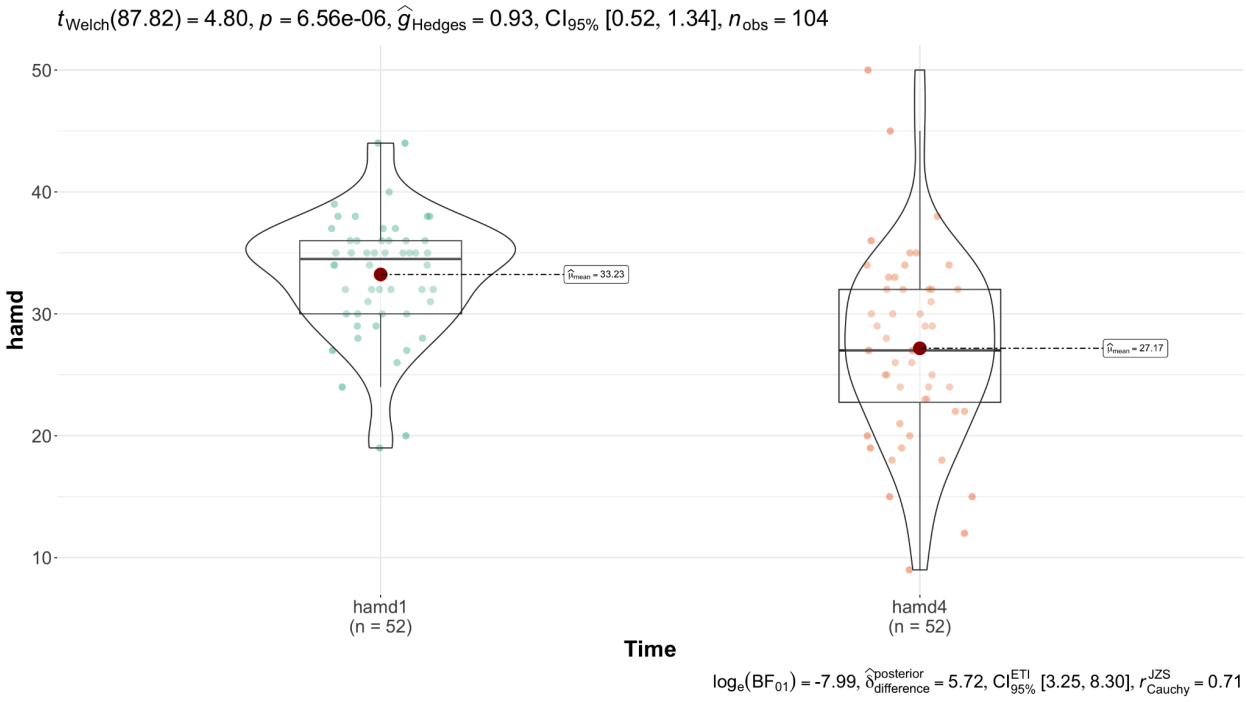
Assignment 1

The primary objective of this study is to assess the impact of drug therapy on levels of depression, as measured by the Hamilton Rating Scale for Depression (HRSD). Specifically, this analysis examines the change in the Hamilton Rating Scale for over four key time points: the onset of the intervention and at each of the three subsequent weeks. Additionally, this investigation considers two other predictors of interest, namely, sex and type of depression, to understand their influence on the therapeutic outcomes.

Question 1 - Using only the first and last time point, explore the amount of change in HAMD scores over the time frame of the intervention. Comment on the magnitude of the change in raw (unstandardized) units. (3 marks)

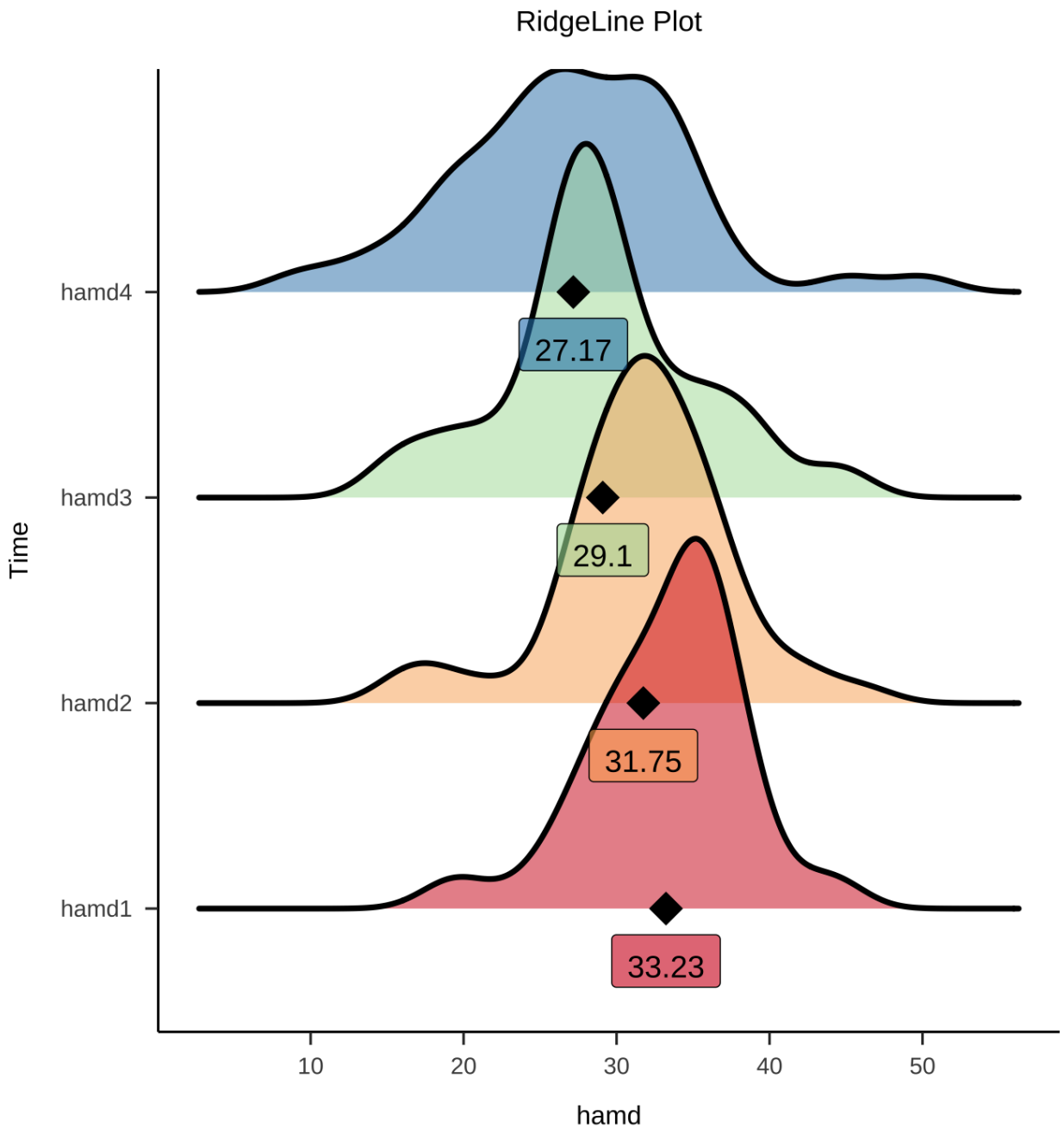


A Welch two-sample t-test was conducted to compare depression scores at the initial timepoint and the final timepoint. A statistically significant difference in mean depression scores between these two timepoints, $t(87.82) = 4.80$, $p < .001$ was observed. This significant finding

indicates a marked improvement in depression levels over the intervention period. The average depression score at the beginning of the study ($M = 33.23$) was significantly higher compared to the end of the study period ($M = 27.17$). Additionally, the mean difference falls within a 99% confidence interval ranging from 2.73 to 9.38. This range of improvement is consistent with the benchmarks established by Rush et al. (2021), which define a 4 to 6 point reduction on the HRSD17 scale as clinically meaningful, whereas a 7 to 12 point decrease is considered clinically substantial.

Question 2 - Using all four time points, explore the amount of change in HAMD scores. No post hoc tests are required, but discuss the magnitude of the change. (3 Marks)

A GLM model was fit to examine with time serving as the sole predictor to examine the change in HAMD scores over time. The results indicated a significant effect of time on HAMD scores, $F(3, 204) = 9.716$, $p < .001$. This indicates that as time varied, there were significant changes in HAMD scores observed across the different time points measured. Examining changes in depression severity over time, the initial average Hamilton Rating Scale for Depression (HAMD) score was estimated at 33.23. Subsequent assessments indicated a consistent reduction in scores that became clinically meaningful by the third time point, with the average decreasing 4.13 points from timepoint two to timepoint three. This aligns with the criteria for clinical meaningfulness established by Rush et al. (2021). By the fourth time point, the average reduction in HAMD scores reached 6.06 points, which can be deemed as a clinically substantial change. This progression reflects a significant improvement in depressive symptoms over the duration of the study, with the most notable enhancement observed in the latter stages.

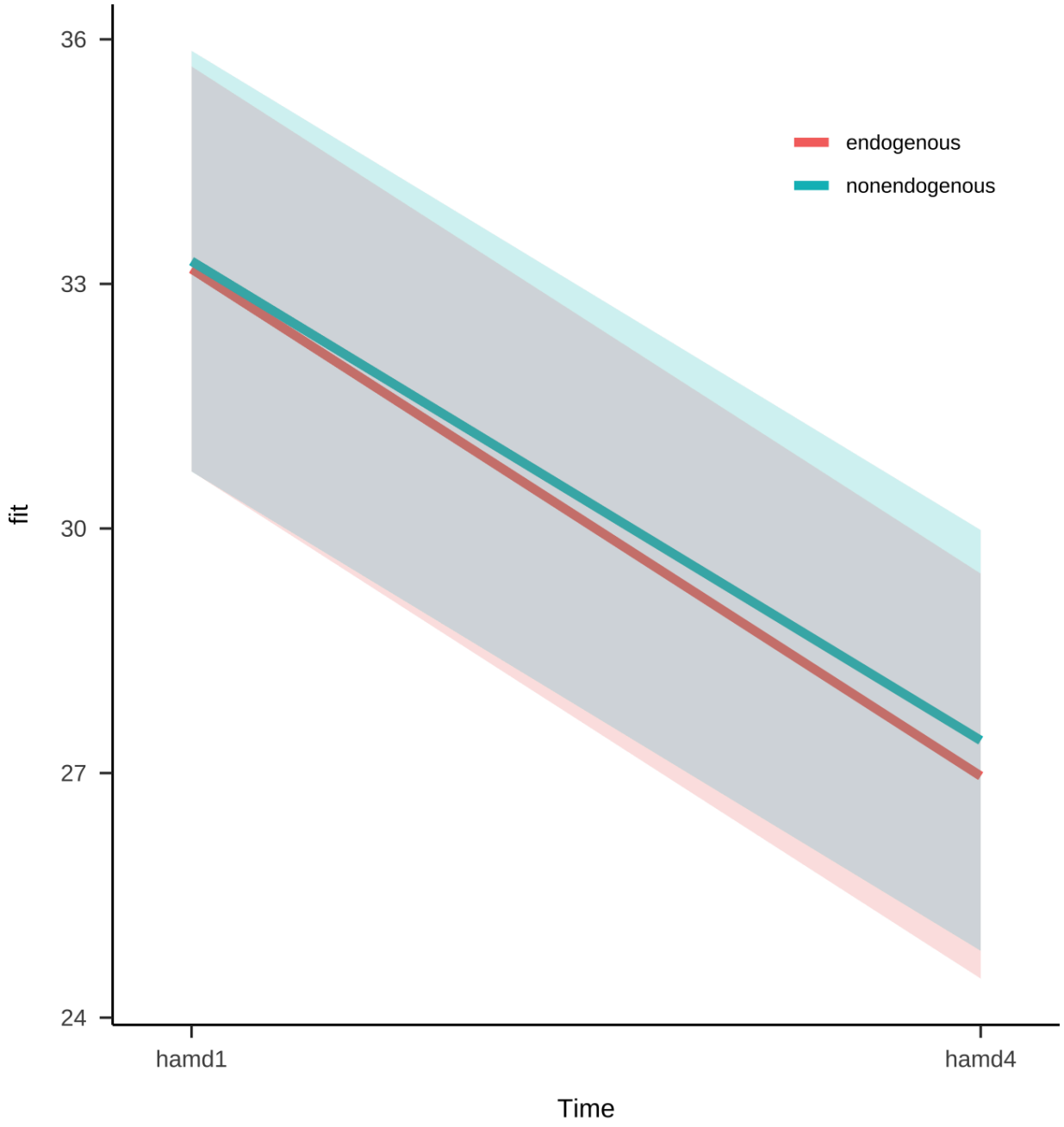


Question 3 - Compare the amount of change from the start of the study to the end of the study (i.e., using only the pretest and final time point) across the different types of depression (endogenous, nonendogenous). Comment on the magnitude of the difference in change across the types, in raw (unstandardized) units. (3 marks)

A linear regression model was fit to explore the impact of time and type of depression on Hamilton Rating Scale for Depression (HAMD) scores. At the final time point, the estimated average HAMD score decreased by 6.22 points from the initial score for individuals with endogenous depression. This magnitude of change is not only statistically significant but also suggests a notable reduction in depressive symptoms over the course of the study. In contrast, for individuals with nonendogenous depression, the interaction term between the final time point and depression type is not statistically significant ($t(100) = 0.134$, $p = 0.894$). This indicates that the change in HAMD scores from timepoint one to timepoint four for the nonendogenous group does not significantly differ from the change observed in the endogenous group. Table 1 depicts this relationship in more detail.

Table 1

Time	type	fit	se	lower	upper
hamd1	endogenous	33.19	1.25	30.70	35.66
hamd4	endogenous	26.96	1.25	24.48	29.44
hamd1	nonendogenous	33.28	1.30	30.69	35.86
hamd4	nonendogenous	27.40	1.30	24.81	29.98



Question 3 - Use a multilevel modeling approach to explore the effects of week, sex and the interaction of week and sex on depression scores. Treat week as continuous, include a random effect for both the week intercept and slope, and include sex as a predictor in both level 2 models. Address the following:

1) **Write out the level 1, level 2 and composite multilevel models (you can do this by hand and screenshot your work if this is easier) (3 marks)**

Level 1 Equation -

$$Y_{ij} = \beta_{0i} + \beta_{1i} \times \text{Time}_{ij} + \epsilon_{ij}$$

Level 2 Equation -

$$\beta_{0i} = \gamma_{00} + \gamma_{01} \times \text{Sex}_i + u_{0i}$$

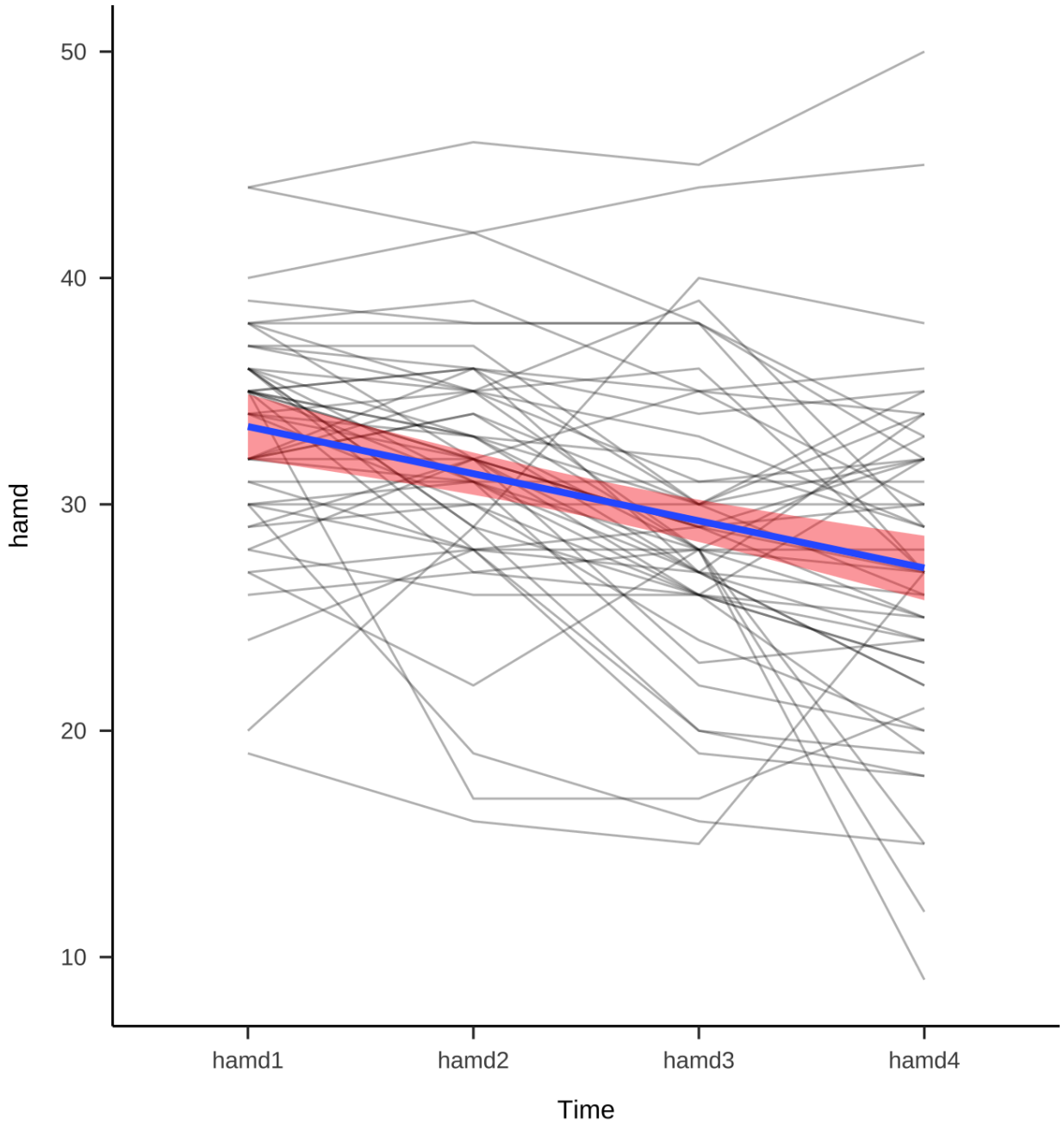
$$\beta_{1i} = \gamma_{10} + \gamma_{11} \times \text{Sex}_i + u_{1i}$$

Composite Model -

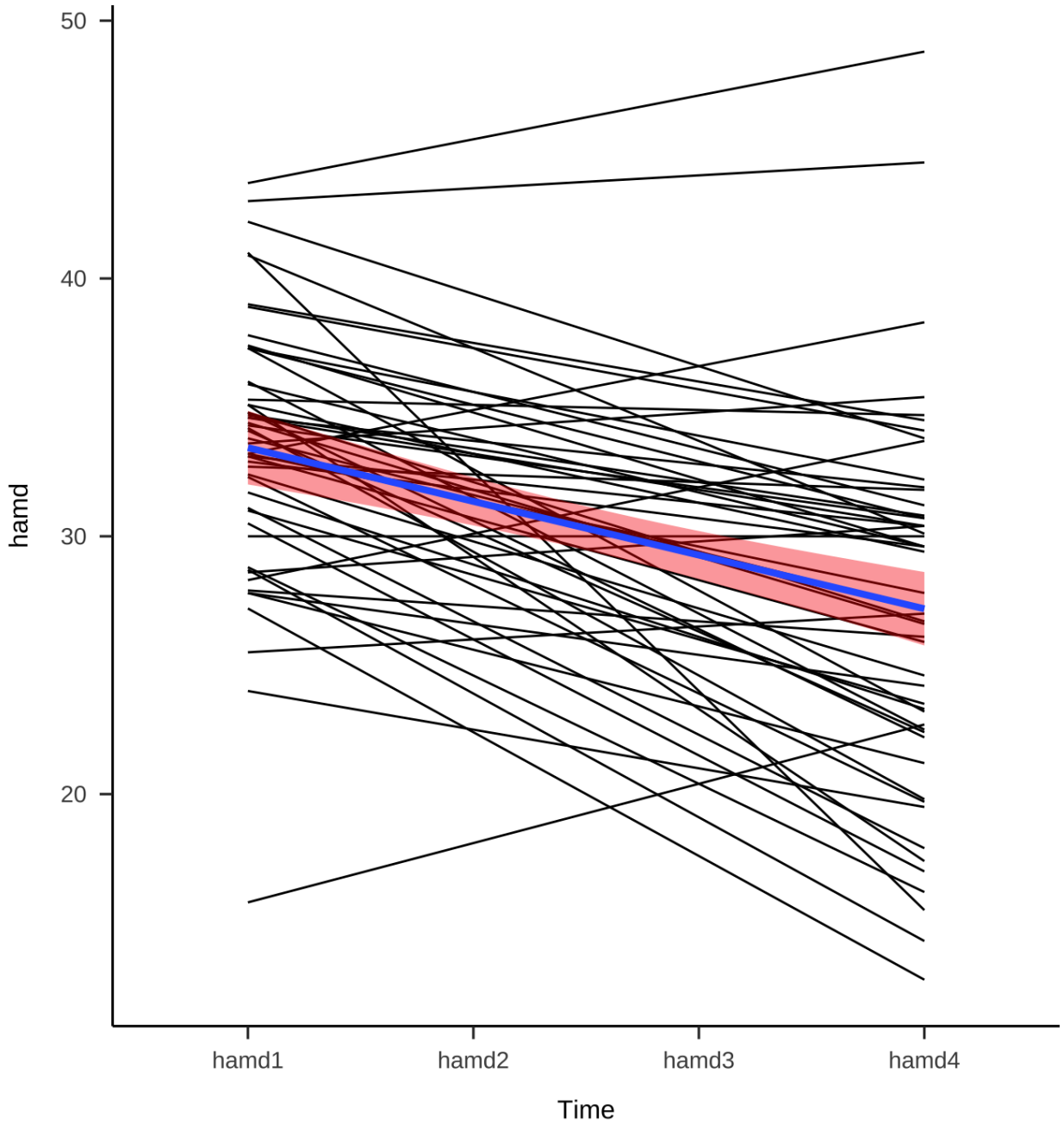
$$Y_{ij} = (\gamma_{00} + \gamma_{01} \times \text{Sex}_i + u_{0i}) + (\gamma_{10} + \gamma_{11} \times \text{Sex}_i + u_{1i}) \times \text{Time}_{ij} + \epsilon_{ij}$$

2) **Graph the change over time for each individual, superimposed with linear regression lines, to determine if a linear model for week is appropriate (2 marks)**

Raw Trajectories



Conditional Trajectories

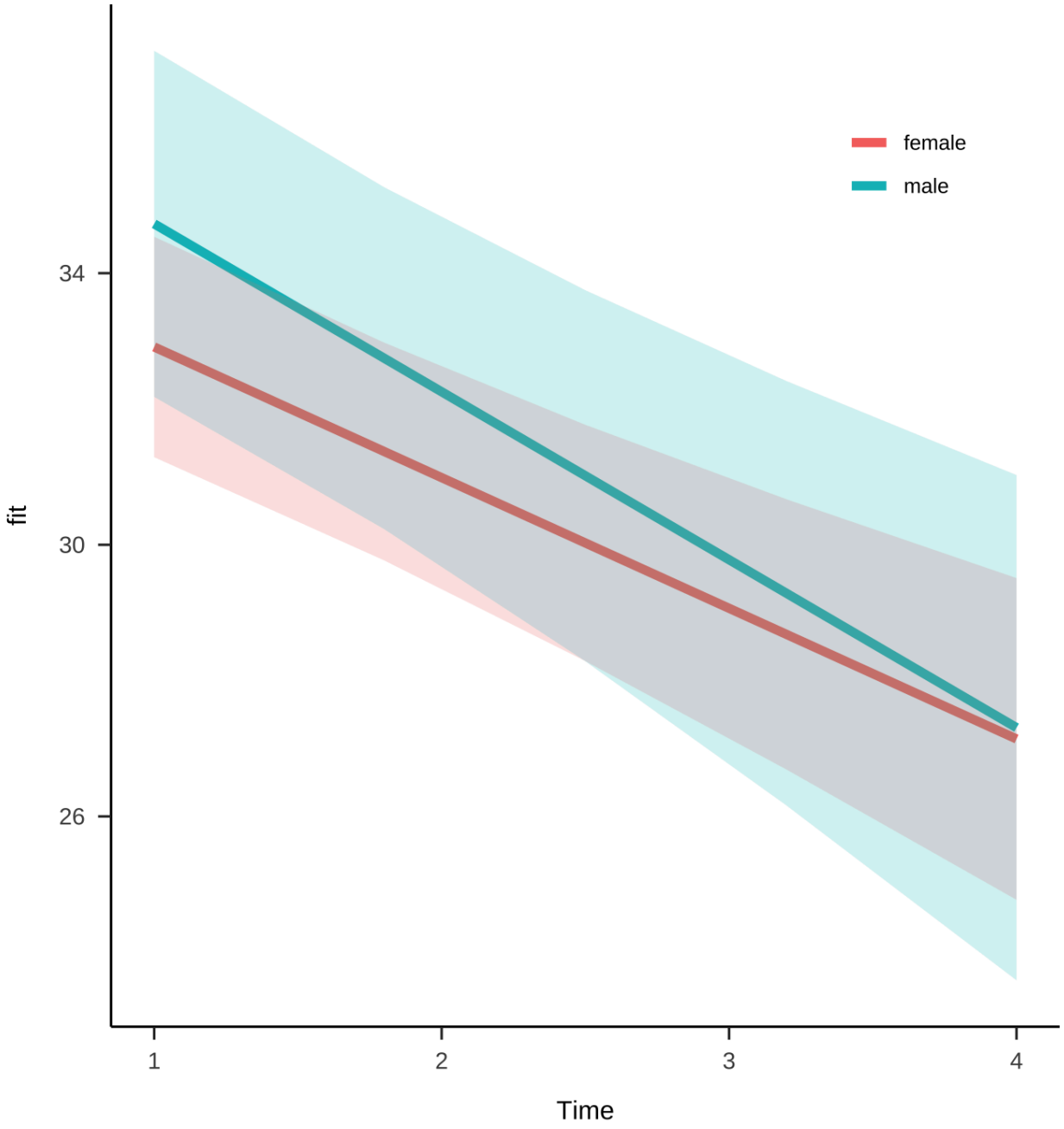


3) **Run the multilevel model for change, and interpret the meaning of each fixed and random coefficient (regardless of statistical significance) (8 marks)**

Results from the fixed effects parameters for the Hamilton Rating Scale for Depression (HAMD) scores indicated a significant negative effect of time (-1.92; 99% CI = [-2.85, -0.99]; $p < 0.001$), suggesting that HAMD scores significantly decreased (i.e., improved) from the baseline assessment to the final time point. The effect of sex was not significant (2.36 for males; 99% CI = [-2.09, 7.05]; $p = 0.193$), indicating that on average across all timepoints, there was no difference in HAMD scores between males and females. The interaction term between time and sex also was not significant (-0.55; 99% CI = [-2.19, 1.07]; $p = 0.409$), suggesting the rate of change in HAMD scores over time did not differ significantly by sex.

Examining the random effects revealed substantial variability in individual baseline HAMD scores (*sd* = 4.42; 99% CI = [2.35, 6.53]), which accounted for the individual differences in depression severity at the start of the study. The variability in the change of HAMD scores over time also differed substantially among individuals (SD = 1.64 for Time; 99% CI = [0.86, 2.44]), suggesting diverse trajectories in symptom change. The estimated correlation between the intercept and slope within individuals was -0.27; 95% CI = [-1.05, 0.42], indicating that the initial severity of symptoms inversely predicted the rate of change over time.

In summary, the model results demonstrate a clear trend of improvement in depression symptoms over time, which did not vary significantly by sex. The presence of random effects was justified by the substantial individual variability observed both in initial depression levels and in changes over time, underscoring the complex and heterogeneous nature of depression trajectories.



4) For effects that are statistically significant, comment on the magnitude of the effects in raw (unstandardized) units.

Examining the significant slope of change over time revealed a significant decrease in depression symptoms, with a raw, unstandardized effect of -1.92 points per unit of time. According to the criteria set by Rush et al. (2021), which state that a 4–6 point change in the HRSD17 is clinically meaningful and a 7–12 point change is clinically substantial, the observed average reduction of approximately 1.92 points, while statistically significant, falls short of the threshold for clinical meaningfulness when moving from one timepoint to the other. However, when examining total change across all timepoints, we observe a clinically substantial reduction in depression symptoms. This indicates that on average, the magnitude of improvement in depressive symptoms over the study period, is statistically significant and clinically substantial according to established guidelines.

Table 2

Time	sex	fit	se	lower	upper
1.0	female	32.91	0.82	31.29	34.54
1.8	female	31.37	0.81	29.77	32.98
2.5	female	30.03	0.88	28.29	31.77
3.2	female	28.68	1.01	26.69	30.67
4.0	female	27.14	1.20	24.77	29.51

Table 3

Time	sex	fit	se	lower	upper
1.0	male	34.73	1.29	32.18	37.27
1.8	male	32.75	1.28	30.23	35.27
2.5	male	31.02	1.39	28.28	33.75
3.2	male	29.29	1.58	26.16	32.41
4.0	male	27.31	1.89	23.59	31.03