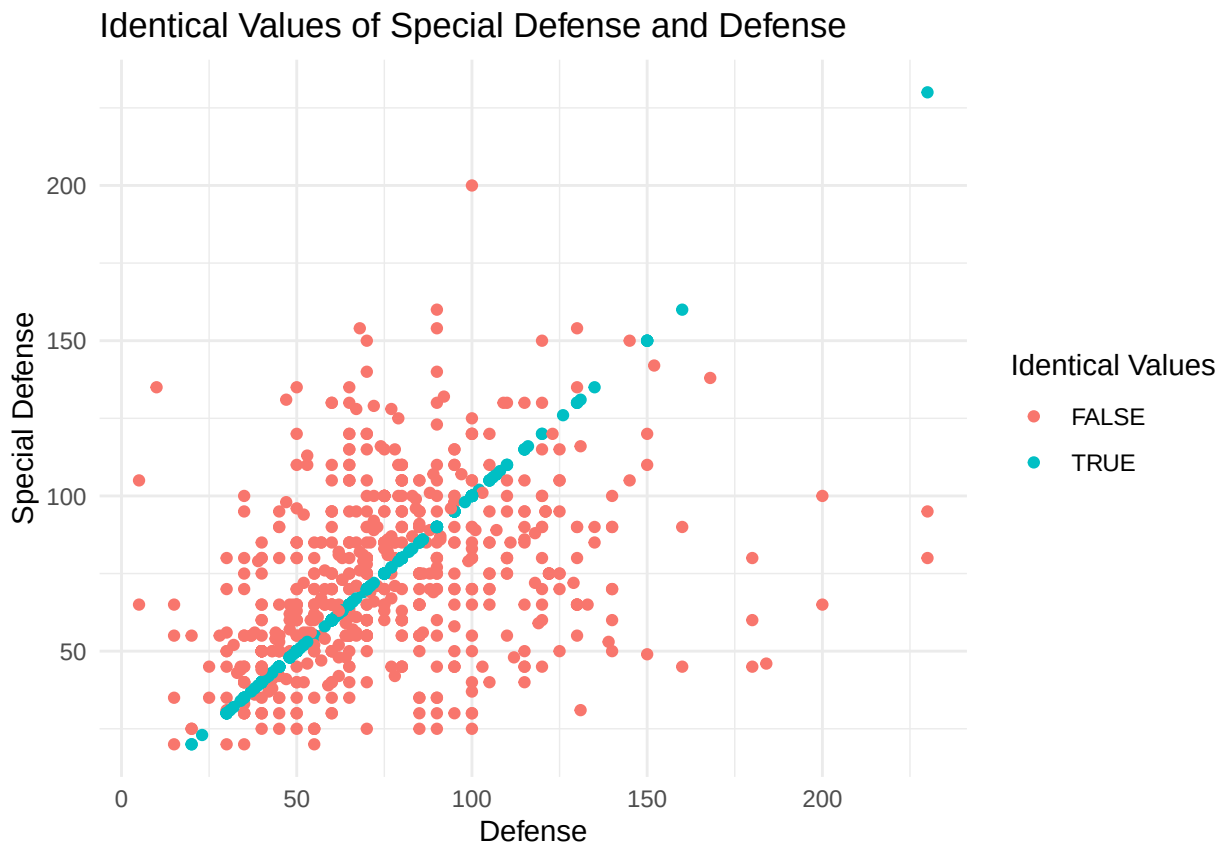

```
special_df <- pokemon |>
  mutate(same_attack  = special_attack  == attack,
         same_defense = special_defense == defense)
p_same_atk <- ggplot(special_df, aes(attack,  special_attack,  color = same_attack))  +
  geom_point() + theme_minimal() + labs(title="Identical Values of Special Attack and Attack", x="Attac
p_same_def <- ggplot(special_df, aes(defense, special_defense, color = same_defense)) +
  geom_point() + theme_minimal() + labs(title="Identical Values of Special Defense and Defense", x="Def
save_plot(p_same_atk, "figures/k_identical_spatk_attack.png")
```

```
## Saved: figures/k_identical_spatk_attack.png
```




```
save_plot(p_same_def, "figures/k_identical_spdef_defense.png")                # pp. 16-17. :contentRef
```

```
## Saved: figures/k_identical_spdef_defense.png
```

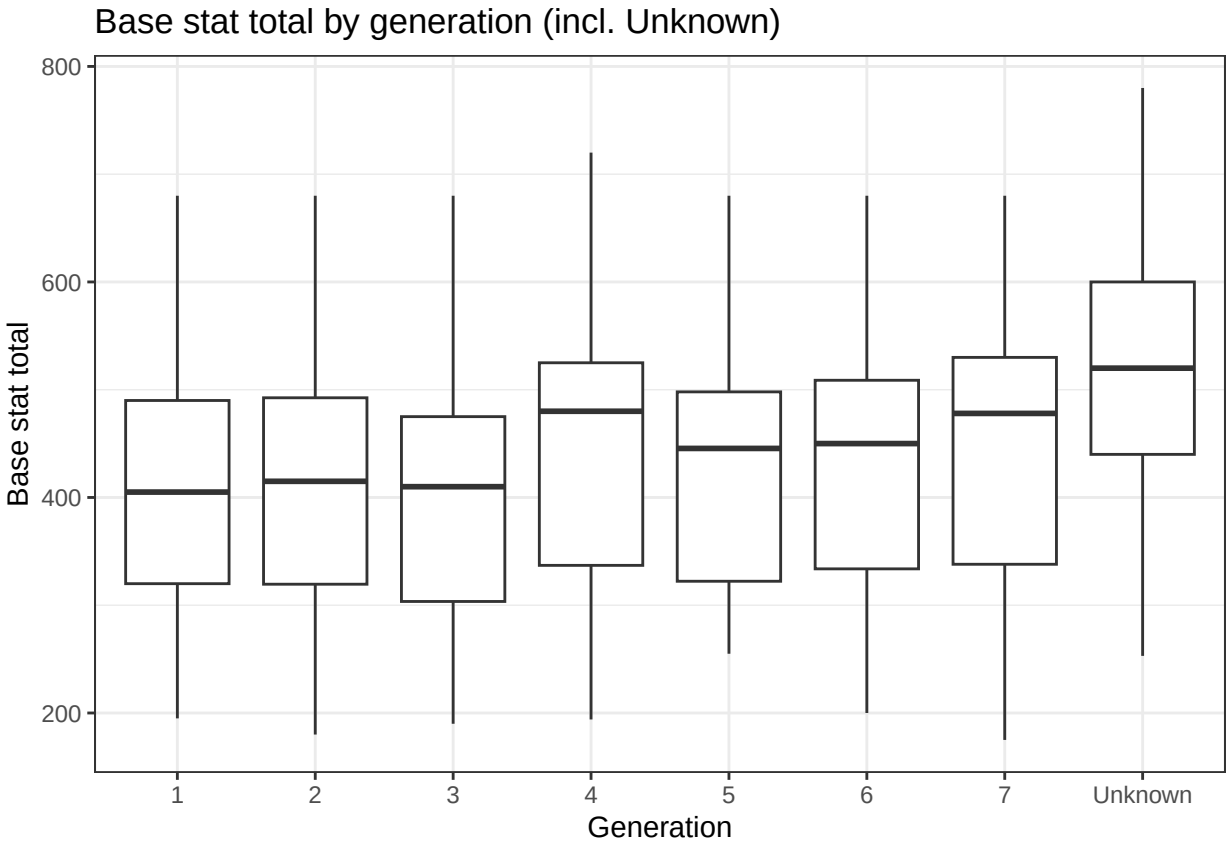


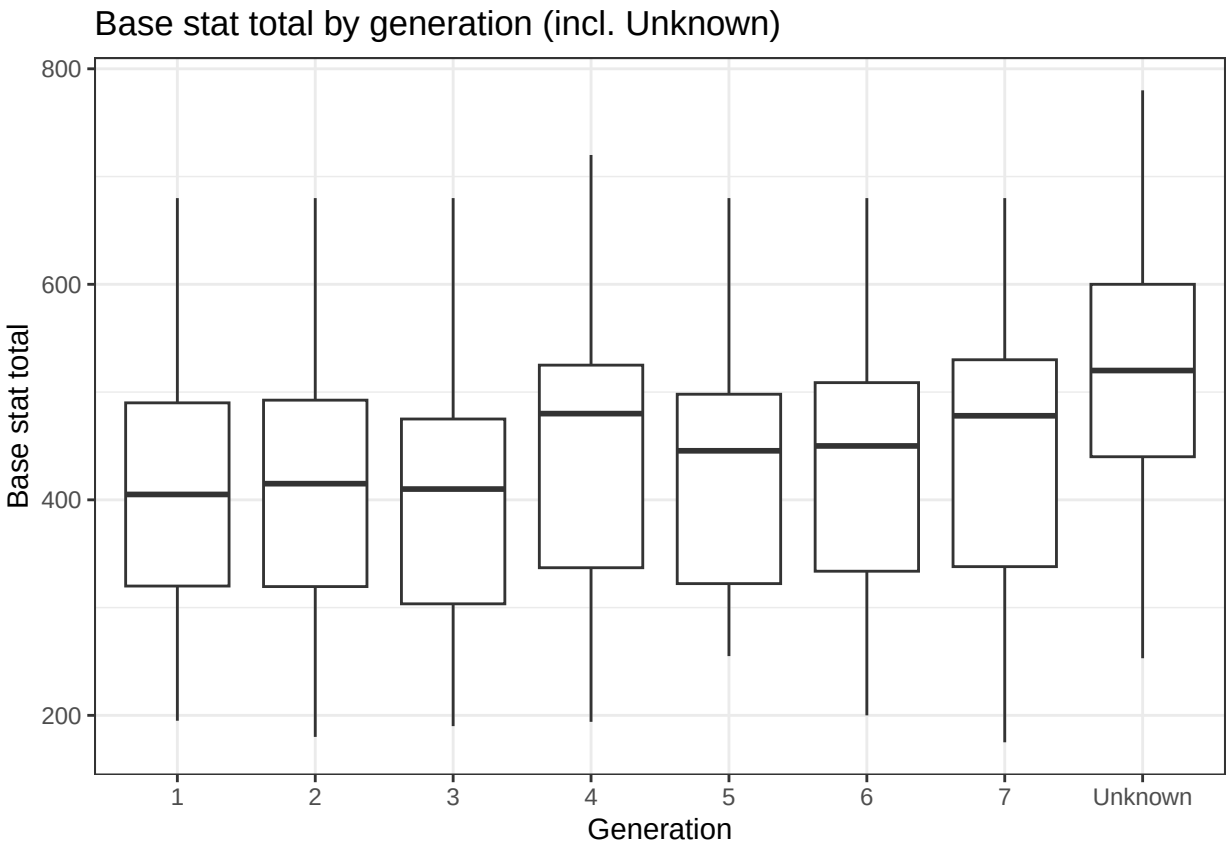

```
# Power creep: base_stat_total by generation (table + boxplot)
gen_total <- pokemon |>
  group_by(generation_id_f) |>
  summarise(n = n(),
            mean_total = mean(base_stat_total, na.rm=TRUE),
            sd_total   = sd(base_stat_total,   na.rm=TRUE)) |>
  arrange(generation_id_f)
save_tbl(gen_total, "tables/gen_base_stat_total_summary.csv", digits = 1)
```

| generation_id_f | n | mean_total | sd_total |
|---|---|---|---|
| 1 | 151 | 407.6 | 99.9 |
| 2 | 100 | 407.2 | 112.5 |
| 3 | 135 | 403.7 | 115.6 |
| 4 | 107 | 445.8 | 117.5 |
| 5 | 156 | 425.8 | 102.5 |
| 6 | 72 | 429.6 | 111.9 |
| 7 | 81 | 443.8 | 118.7 |
| Unknown | 147 | 520.5 | 122.9 |

```
p_gen_total <- ggplot(pokemon, aes(generation_id_f, base_stat_total)) +
  geom_boxplot(outlier.alpha=.4) + theme_bw() +
  labs(title="Base stat total by generation (incl. Unknown)", x="Generation", y="Base stat total")
save_plot(p_gen_total, "figures/box_basetotal_by_generation.png") ; p_gen_total
```

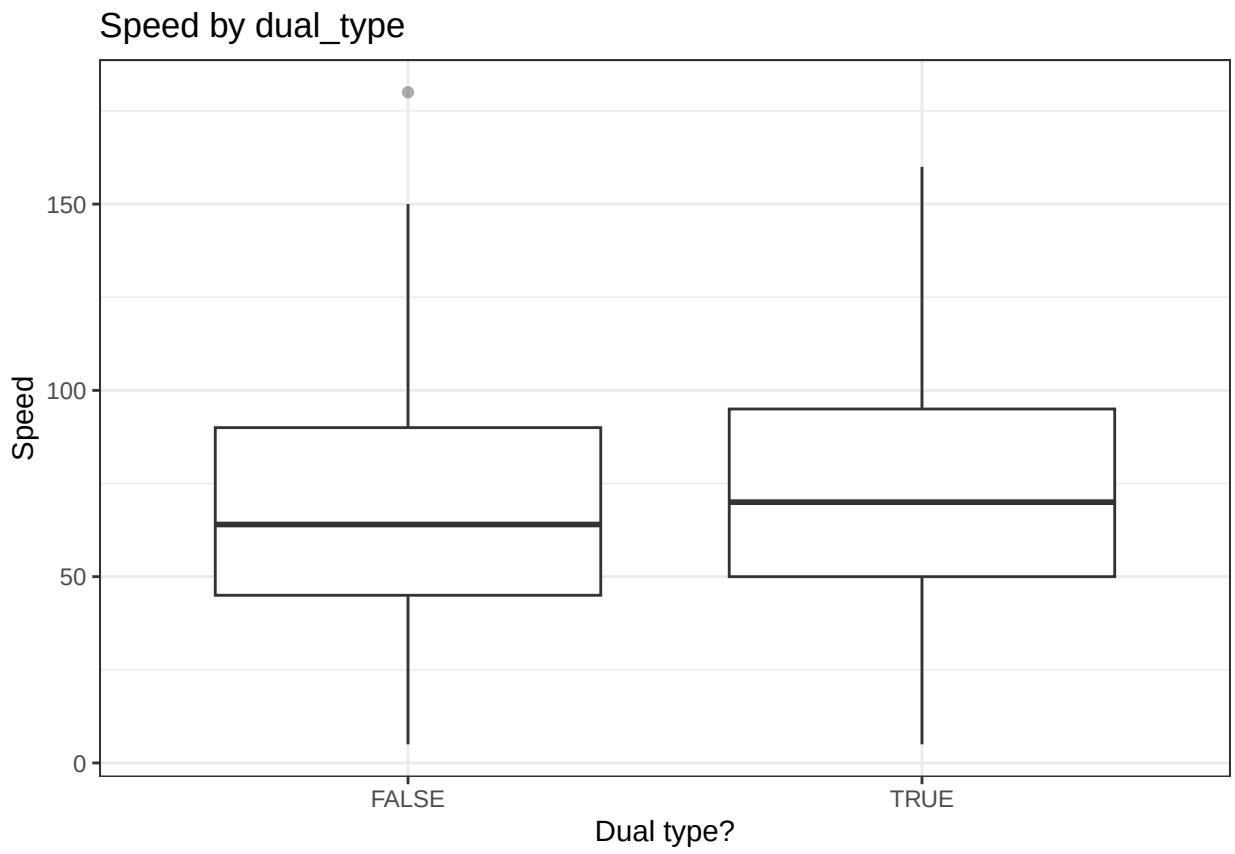
```
## Saved: figures/box_basetotal_by_generation.png
```






```
# Speed by dual_type (boxplot + quick t-test)
p_speed_dual <- ggplot(pokemon, aes(x = dual_type, y = speed)) +
  geom_boxplot(outlier.alpha=.4) + theme_bw() +
  labs(title="Speed by dual_type", x="Dual type?", y="Speed")
save_plot(p_speed_dual, "figures/box_speed_by_dualtype.png")
```

```
## Saved: figures/box_speed_by_dualtype.png
```




```
tt_speed <- broom::tidy(t.test(speed ~ dual_type, data = pokemon))
save_tbl(tt_speed, "tables/t_test_speed_dualtype.csv")
```

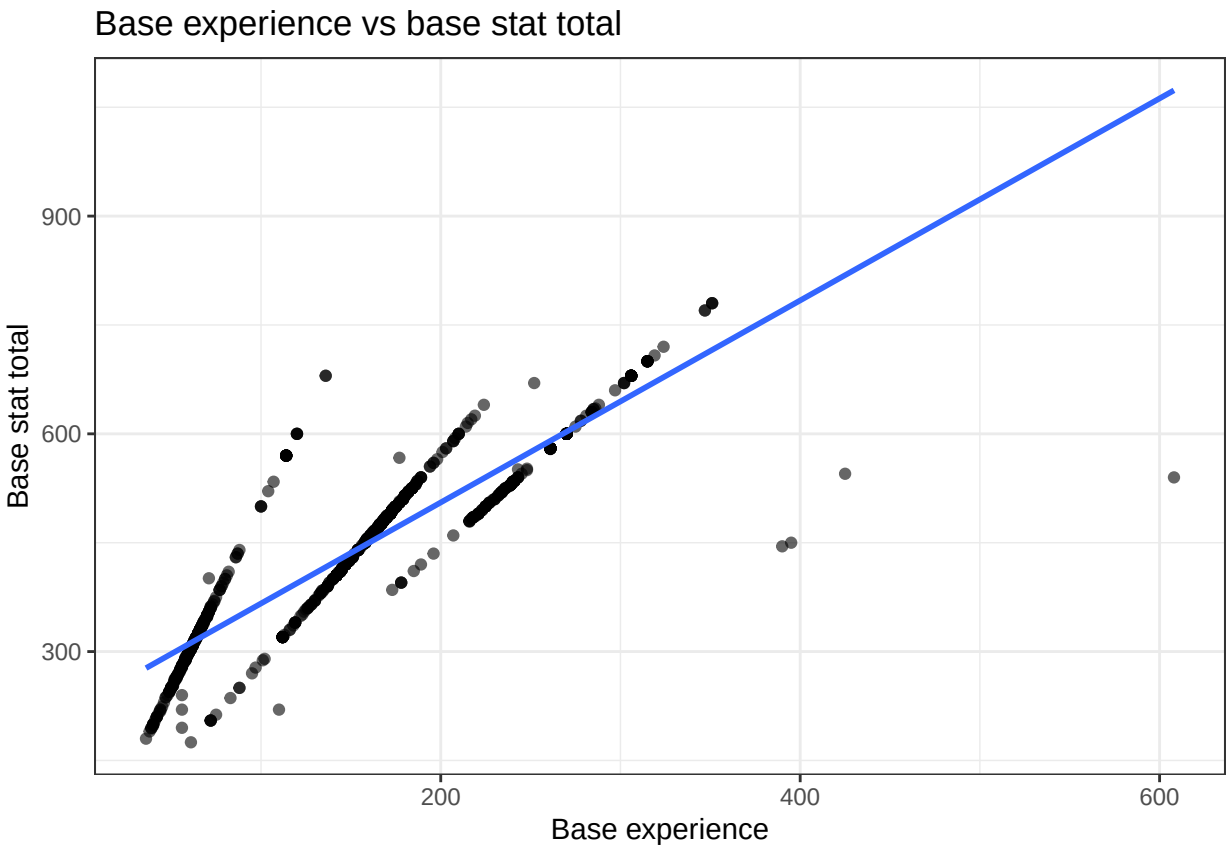
| estimate | estimate1 | estimate2 | statistic | p.value | parameter | conf.low | conf.high | method | alternative |
|---|---|---|---|---|---|---|---|---|---|
| -5.163 | 66.248 | 71.412 | -2.726 | 0.007 | 927.629 | -8.881 | -1.446 | Welch Two Sample t-test | two.sided |

```
# Base experience vs base stat total (scatter + OLS line)
p_exp_total <- ggplot(pokemon, aes(base_experience, base_stat_total)) +
  geom_point(alpha=.6) + geom_smooth(method="lm", se=FALSE) + theme_bw() +
  labs(title="Base experience vs base stat total", x="Base experience", y="Base stat total")
save_plot(p_exp_total, "figures/baseexp_vs_basetotal.png") ; p_exp_total
```

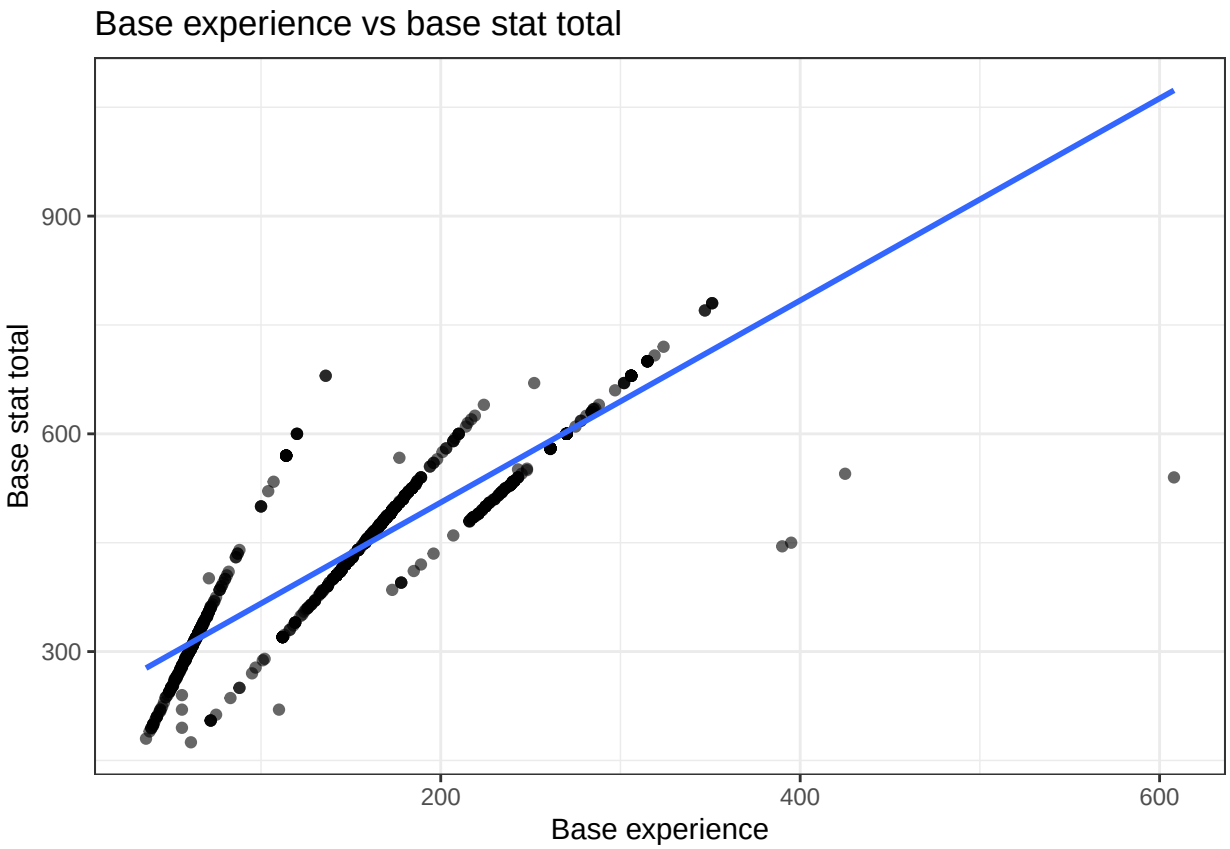
```
## `geom_smooth()` using formula = 'y ~ x'

## Saved: figures/baseexp_vs_basetotal.png

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




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

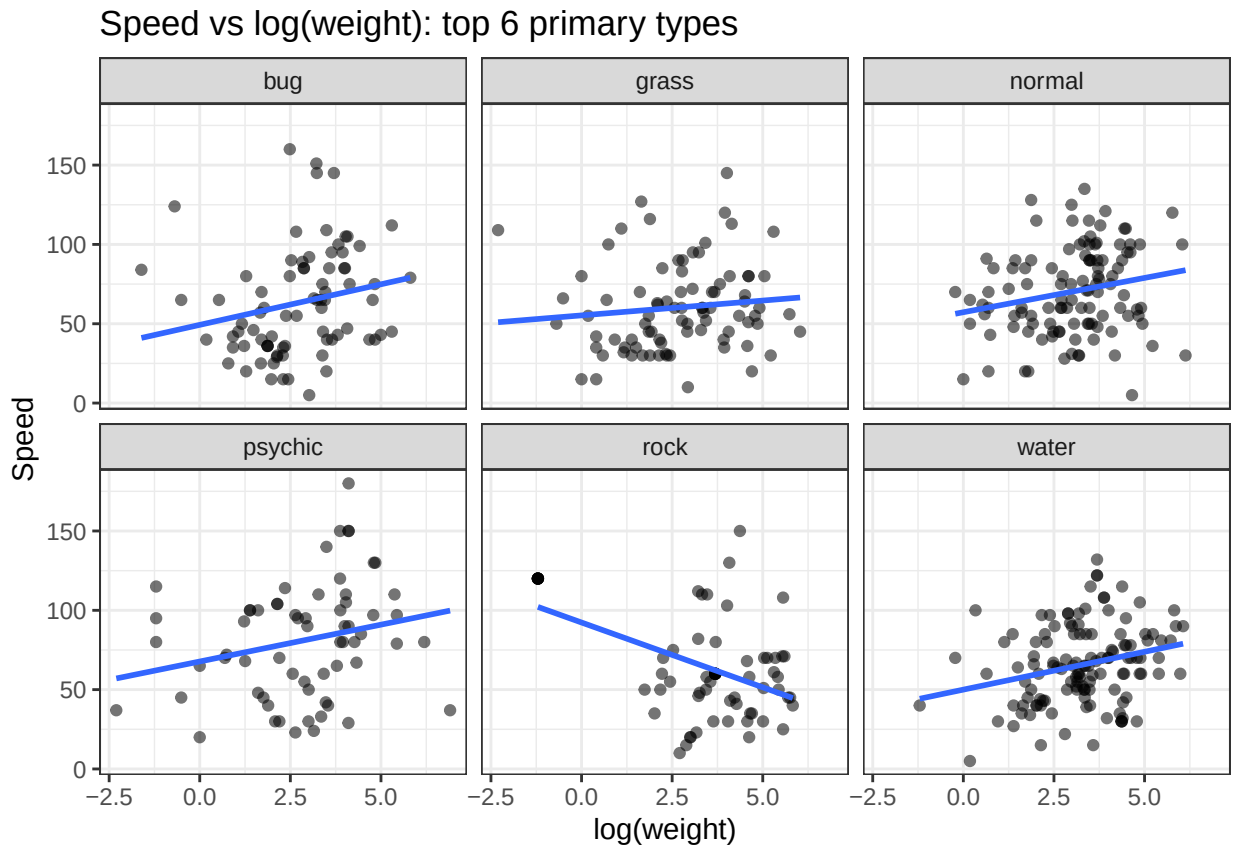



```
# Speed vs log(weight), faceted by top 6 primary types
top6 <- pokemon |> count(type_1) |> arrange(desc(n)) |> slice_head(n=6) |> pull(type_1)
p_speed_lw_facets <- pokemon |>
  filter(type_1 %in% top6, !is.na(log_weight)) |>
  ggplot(aes(log_weight, speed)) +
  geom_point(alpha=.55) + geom_smooth(method="lm", se=FALSE) +
  facet_wrap(~type_1, ncol=3) + theme_bw() +
  labs(title="Speed vs log(weight): top 6 primary types", x="log(weight)", y="Speed")
save_plot(p_speed_lw_facets, "figures/speed_vs_logweight_top6_types.png", w=9, h=6) ; p_speed_lw_facets
```

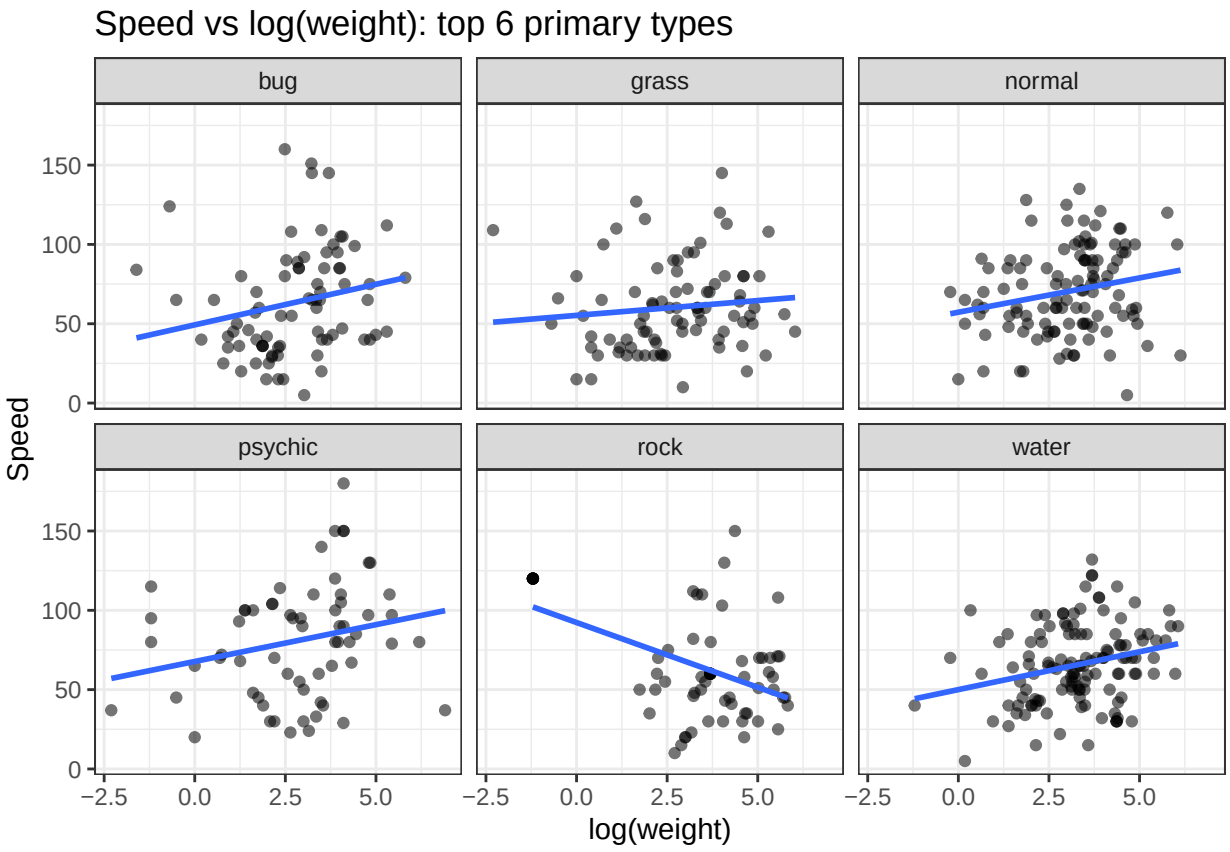
```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Saved: figures/speed_vs_logweight_top6_types.png
```

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




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


Speed vs log(weight): top 6 primary types
bug
grass
normal
psychic
rock
water
Speed
log(weight)
150
100
50
0
−2.5
0.0
2.5
5.0