MA679 Final Project - PT Data Analysis

Team 1

5/5/2020

Abstract

Physical therapy has always been an intriguing topic on the data end, because a lot of features in this field would be hard to quantify. As statisticians, we always wonder the relationship between different variables. With the data from our client, we can now better understand what it would take to make a successful therapy and thus carry out further analysis.

Introduction

In this project, our team wish to determine what attributes would best differentiate multiple clusters of patients and how they vary. In theory, this would help our clients better understand their overall patient audience, and potentially find niches they might not be aware of before.

We plan to perform unsupervised clustering methods including Autoencoders and K-Means Clustering to the PT patient data provided.

DATA CLEANING

Our data cleaning process is basically divided into 3 steps. Firstly, we looked into each column, detected and dealt with unusual values. Secondly, we determined the effectiveness of each therapeutic process based on the evaluation criteria of each outcome type. Specifically, we evaluated the effectiveness of pain reduction and the overall improvement. Then, we aggregated some therapy summaries which were logically duplicated, and reevaluated them by taking average.

i)

In the first step, we mainly worked on fixing typos, removing repeated rows, detected and fixed (or removed) problematic values. Typos are general problems caused by inconsistent upper/lower case spelling. And there are many special problems for each column, we analyzed and determined how to smooth the potential errors:

(a) We deleted the record with discharge date in June 2020.

(b) We deleted a 7-digit ROMS ID.

(c) We deleted the negative age and adjusted the inconsistent age based on earlier therapy record.

(d) We adjusted chronic pain as NA if values for chronic pain conflicted with itself.

(e) We fixed inconsistent admission date and discharge date. Particularly, holding other criteria constant (ID, classification, body region, outcome and admission date), if the discharge date varied, then we adjusted all the discharge dates to be the same as the last discharge date of this therapy. Similarly, holding other criteria constant (ID, classification, body region, outcome and discharge date), if the admission date varied, then we adjusted all the admission dates to be the same as the first admission date of this therapy.

(f) After the data cleaning steps mentioned above, we grouped the data by conditions including ROMS ID, Body Region, Outcome, Classification, Admission Date and Discharge Date. We defined each group of data as a combination of therapy records during one entire treatment process. Then we recounted visit times and the time(days) during one entire therapy.

(g) We removed the outcome scores that were out of range. The maximum possible value for LOWER EXTREMITY FUNC SCALE is 80, we eliminated the records for those LOWER EXTREMITY FUNC SCALE values larger than 80 (applied to either admission scores or discharge scores).

ii)

In the second step, we evaluated the effectiveness of pain reduction and the overall improvement of each treatment and gave binary scores to them.

(a) For pain result, if pain scores were reduced by at least 2 points, or reduced from less than 2 to 0, then pain reduction effectiveness was good, we assigned 1 to the result. Otherwise, we considered the therapy's effectiveness of pain reduction was not good, and we assigned 0 to the result.

(b) For overall outcome result, we needed to specify different criteria for different outcome types:

   (1) When outcome type was LOWER EXTREMITY FUNC SCALE, if the score increased at least 9 points or increased from larger than 71 to 80 (max), then we considered the treatment is effective overall, and we assigned the overall effect with score 1. Otherwise, we gave the overall effect with score 0.

   (2) when outcome type was KNEE OUTCOME SURVEY, if the score increased at least 9 points or increased from larger than 91 to 100 (max), then we considered the treatment is effective overall, and we assigned the overall effect with score 1. Otherwise, we gave the overall effect with score 0.

   (3) When outcome belongs to other 3 types, if the score decreased at least 10 points or decreased from less than 10 to 0 (minimum), then we considered the treatment is effective overall, and we assigned the overall effect with score 1. Otherwise, we gave the overall effect with score 0.

iii)

After those 2 steps, then we aggregated some therapy summaries and evaluated them by taking average. For the treatments with identical same ID, body region, classification and treatment time, if the categories of outcome are different, we took the average of the pain reduction effectiveness scores (1 or 0) and took the average of the effect for overall improvement (1 or 0). Since we aggregated some rows, some columns became invalid logically, so they are assigned NA.

[1] 3104

[1] 3651

EDA

Distribution of treatment duration given admission pain scores based on Outcome
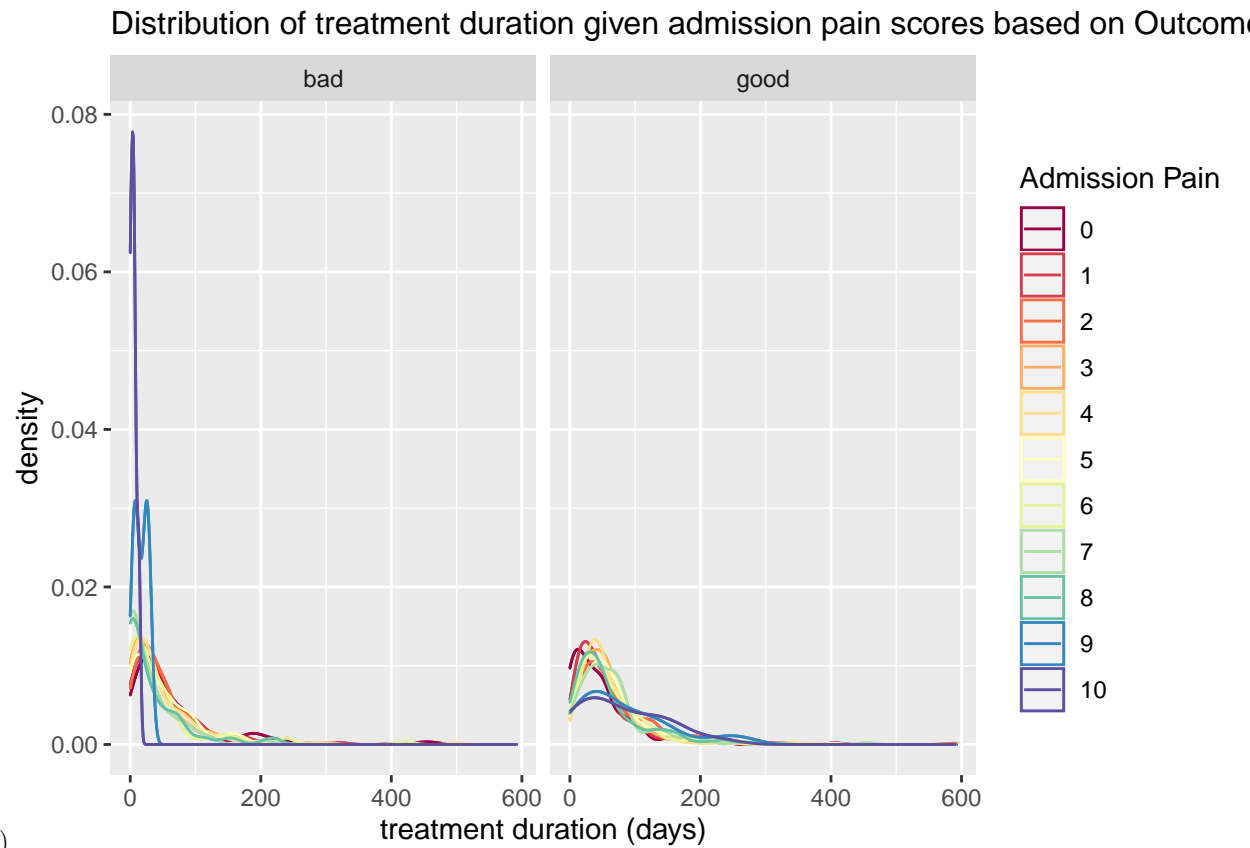

(needs comments)

From the plot on the left side, we can see that patients with higher admission pain score tend to have shorter durations which might be due to their change to surgery because of the bad outcome. On the other hand, for the good outcome score, patients with lower pain score would tend to stay for a certain amount of time because of the length of treatment. Patients with higher admission pain score would have longer treatment durations than others.

Association between Pain changes and Whether reach outcome Minimal Clinical Importa
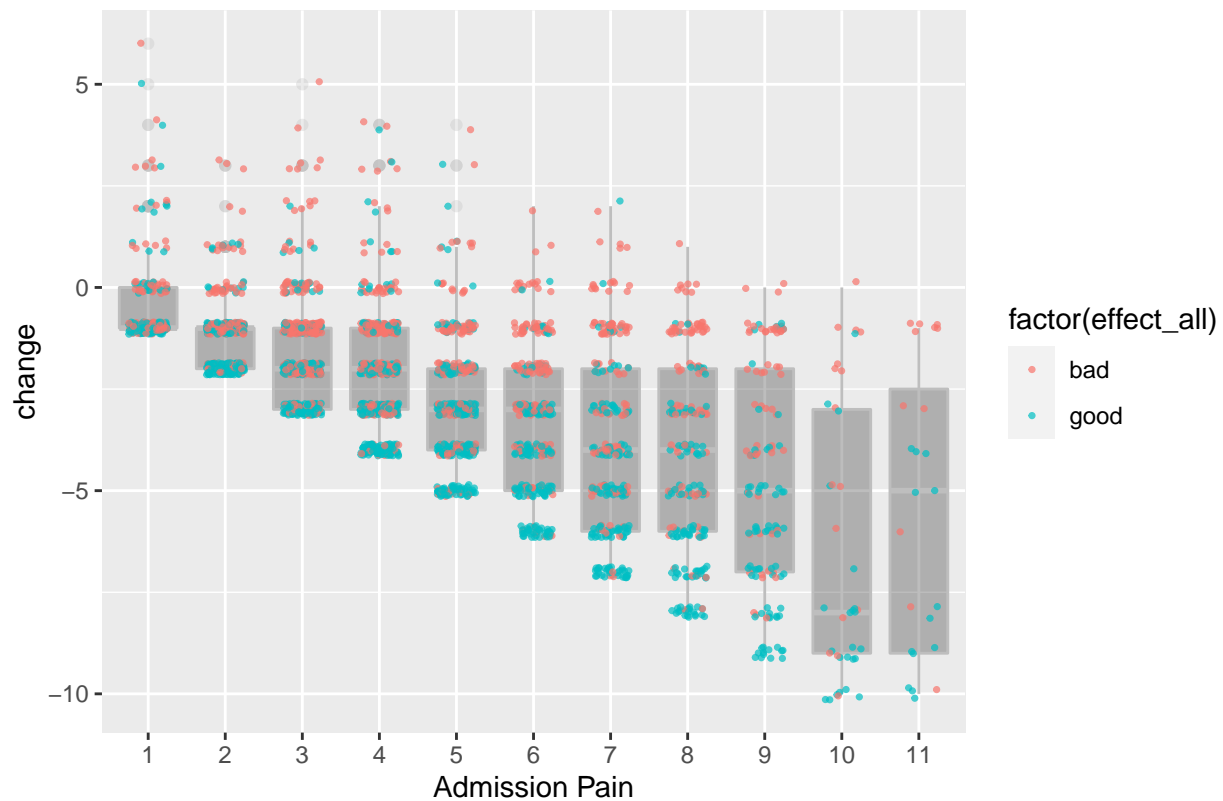
From this plot, we can see the change in pain score between the admission and discharge of patients. The closer to the right of the graph, the more pain the patient had when he/she first came to the treatment. And the lower half of the graph represents a declining of pain score implay an improvement in the condition from the therapy.

Surgical Vs. Non Surgical Injuries
by Chronic Pain
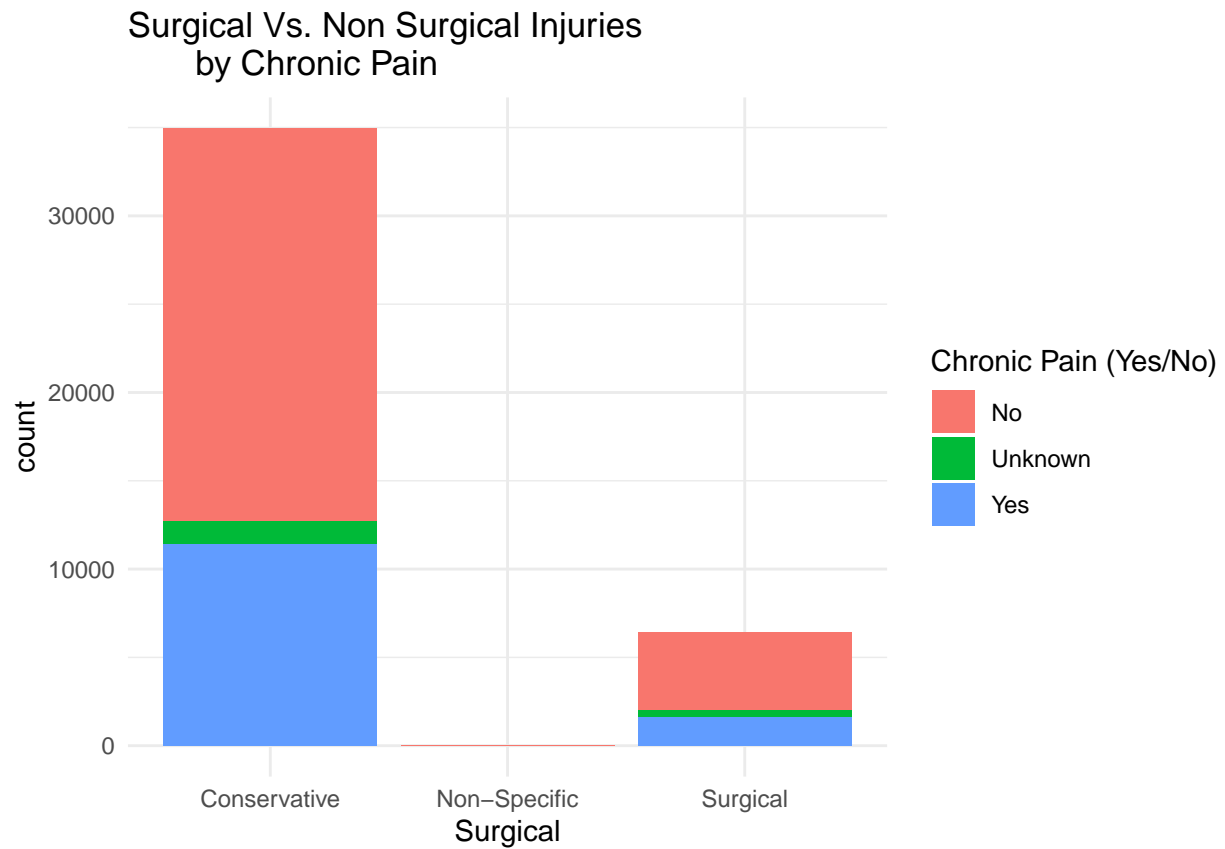
From this plot, surgical injuries did not necessarily have more to do with the chronic pain. However, this plot could not show enough details that we need so we plotted the chronic pain and surgical condition versus body regions in the next part.

Distribution of Body Region Injuries, Surgical Vs. Non – Surgical
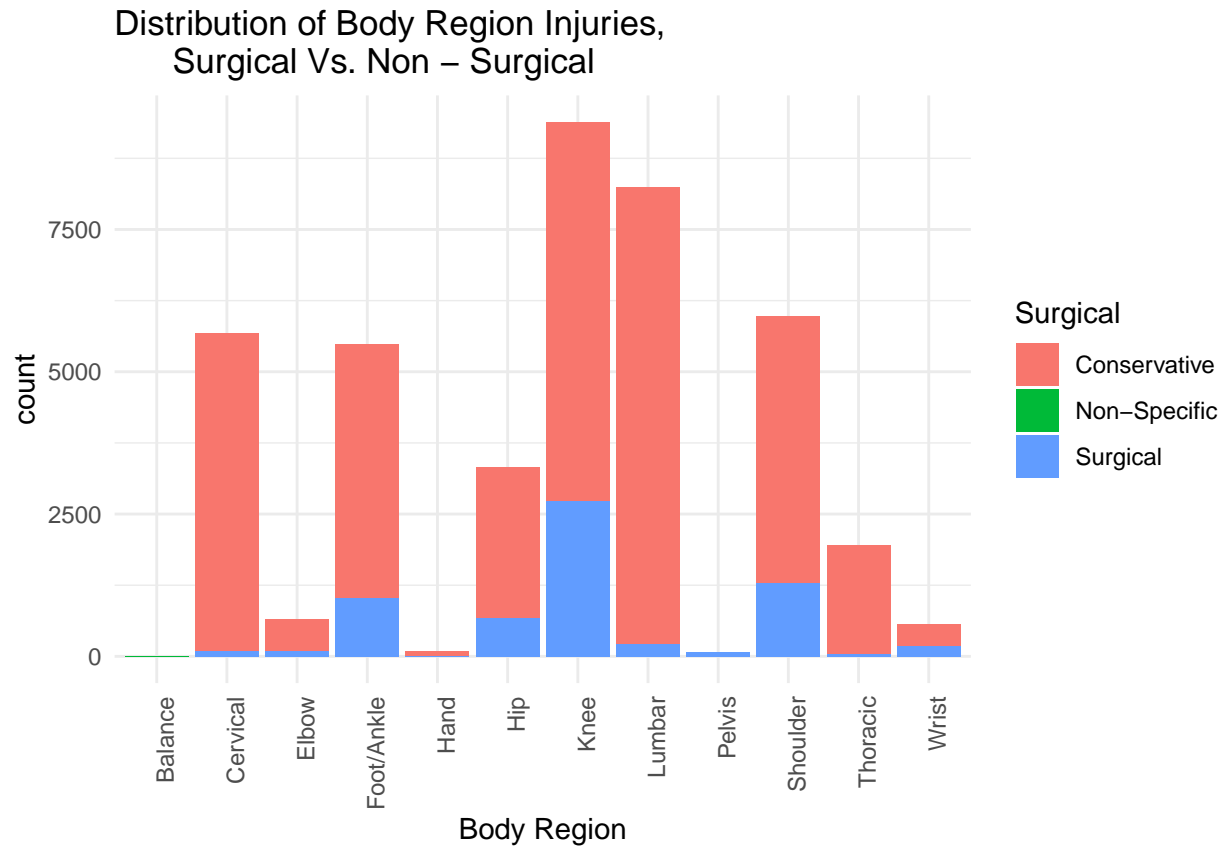
Overall, we can see that not many of the patients would take the surgery since most of them are seeking physical therapies. However, we observed that the highest proportion for body injuries for which the patient would take a surgery is a knee pain. Besides knee, we also noticed that foot/ankle and shoulder injuries would be more likely to result in a surgery than injuries in other body regions.

Distribution of Body Region Injuries,
Chronic vs. Not
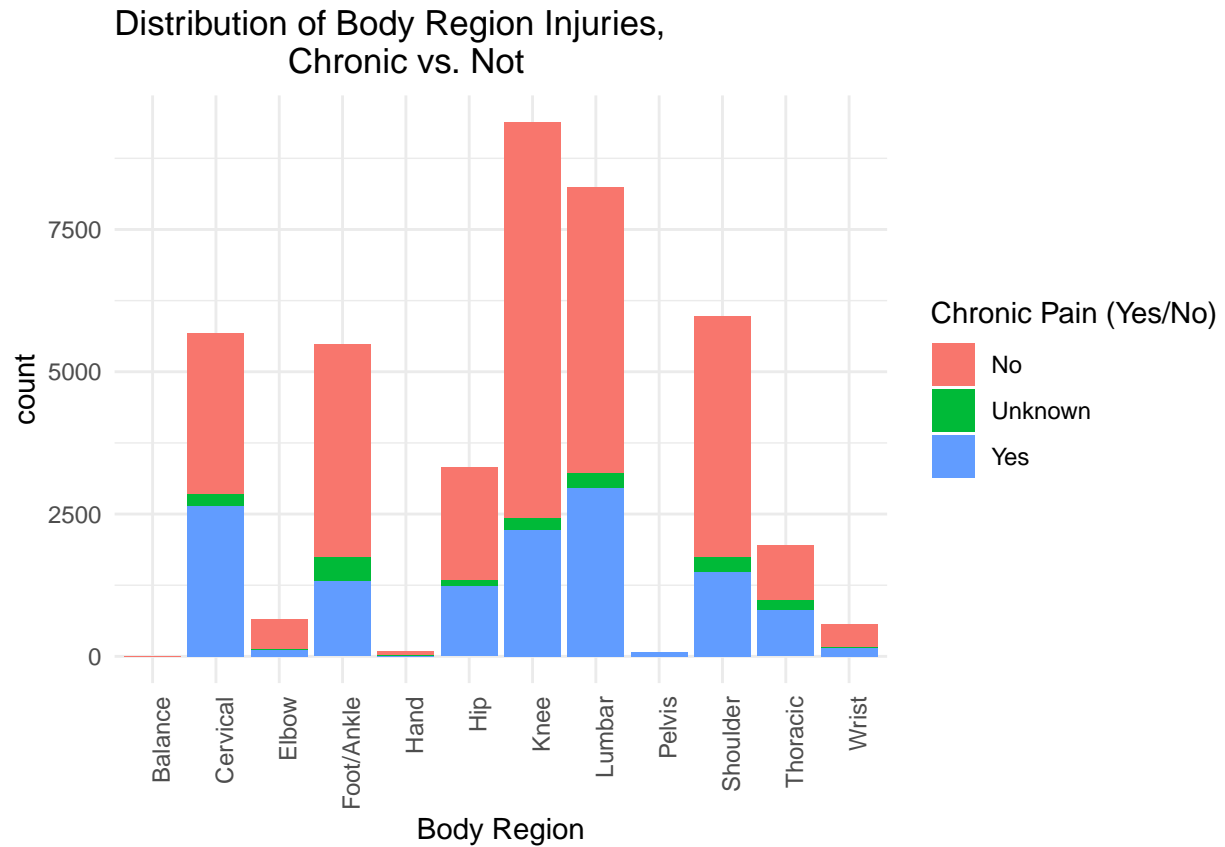
Injuries over most of body regions would result in a chronic pain more likely than taking a surgery. comparing to the former plot, the rise on the rate is obvious excpet for the body regions that were more likely to result in surgeries.

Patient Visit Numbers by Injury Body Region
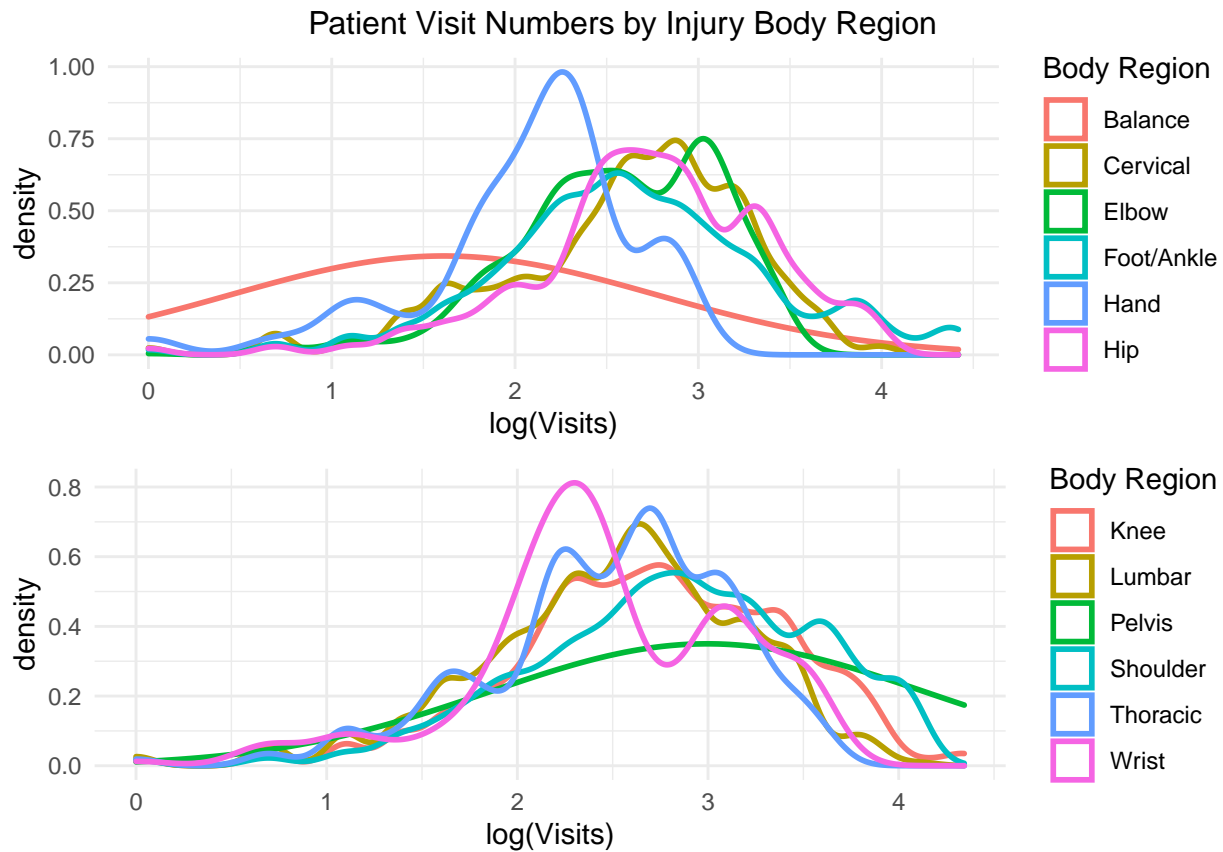
We used logrithm on the number of visits to arrange them on the same scale and we can see that most of visit by injury body region are around 2 to 3. The exponential of 2.5 is around 12 so we suppose that was a treatment phase. Noticeably, for injury at pelvis, the log of visit is more smoothly distributed throughout the region rather than had a densed range like other body regions. This might be helpful for our later analysis.

Autoencoder & K-means Clustering

Discussion & Conclusion

Appendix

Admission Pain and the Distribution of Body Region

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##  $ line                    :List of 6
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##   ..$ inherit.blank: logi TRUE
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##   ..$ linetype     : num 1
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##  $ text                    :List of 11
##   ..$ family       : chr ""
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##   ..$ size         : num 11
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##   ..$ vjust        : num 0.5
##   ..$ angle        : num 0
##   ..$ lineheight   : num 0.9
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
```
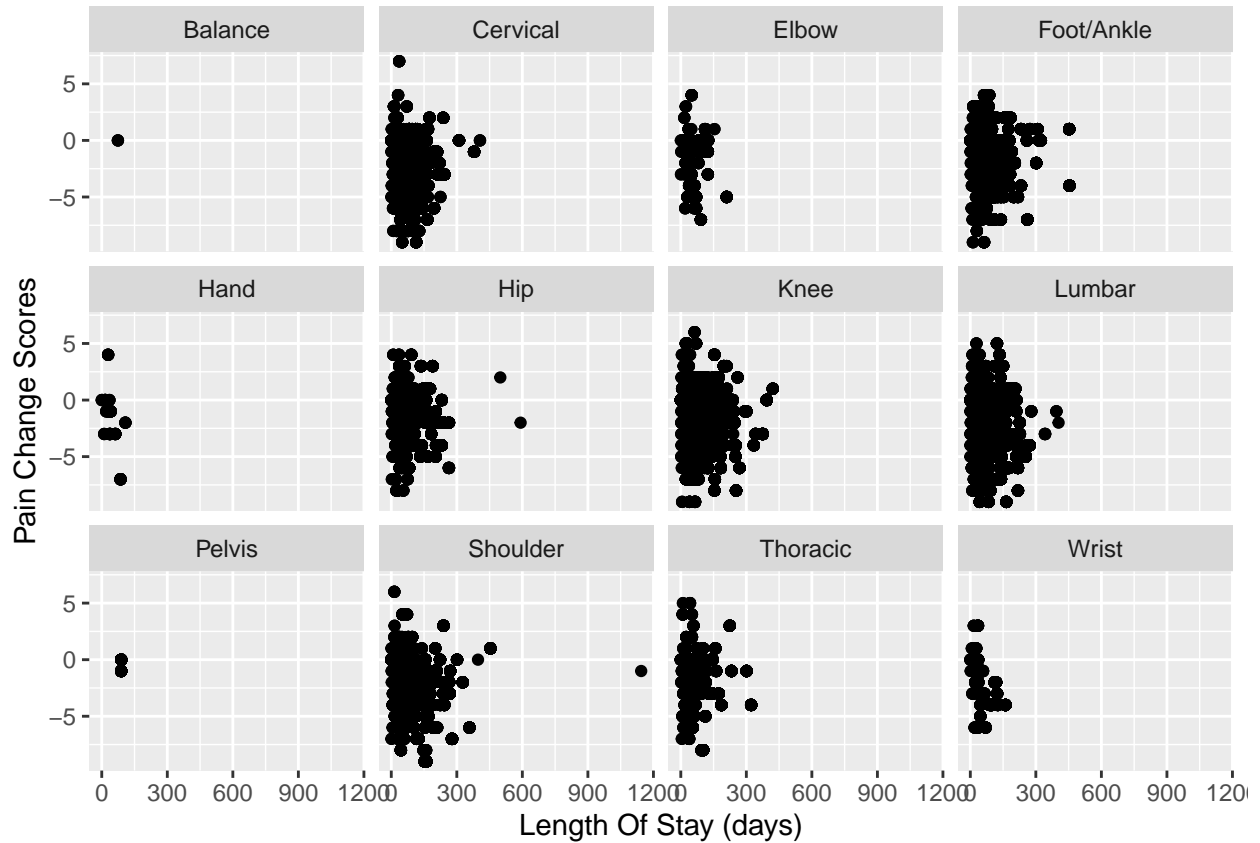
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## $ axis.title               : NULL
## $ axis.title.x             :List of 11
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##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : NULL
##   ..$ vjust       : num 1
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
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##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
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##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : NULL
##   ..$ vjust       : num 0
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 2.75pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
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##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.x.bottom      : NULL
## $ axis.title.y             :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : NULL
##   ..$ vjust       : num 1
##   ..$ angle       : num 90
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 2.75pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.y.left        : NULL
```

```
##  $ axis.title.y.right        :List of 11
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
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##   ..$ vjust        : num 0
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.75pt
##   .. ..- attr(*, "valid.unit")= int 8
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##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
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##   ..$ colour       : chr "grey30"
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##   ..$ vjust        : NULL
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##   ..$ lineheight   : NULL
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##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x              :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 2.2pt 0pt 0pt 0pt
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##   .. ..- attr(*, "unit")= chr "pt"
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##   ..$ colour       : NULL
##   ..$ size         : NULL
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##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 2.2pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
```

```
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## $ axis.text.y               :List of 11
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##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : num 1
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 2.2pt 0pt 0pt
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##    .. ..- attr(*, "unit")= chr "pt"
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##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
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## $ axis.text.y.right         :List of 11
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##    ..$ colour       : NULL
##    ..$ size         : NULL
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##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.2pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
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## $ axis.ticks                : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
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## $ axis.ticks.x.top          : NULL
## $ axis.ticks.x.bottom       : NULL
## $ axis.ticks.y              : NULL
## $ axis.ticks.y.left         : NULL
## $ axis.ticks.y.right        : NULL
## $ axis.ticks.length         : 'unit' num 2.75pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
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## $ axis.ticks.length.x.top   : NULL
## $ axis.ticks.length.x.bottom: NULL
## $ axis.ticks.length.y       : NULL
## $ axis.ticks.length.y.left  : NULL
## $ axis.ticks.length.y.right : NULL
## $ axis.line                 : list()
```

```
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## $ axis.line.y.right        : NULL
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##    ..- attr(*, "unit")= chr "pt"
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##    ..- attr(*, "unit")= chr "lines"
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## $ legend.key.width         : NULL
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##    ..$ family      : NULL
##    ..$ face        : NULL
##    ..$ colour      : NULL
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##    ..$ hjust       : NULL
##    ..$ vjust       : NULL
##    ..$ angle       : NULL
##    ..$ lineheight  : NULL
##    ..$ margin      : NULL
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## $ legend.title             :List of 11
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##    ..$ face        : NULL
##    ..$ colour      : NULL
##    ..$ size        : NULL
##    ..$ hjust       : num 0
##    ..$ vjust       : NULL
##    ..$ angle       : NULL
##    ..$ lineheight  : NULL
##    ..$ margin      : NULL
##    ..$ debug       : NULL
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## $ legend.direction         : NULL
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##  $ panel.spacing.y          : NULL
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```

```
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##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
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##   .. ..- attr(*, "unit")= chr "pt"
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##   ..$ vjust        : num 0.5
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##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
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## $ plot.margin               : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
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##   ..- attr(*, "unit")= chr "pt"
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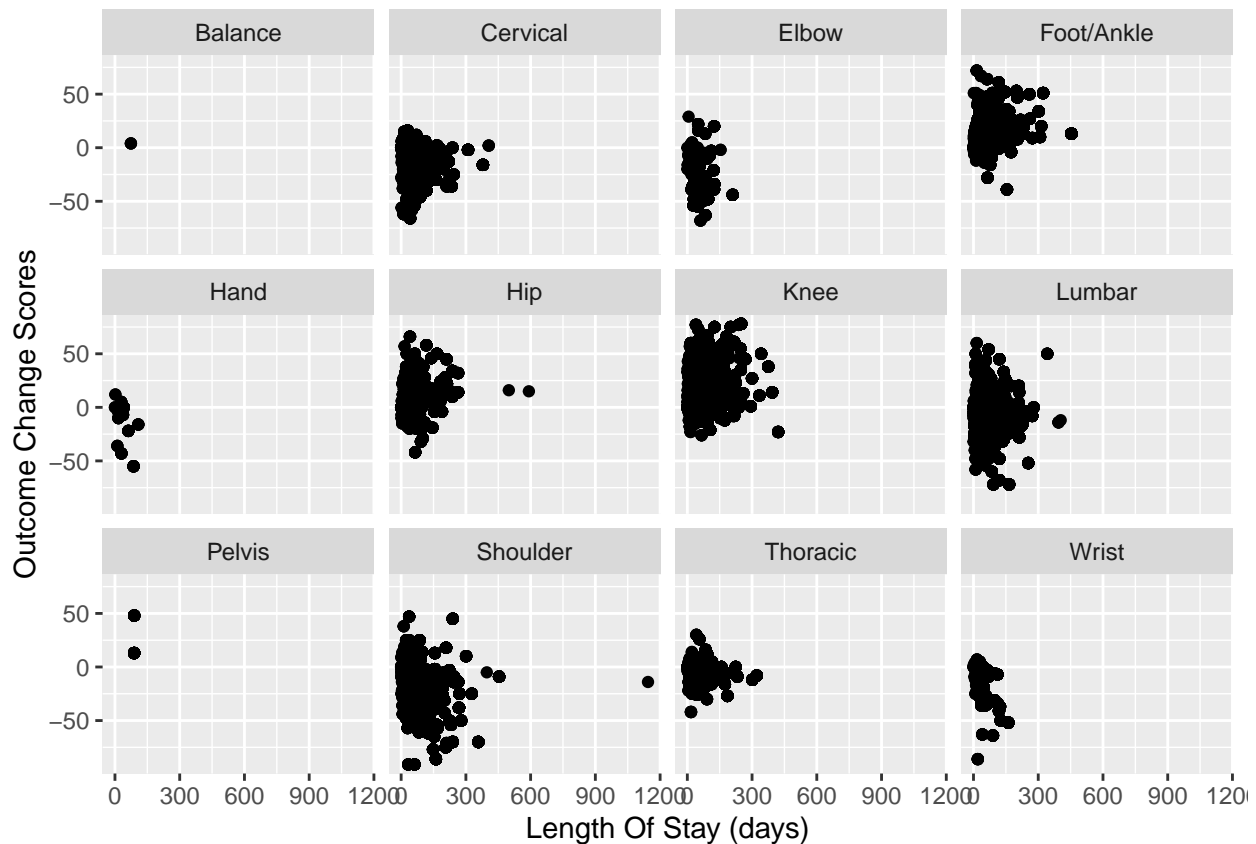
```
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##   ..$ vjust        : NULL
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##   ..$ family       : NULL
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##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
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##   ..- attr(*, "unit")= chr "pt"
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##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
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##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
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##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
```

```
##   - attr(*, "complete")= logi TRUE
##   - attr(*, "validate")= logi TRUE
```



```
## List of 93
##  $ line                      :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ rect                      :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                      :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
##   ..$ size         : num 11
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : num 0
```

```
##    ..$ lineheight   : num 0.9
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : logi FALSE
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ title                  : NULL
##  $ aspect.ratio           : NULL
##  $ axis.title             : NULL
##  $ axis.title.x           :List of 11
##    ..$ family     : NULL
##    ..$ face       : NULL
##    ..$ colour     : NULL
##    ..$ size       : NULL
##    ..$ hjust      : NULL
##    ..$ vjust      : num 1
##    ..$ angle      : NULL
##    ..$ lineheight : NULL
##    ..$ margin     : 'margin' num [1:4] 2.75pt 0pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug      : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x.top       :List of 11
##    ..$ family     : NULL
##    ..$ face       : NULL
##    ..$ colour     : NULL
##    ..$ size       : NULL
##    ..$ hjust      : NULL
##    ..$ vjust      : num 0
##    ..$ angle      : NULL
##    ..$ lineheight : NULL
##    ..$ margin     : 'margin' num [1:4] 0pt 0pt 2.75pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug      : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.x.bottom    : NULL
##  $ axis.title.y           :List of 11
##    ..$ family     : NULL
##    ..$ face       : NULL
##    ..$ colour     : NULL
##    ..$ size       : NULL
##    ..$ hjust      : NULL
##    ..$ vjust      : num 1
##    ..$ angle      : num 90
##    ..$ lineheight : NULL
##    ..$ margin     : 'margin' num [1:4] 0pt 2.75pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug      : NULL
```

```
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.y.left        : NULL
## $ axis.title.y.right       :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 0
##    ..$ angle        : num -90
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.75pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text                :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : chr "grey30"
##    ..$ size         : 'rel' num 0.8
##    ..$ hjust        : NULL
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.x              :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 1
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 2.2pt 0pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.x.top          :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 0
##    ..$ angle        : NULL
```

```
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 2.2pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x.bottom       : NULL
##  $ axis.text.y              :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : num 1
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 2.2pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.y.left         : NULL
##  $ axis.text.y.right        :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : num 0
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.2pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.ticks               : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ axis.ticks.x             : NULL
##  $ axis.ticks.x.top         : NULL
##  $ axis.ticks.x.bottom      : NULL
##  $ axis.ticks.y             : NULL
##  $ axis.ticks.y.left        : NULL
##  $ axis.ticks.y.right       : NULL
##  $ axis.ticks.length        : 'unit' num 2.75pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
##  $ axis.ticks.length.x       : NULL
##  $ axis.ticks.length.x.top   : NULL
##  $ axis.ticks.length.x.bottom: NULL
##  $ axis.ticks.length.y       : NULL
```

```
##   $ axis.ticks.length.y.left  : NULL
##   $ axis.ticks.length.y.right : NULL
##   $ axis.line                 : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ axis.line.x               : NULL
##   $ axis.line.x.top           : NULL
##   $ axis.line.x.bottom        : NULL
##   $ axis.line.y               : NULL
##   $ axis.line.y.left          : NULL
##   $ axis.line.y.right         : NULL
##   $ legend.background         : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ legend.margin             : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
##   $ legend.spacing            : 'unit' num 11pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
##   $ legend.spacing.x          : NULL
##   $ legend.spacing.y          : NULL
##   $ legend.key                : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ legend.key.size           : 'unit' num 1.2lines
##    ..- attr(*, "valid.unit")= int 3
##    ..- attr(*, "unit")= chr "lines"
##   $ legend.key.height         : NULL
##   $ legend.key.width          : NULL
##   $ legend.text               :List of 11
##    ..$ family      : NULL
##    ..$ face        : NULL
##    ..$ colour      : NULL
##    ..$ size        : 'rel' num 0.8
##    ..$ hjust       : NULL
##    ..$ vjust       : NULL
##    ..$ angle       : NULL
##    ..$ lineheight  : NULL
##    ..$ margin      : NULL
##    ..$ debug       : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##   $ legend.text.align         : NULL
##   $ legend.title              :List of 11
##    ..$ family      : NULL
##    ..$ face        : NULL
##    ..$ colour      : NULL
##    ..$ size        : NULL
##    ..$ hjust       : num 0
##    ..$ vjust       : NULL
##    ..$ angle       : NULL
##    ..$ lineheight  : NULL
##    ..$ margin      : NULL
##    ..$ debug       : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
```

```
##  $ legend.title.align      : NULL
##  $ legend.position         : chr "right"
##  $ legend.direction        : NULL
##  $ legend.justification     : chr "center"
##  $ legend.box              : NULL
##  $ legend.box.just         : NULL
##  $ legend.box.margin       : 'margin' num [1:4] 0cm 0cm 0cm 0cm
##   ..- attr(*, "valid.unit")= int 1
##   ..- attr(*, "unit")= chr "cm"
##  $ legend.box.background    : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.box.spacing       : 'unit' num 11pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ panel.background         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.border            : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ panel.spacing           : 'unit' num 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ panel.spacing.x         : NULL
##  $ panel.spacing.y         : NULL
##  $ panel.grid              :List of 6
##   ..$ colour     : chr "grey92"
##   ..$ size       : NULL
##   ..$ linetype   : NULL
##   ..$ lineend    : NULL
##   ..$ arrow      : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ panel.grid.major        : NULL
##  $ panel.grid.minor        :List of 6
##   ..$ colour     : NULL
##   ..$ size       : 'rel' num 0.5
##   ..$ linetype   : NULL
##   ..$ lineend    : NULL
##   ..$ arrow      : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ panel.grid.major.x      : NULL
##  $ panel.grid.major.y      : NULL
##  $ panel.grid.minor.x      : NULL
##  $ panel.grid.minor.y      : NULL
##  $ panel.ontop             : logi FALSE
##  $ plot.background         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ plot.title              :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : 'rel' num 1.2
##   ..$ hjust      : num 0
##   ..$ vjust      : num 1
```

```
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.title.position     : chr "panel"
## $ plot.subtitle           :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : num 0
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.caption            :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 0.8
##   ..$ hjust        : num 1
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 5.5pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.caption.position   : chr "panel"
## $ plot.tag                :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 1.2
##   ..$ hjust        : num 0.5
##   ..$ vjust        : num 0.5
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.tag.position       : chr "topleft"
```
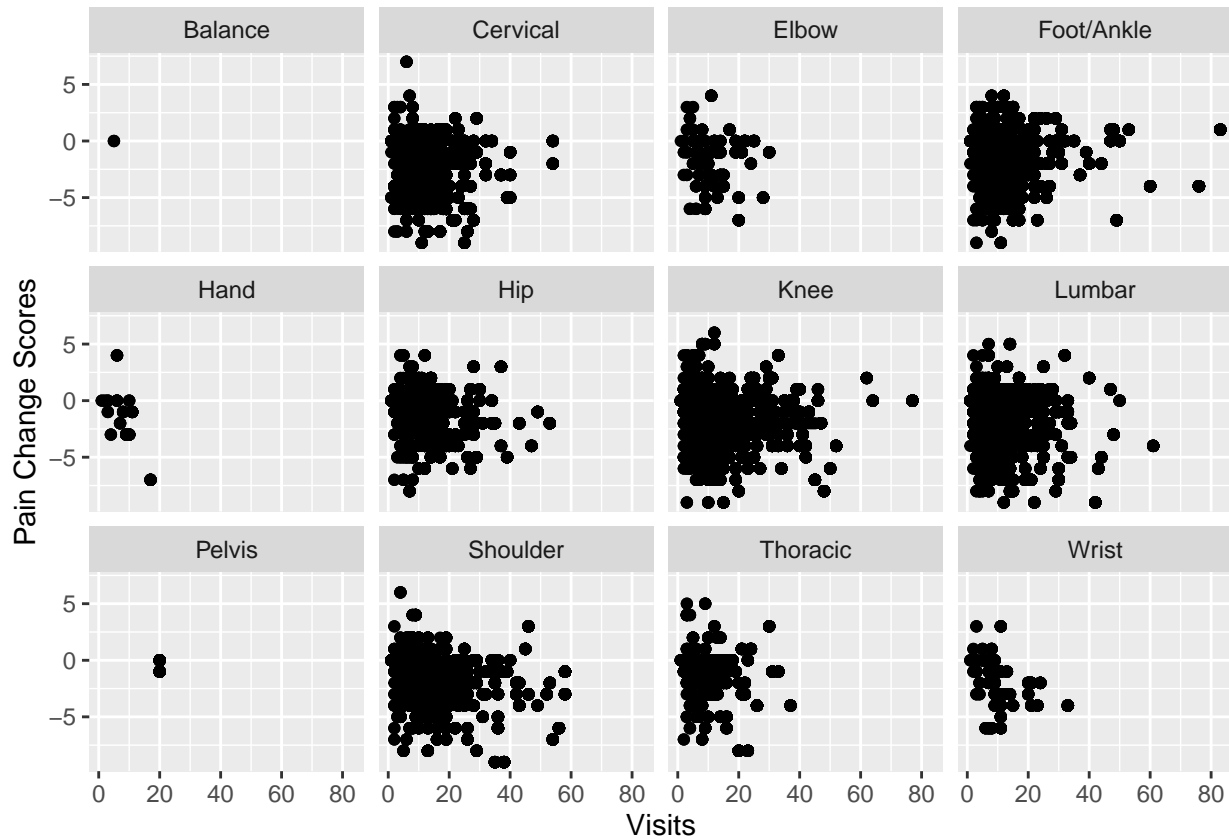
```
##  $ plot.margin               : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ strip.background          : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ strip.background.x        : NULL
##  $ strip.background.y        : NULL
##  $ strip.placement           : chr "inside"
##  $ strip.text                :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey10"
##   ..$ size         : 'rel' num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 4.4pt 4.4pt 4.4pt 4.4pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.text.x              : NULL
##  $ strip.text.y              :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ strip.switch.pad.grid     : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ strip.switch.pad.wrap     : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ strip.text.y.left         :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
```

```
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```



```
## List of 93
##  $ line                  :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ rect                  :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                  :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
##   ..$ size         : num 11
##   ..$ hjust        : num 0.5
```

```
##   ..$ vjust      : num 0.5
##   ..$ angle      : num 0
##   ..$ lineheight : num 0.9
##   ..$ margin     : 'margin' num [1:4] 0pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ title                  : NULL
## $ aspect.ratio           : NULL
## $ axis.title             : NULL
## $ axis.title.x           :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : NULL
##   ..$ vjust      : num 1
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 2.75pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.x.top       :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : NULL
##   ..$ vjust      : num 0
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 0pt 0pt 2.75pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.x.bottom    : NULL
## $ axis.title.y           :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : NULL
##   ..$ vjust      : num 1
##   ..$ angle      : num 90
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 0pt 2.75pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
```

```
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y.left        : NULL
##  $ axis.title.y.right       :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 0
##    ..$ angle        : num -90
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.75pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text               :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : chr "grey30"
##    ..$ size         : 'rel' num 0.8
##    ..$ hjust        : NULL
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x             :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 1
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 2.2pt 0pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x.top         :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
```

```
##   ..$ vjust       : num 0
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 2.2pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.x.bottom       : NULL
## $ axis.text.y              :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : num 1
##   ..$ vjust       : NULL
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 2.2pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.y.left         : NULL
## $ axis.text.y.right        :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : num 0
##   ..$ vjust       : NULL
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 0pt 2.2pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.ticks               : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ axis.ticks.x             : NULL
## $ axis.ticks.x.top         : NULL
## $ axis.ticks.x.bottom      : NULL
## $ axis.ticks.y             : NULL
## $ axis.ticks.y.left        : NULL
## $ axis.ticks.y.right       : NULL
## $ axis.ticks.length        : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ axis.ticks.length.x      : NULL
## $ axis.ticks.length.x.top  : NULL
```

```
##   $ axis.ticks.length.x.bottom: NULL
##   $ axis.ticks.length.y        : NULL
##   $ axis.ticks.length.y.left   : NULL
##   $ axis.ticks.length.y.right  : NULL
##   $ axis.line                  : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ axis.line.x                : NULL
##   $ axis.line.x.top            : NULL
##   $ axis.line.x.bottom         : NULL
##   $ axis.line.y                : NULL
##   $ axis.line.y.left           : NULL
##   $ axis.line.y.right          : NULL
##   $ legend.background          : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ legend.margin              : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
##   $ legend.spacing             : 'unit' num 11pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
##   $ legend.spacing.x           : NULL
##   $ legend.spacing.y           : NULL
##   $ legend.key                 : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##   $ legend.key.size            : 'unit' num 1.2lines
##    ..- attr(*, "valid.unit")= int 3
##    ..- attr(*, "unit")= chr "lines"
##   $ legend.key.height          : NULL
##   $ legend.key.width           : NULL
##   $ legend.text                :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : 'rel' num 0.8
##    ..$ hjust        : NULL
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##   $ legend.text.align          : NULL
##   $ legend.title               :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : num 0
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
```

```
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ legend.title.align       : NULL
## $ legend.position          : chr "right"
## $ legend.direction         : NULL
## $ legend.justification     : chr "center"
## $ legend.box               : NULL
## $ legend.box.just          : NULL
## $ legend.box.margin        : 'margin' num [1:4] 0cm 0cm 0cm 0cm
##   ..- attr(*, "valid.unit")= int 1
##   ..- attr(*, "unit")= chr "cm"
## $ legend.box.background     : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ legend.box.spacing        : 'unit' num 11pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ panel.background          : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ panel.border             : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ panel.spacing            : 'unit' num 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ panel.spacing.x          : NULL
## $ panel.spacing.y          : NULL
## $ panel.grid               :List of 6
##   ..$ colour      : chr "grey92"
##   ..$ size        : NULL
##   ..$ linetype    : NULL
##   ..$ lineend     : NULL
##   ..$ arrow       : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
## $ panel.grid.major         : NULL
## $ panel.grid.minor         :List of 6
##   ..$ colour      : NULL
##   ..$ size        : 'rel' num 0.5
##   ..$ linetype    : NULL
##   ..$ lineend     : NULL
##   ..$ arrow       : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
## $ panel.grid.major.x       : NULL
## $ panel.grid.major.y       : NULL
## $ panel.grid.minor.x       : NULL
## $ panel.grid.minor.y       : NULL
## $ panel.ontop              : logi FALSE
## $ plot.background          : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ plot.title               :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : 'rel' num 1.2
```

```
##   ..$ hjust      : num 0
##   ..$ vjust      : num 1
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.title.position    : chr "panel"
## $ plot.subtitle          :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : num 0
##   ..$ vjust      : num 1
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.caption           :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : 'rel' num 0.8
##   ..$ hjust      : num 1
##   ..$ vjust      : num 1
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 5.5pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.caption.position  : chr "panel"
## $ plot.tag               :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : 'rel' num 1.2
##   ..$ hjust      : num 0.5
##   ..$ vjust      : num 0.5
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : NULL
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
```
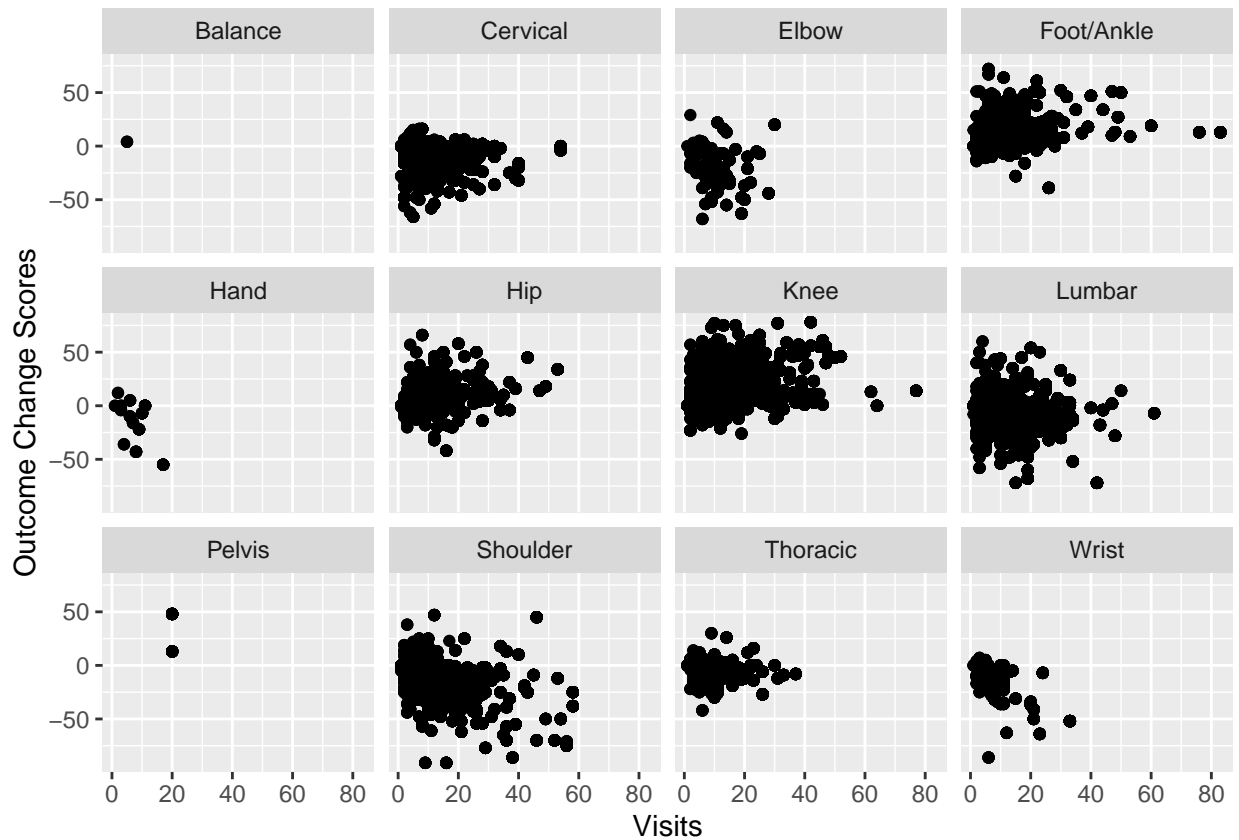
```
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.tag.position        : chr "topleft"
## $ plot.margin              : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##    ..- attr(*, "valid.unit")= int 8
##    ..- attr(*, "unit")= chr "pt"
## $ strip.background         : list()
##    ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ strip.background.x       : NULL
## $ strip.background.y       : NULL
## $ strip.placement          : chr "inside"
## $ strip.text               :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : chr "grey10"
##   ..$ size       : 'rel' num 0.8
##   ..$ hjust      : NULL
##   ..$ vjust      : NULL
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : 'margin' num [1:4] 4.4pt 4.4pt 4.4pt 4.4pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ strip.text.x             : NULL
## $ strip.text.y             :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : NULL
##   ..$ vjust      : NULL
##   ..$ angle      : num -90
##   ..$ lineheight : NULL
##   ..$ margin     : NULL
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ strip.switch.pad.grid    : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ strip.switch.pad.wrap    : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ strip.text.y.left        :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : NULL
##   ..$ vjust      : NULL
##   ..$ angle      : num 90
##   ..$ lineheight : NULL
```

```
##    ..$ margin        : NULL
##    ..$ debug         : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```



```
## List of 93
##  $ line                    :List of 6
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ lineend      : chr "butt"
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
##  $ rect                    :List of 5
##   ..$ fill         : chr "white"
##   ..$ colour       : chr "black"
##   ..$ size         : num 0.5
##   ..$ linetype     : num 1
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_rect" "element"
##  $ text                    :List of 11
##   ..$ family       : chr ""
##   ..$ face         : chr "plain"
##   ..$ colour       : chr "black"
```

```
##   ..$ size        : num 11
##   ..$ hjust       : num 0.5
##   ..$ vjust       : num 0.5
##   ..$ angle       : num 0
##   ..$ lineheight   : num 0.9
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ title                   : NULL
## $ aspect.ratio            : NULL
## $ axis.title              : NULL
## $ axis.title.x            :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 2.75pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.x.top        :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 0
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 0pt 0pt 2.75pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.title.x.bottom     : NULL
## $ axis.title.y            :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : num 1
##   ..$ angle        : num 90
##   ..$ lineheight   : NULL
```

```
##    ..$ margin       : 'margin' num [1:4] 0pt 2.75pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.title.y.left        : NULL
##  $ axis.title.y.right       :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 0
##    ..$ angle        : num -90
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 0pt 0pt 0pt 2.75pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text                :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : chr "grey30"
##    ..$ size         : 'rel' num 0.8
##    ..$ hjust        : NULL
##    ..$ vjust        : NULL
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x              :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
##    ..$ size         : NULL
##    ..$ hjust        : NULL
##    ..$ vjust        : num 1
##    ..$ angle        : NULL
##    ..$ lineheight   : NULL
##    ..$ margin       : 'margin' num [1:4] 2.2pt 0pt 0pt 0pt
##    .. ..- attr(*, "valid.unit")= int 8
##    .. ..- attr(*, "unit")= chr "pt"
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ axis.text.x.top          :List of 11
##    ..$ family       : NULL
##    ..$ face         : NULL
##    ..$ colour       : NULL
```

```
##   ..$ size        : NULL
##   ..$ hjust       : NULL
##   ..$ vjust       : num 0
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 2.2pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.x.bottom      : NULL
## $ axis.text.y             :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : num 1
##   ..$ vjust       : NULL
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 2.2pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.text.y.left        : NULL
## $ axis.text.y.right       :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : num 0
##   ..$ vjust       : NULL
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 0pt 2.2pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ axis.ticks              : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ axis.ticks.x            : NULL
## $ axis.ticks.x.top        : NULL
## $ axis.ticks.x.bottom     : NULL
## $ axis.ticks.y            : NULL
## $ axis.ticks.y.left       : NULL
## $ axis.ticks.y.right      : NULL
## $ axis.ticks.length       : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
```

```
##  $ axis.ticks.length.x        : NULL
##  $ axis.ticks.length.x.top    : NULL
##  $ axis.ticks.length.x.bottom: NULL
##  $ axis.ticks.length.y        : NULL
##  $ axis.ticks.length.y.left   : NULL
##  $ axis.ticks.length.y.right  : NULL
##  $ axis.line                  : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ axis.line.x                : NULL
##  $ axis.line.x.top            : NULL
##  $ axis.line.x.bottom         : NULL
##  $ axis.line.y                : NULL
##  $ axis.line.y.left           : NULL
##  $ axis.line.y.right          : NULL
##  $ legend.background          : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.margin              : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ legend.spacing             : 'unit' num 11pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
##  $ legend.spacing.x           : NULL
##  $ legend.spacing.y           : NULL
##  $ legend.key                 : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
##  $ legend.key.size            : 'unit' num 1.2lines
##   ..- attr(*, "valid.unit")= int 3
##   ..- attr(*, "unit")= chr "lines"
##  $ legend.key.height          : NULL
##  $ legend.key.width           : NULL
##  $ legend.text                :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : 'rel' num 0.8
##   ..$ hjust      : NULL
##   ..$ vjust      : NULL
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
##   ..$ margin     : NULL
##   ..$ debug      : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ legend.text.align          : NULL
##  $ legend.title               :List of 11
##   ..$ family     : NULL
##   ..$ face       : NULL
##   ..$ colour     : NULL
##   ..$ size       : NULL
##   ..$ hjust      : num 0
##   ..$ vjust      : NULL
##   ..$ angle      : NULL
##   ..$ lineheight : NULL
```

```
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ legend.title.align     : NULL
## $ legend.position        : chr "right"
## $ legend.direction       : NULL
## $ legend.justification   : chr "center"
## $ legend.box             : NULL
## $ legend.box.just        : NULL
## $ legend.box.margin      : 'margin' num [1:4] 0cm 0cm 0cm 0cm
##   ..- attr(*, "valid.unit")= int 1
##   ..- attr(*, "unit")= chr "cm"
## $ legend.box.background   : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ legend.box.spacing      : 'unit' num 11pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ panel.background        : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ panel.border            : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ panel.spacing           : 'unit' num 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ panel.spacing.x         : NULL
## $ panel.spacing.y         : NULL
## $ panel.grid              :List of 6
##   ..$ colour       : chr "grey92"
##   ..$ size         : NULL
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
## $ panel.grid.major        : NULL
## $ panel.grid.minor        :List of 6
##   ..$ colour       : NULL
##   ..$ size         : 'rel' num 0.5
##   ..$ linetype     : NULL
##   ..$ lineend      : NULL
##   ..$ arrow        : logi FALSE
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_line" "element"
## $ panel.grid.major.x      : NULL
## $ panel.grid.major.y      : NULL
## $ panel.grid.minor.x      : NULL
## $ panel.grid.minor.y      : NULL
## $ panel.ontop             : logi FALSE
## $ plot.background         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ plot.title              :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
```

```
##   ..$ colour      : NULL
##   ..$ size        : 'rel' num 1.2
##   ..$ hjust       : num 0
##   ..$ vjust       : num 1
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.title.position     : chr "panel"
##  $ plot.subtitle           :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : NULL
##   ..$ hjust       : num 0
##   ..$ vjust       : num 1
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 0pt 0pt 5.5pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.caption            :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : 'rel' num 0.8
##   ..$ hjust       : num 1
##   ..$ vjust       : num 1
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : 'margin' num [1:4] 5.5pt 0pt 0pt 0pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug       : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  $ plot.caption.position   : chr "panel"
##  $ plot.tag                :List of 11
##   ..$ family      : NULL
##   ..$ face        : NULL
##   ..$ colour      : NULL
##   ..$ size        : 'rel' num 1.2
##   ..$ hjust       : num 0.5
##   ..$ vjust       : num 0.5
##   ..$ angle       : NULL
##   ..$ lineheight  : NULL
##   ..$ margin      : NULL
```

```
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ plot.tag.position        : chr "topleft"
## $ plot.margin              : 'margin' num [1:4] 5.5pt 5.5pt 5.5pt 5.5pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ strip.background         : list()
##   ..- attr(*, "class")= chr [1:2] "element_blank" "element"
## $ strip.background.x       : NULL
## $ strip.background.y       : NULL
## $ strip.placement          : chr "inside"
## $ strip.text               :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : chr "grey10"
##   ..$ size         : 'rel' num 0.8
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : NULL
##   ..$ lineheight   : NULL
##   ..$ margin       : 'margin' num [1:4] 4.4pt 4.4pt 4.4pt 4.4pt
##   .. ..- attr(*, "valid.unit")= int 8
##   .. ..- attr(*, "unit")= chr "pt"
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ strip.text.x             : NULL
## $ strip.text.y             :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
##   ..$ angle        : num -90
##   ..$ lineheight   : NULL
##   ..$ margin       : NULL
##   ..$ debug        : NULL
##   ..$ inherit.blank: logi TRUE
##   ..- attr(*, "class")= chr [1:2] "element_text" "element"
## $ strip.switch.pad.grid    : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ strip.switch.pad.wrap    : 'unit' num 2.75pt
##   ..- attr(*, "valid.unit")= int 8
##   ..- attr(*, "unit")= chr "pt"
## $ strip.text.y.left        :List of 11
##   ..$ family       : NULL
##   ..$ face         : NULL
##   ..$ colour       : NULL
##   ..$ size         : NULL
##   ..$ hjust        : NULL
##   ..$ vjust        : NULL
```

```
##    ..$ angle        : num 90
##    ..$ lineheight   : NULL
##    ..$ margin       : NULL
##    ..$ debug        : NULL
##    ..$ inherit.blank: logi TRUE
##    ..- attr(*, "class")= chr [1:2] "element_text" "element"
##  - attr(*, "class")= chr [1:2] "theme" "gg"
##  - attr(*, "complete")= logi TRUE
##  - attr(*, "validate")= logi TRUE
```

Chronic Pain against Overall Pain Change Scores

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Chronic Pain against Overall Pain Change Scores