# Rope Force Experiment

## Notes

Some rows of data were omitted from this analysis because they either contained inconsistencies (e.g. walking unaware) or were incomplete.

## Assumptions

"Standing facing down" is equivalent to "standing" in the comments column.

## Comment

 The method does not appear to be consistent throughout the experiment. Not every guide was tested the same number of times at each mass for each technique. This was due to time constraints and may be reflected in the results. A suggestion for future experiments would be to test at a greater range of falling masses, or at smaller intervals. A set number of tests at each mass and technique should be performed for each guide.

## Analysis

5 columns of data were compared:

1. Body Mass (kg)
2. Technique (9 options)
3. Falling Mass (kg)
4. Force Gauge Measure (N)
5. Hold (successful/unsuccessful)

Correlation coefficients and the corresponding p-values (testing for the hypothesis of no correlation) were calculated for the data set. Each p-value is the probability of getting a correlation as large as the observed value by random chance, when the true correlation is zero. If p is small, say less than 0.05 then the correlation is considered significant. Significant correlations were found between the following data columns (p values are given to 5s.f.):

  i.     Body Mass vs. Falling Mass: $p = 1.5418e\text{-}028$
 ii.     Body Mass vs. Force Gauge Measure: $p = 6.4046e\text{-}012$
iii.     Technique vs. Falling Mass: $p = 0.0033782$
 iv.     Technique vs. Force Gauge Measure: $p = 0.013168$
  v.     Technique vs. Successful Hold: $p = 0.011761$
 vi.     Falling Mass vs. Force Gauge Measure: $p = 2.6761e\text{-}038$
vii.     Falling Mass vs. Successful Hold: $p = 2.0878e\text{-}005$

From this p-value analysis the sets i, iii, v, and vii were selected for a more thorough analysis. In particular it would be interesting to investigate the relationship between a guide's body mass and the maximum successful falling mass held for the various techniques.

The original data set was split into successful and unsuccessful holds then divided further into the 9 separate techniques. Each of these 9 sets was then analysed to find the maximum successful holding mass for each body mass (guide) for each technique.

Each set was analysed separately, results can be seen in figure 1 ('Individual Techniques'). P-values and x- and y- standard deviations (n.b. the 'variance' is the standard deviation squared) were computed for each set. If the p value was less than 5% (0.05), then it was considered that there was a significant correlation of the data in that set, and least-squares regression lines with 95% confidence intervals were plotted accordingly. In one case (direct attachment, downhill walking), there was insufficient data to compute p-values and standard deviations.

Data sets for each attachment technique (direct, short loop and long loop - i.e. standing, walking uphill and walking downhill techniques are combined in each of these sets) were obtained from the original data set, and maximum successful holding masses per body mass (guide) were obtained and analysed in a similar fashion as outlined above. The results can be seen in figure 2 ('Attachment Techniques'). As each of these sets was considered to be sufficiently correlated, the regression lines were plotted together in one graph for comparison of the techniques. This can be seen in figure 3 ('Comparison of Attachment Techniques').

Similarly, each of the walking techniques (standing, walking uphill and walking downhill) was compared. The results for each technique can be seen in figure 4 ('Walking Techniques'). Again the regression lines could be compared and are shown in figure 5 ('Comparison of Walking Techniques').

Additionally, bar graphs of the percentage of successful holds per falling mass and the percentage of successful holds per technique were generated. These can be seen in figure 6 ('Additional Graphs'). The techniques in the lower graph are numbered 1 to 9. These numbers correspond to the techniques: direct attachment (standing), direct attachment (walking uphill), direct attachment (walking downhill), short loop attachment (standing), short loop attachment (walking uphill), short loop attachment (walking downhill), long loop attachment (standing), long loop attachment (walking uphill) and long loop attachment (walking downhill).
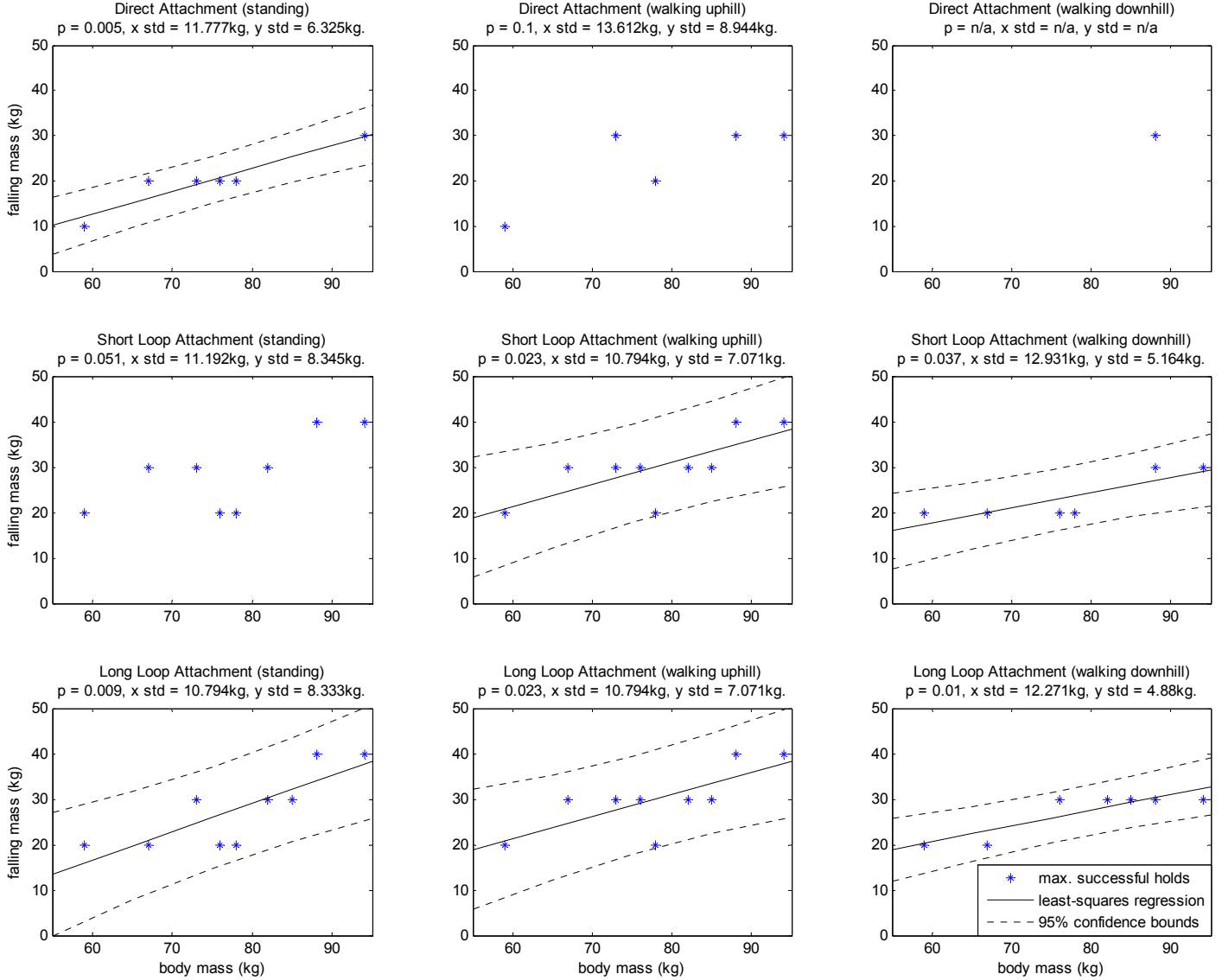
# Figures/Graphs



Figure 1 ('Individual Techniques')
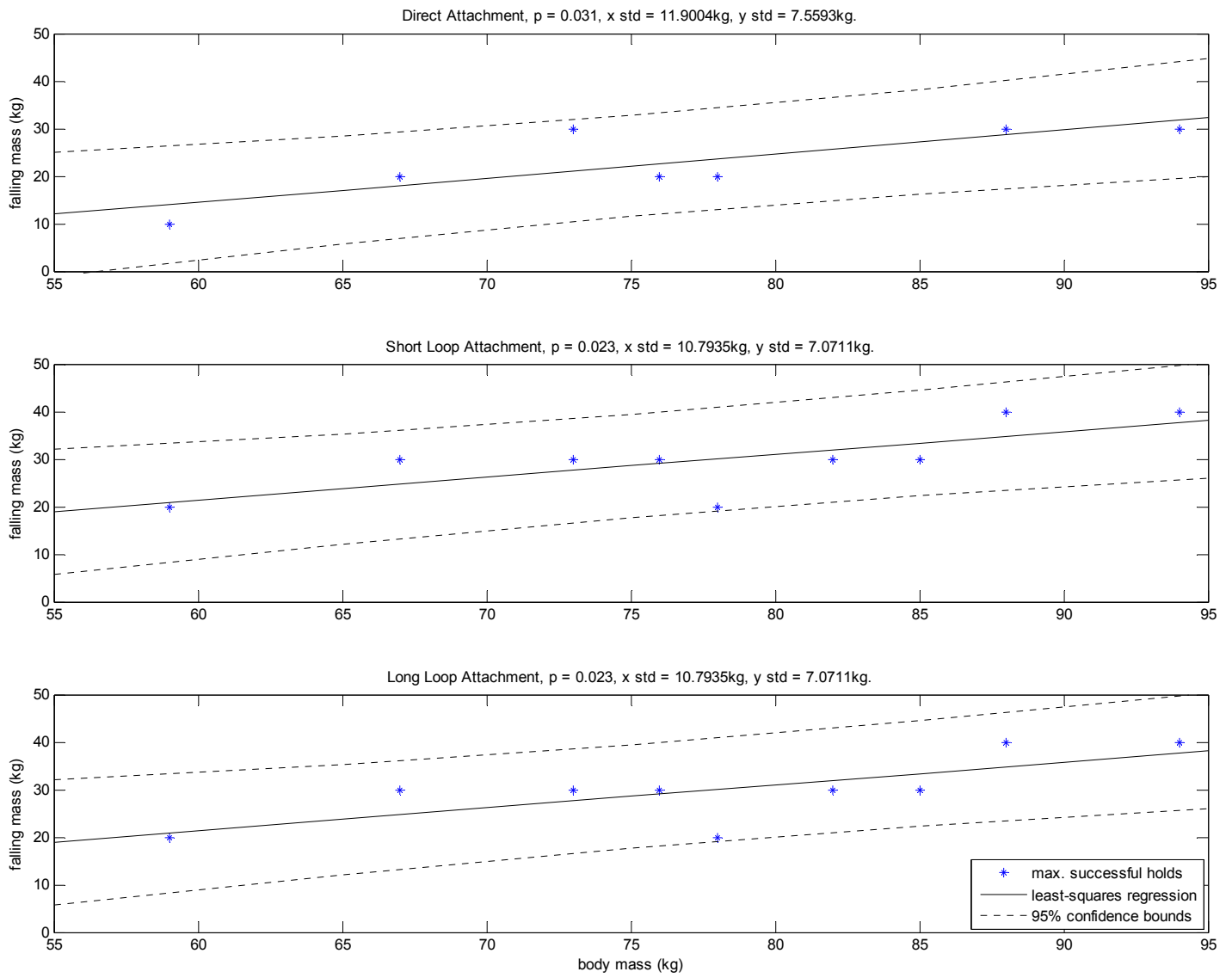
# Figure 2 ('Attachment Techniques')



Direct Attachment, p = 0.031, x std = 11.9004kg, y std = 7.5593kg.
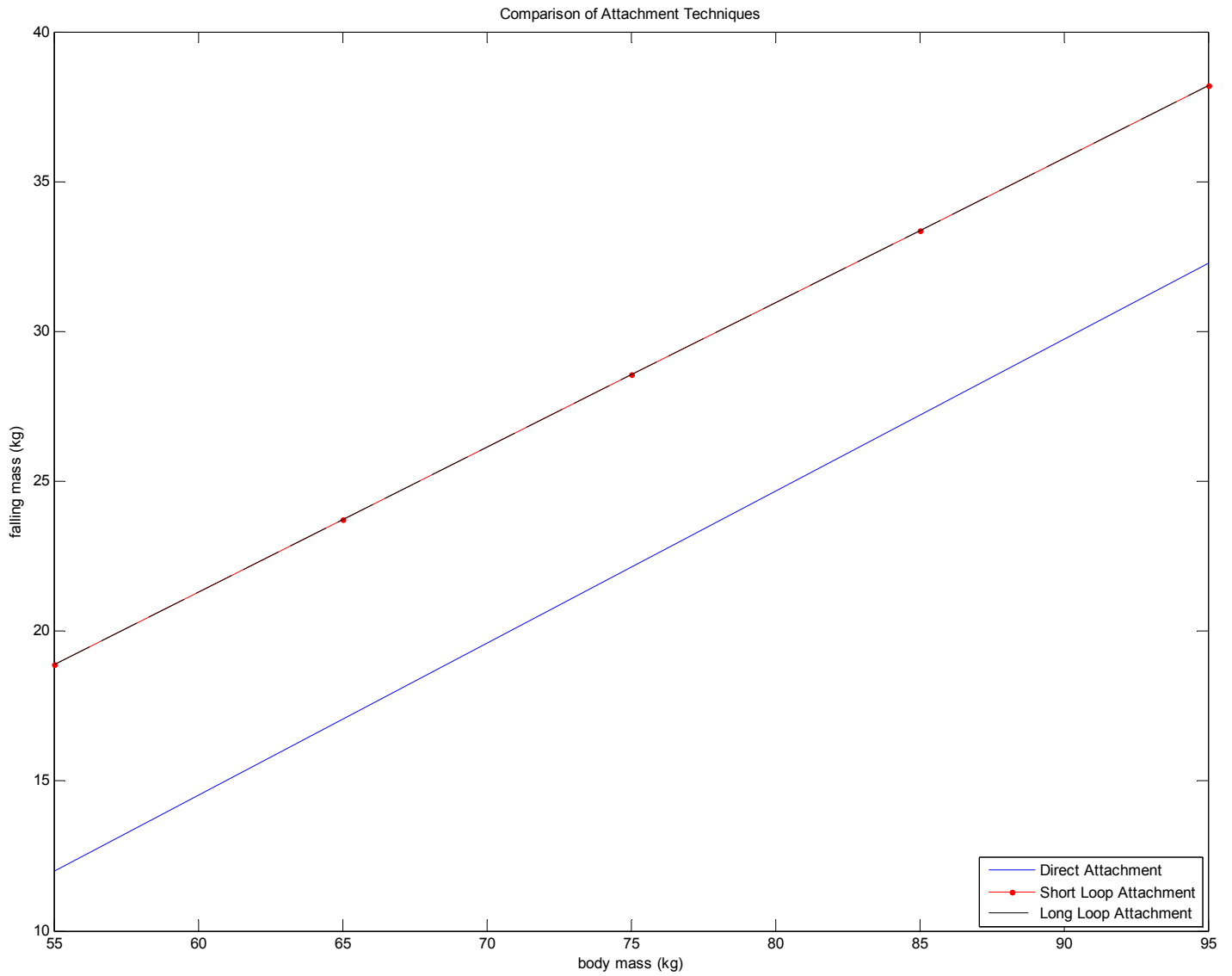
Short Loop Attachment, p = 0.023, x std = 10.7935kg, y std = 7.0711kg.

Long Loop Attachment, p = 0.023, x std = 10.7935kg, y std = 7.0711kg.

# Figure 3 ('Comparison of Attachment Techniques')



Comparison of Attachment Techniques

## Figure 4 ('Walking Techniques')

Standing, p = 0.037, x std = 10.7935kg, y std = 7.8174kg.

Walking Uphill, p = 0.023, x std = 10.7935kg, y std = 7.0711kg.

Walking Downhill, p = 0.024, x std = 11.3633kg, y std = 5.1755kg.

* max. successful holds
— least-squares regression
-- 95% confidence bounds
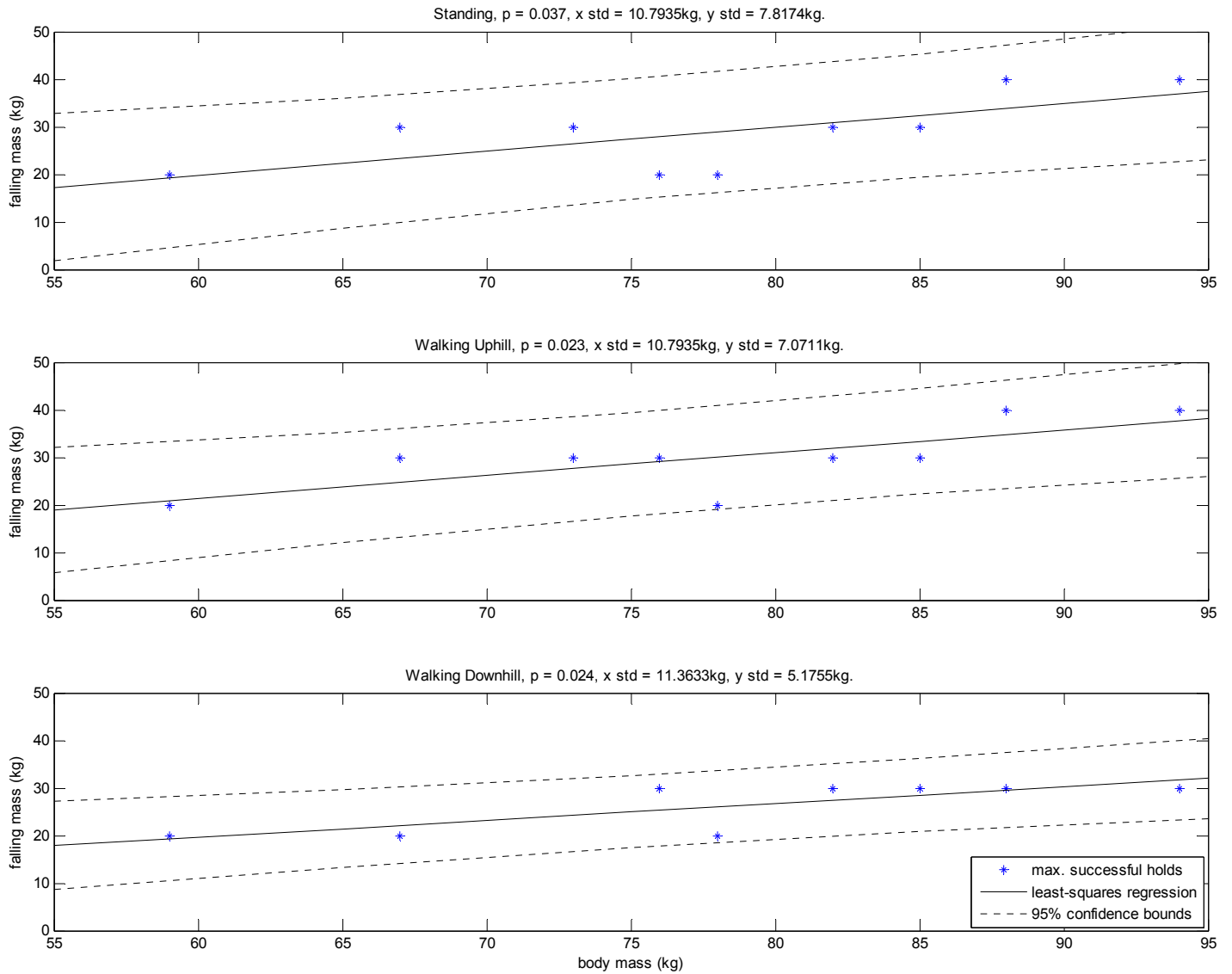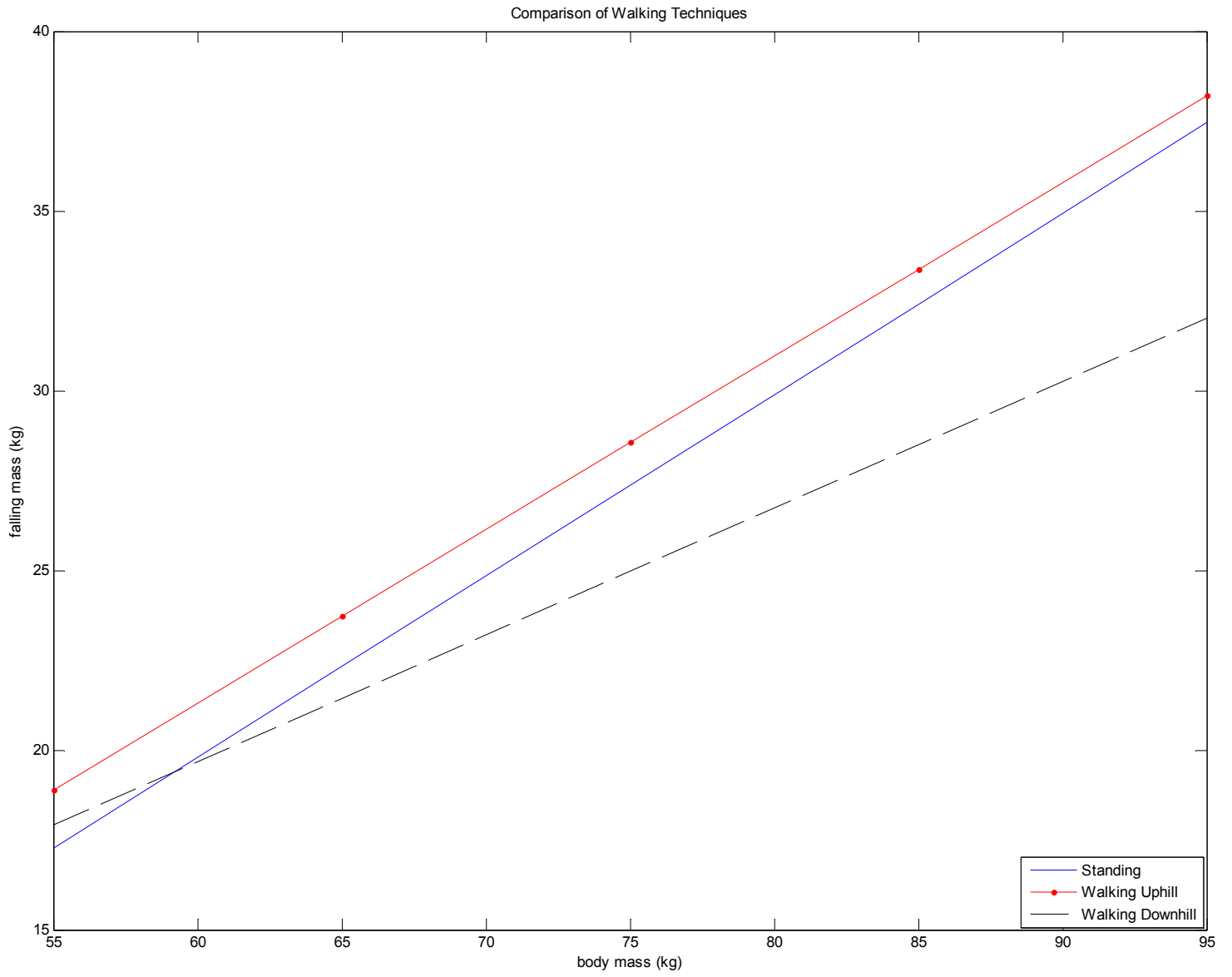
body mass (kg)

falling mass (kg)

Figure 5 ('Comparison of Walking Techniques')

Figure 6 ('Additional Graphs')


Percentage successful holds per falling mass.


Percentage successful holds per technique.