Analysis

Using R[1], multiple tests and models were used to analyze 79 participant ADHD Rating Scale-IV: Home Version Tests.[8] 35 participants are diagnosed, while 42 are not. The scale consisted of 18 behavior questions as answered by a parent or teacher, along with the participants' ADHD Hyperactivity-Impulsivity, Inattention, and Total raw score.[2] As the behavior questions were on a scale of 0 to 3, with 0 being never or rarely and 3 being very often, there were no outliers for these variables. The ADHD raw scores are sums of the behavior questions[2], meaning there were no outliers for these variables either. The main question for this analysis was then: which questions best predict the total score?

First, the data was formatted and modified using dplyr for ease of use in statistical analysis.[3] Next, the number of questions analyzed was reduced through examining their normal distribution[4] and creating pair plots (with correlations greater than 0.7)[5] to study the relationship between the questions. With the remaining questions, the relationship between question scores and overall ADHD Total Raw scores was explored using linear regression.[1] An AIC analysis[6] was then used on the linear models to discover which questions best predict the total score, with the models within 7 points of the best model considered the best questions. The best models would then be plotted using the package ggplot2[7] as a function of predicted and actual total scores compared to the response to that question.

Results

We know 35 out of 79 participants are diagnosed with ADHD, and Figure 1[7] here summarizes their respective total raw scores. For the study here, the minimum score for a diagnosed participant was 20, while there was a participant with a score of up to 42 that is not diagnosed with ADHD.[8]

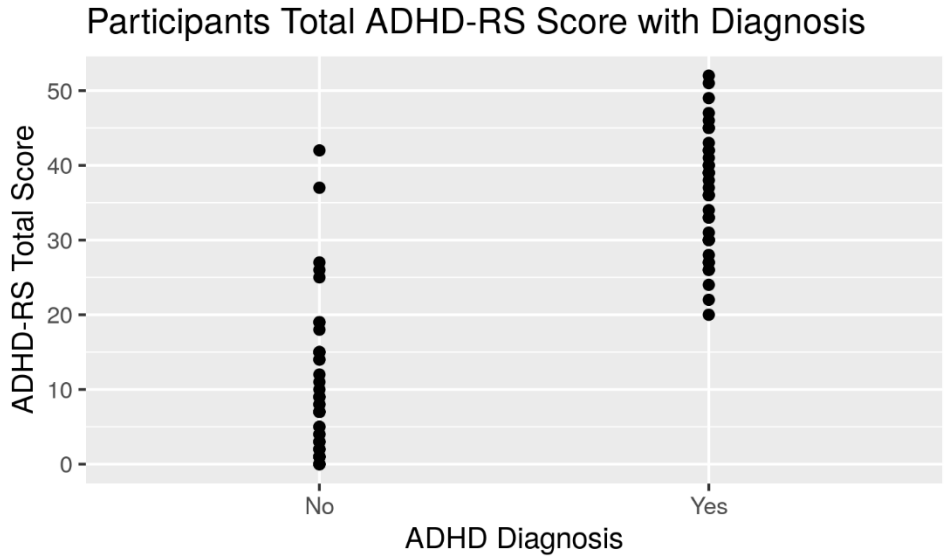

Figure 1: The total ADHD raw score of participants based off their ADHD diagnosis.

After checking the normal distribution of the 18 questions and which ones had correlations greater than 0.7, seven questions remained: 1, 2, 4, 5, 6, 8, and 14. As the odd-numbered questions sum to the

Inattention score and the even-numbered questions sum to the Hyperactivity-Impulsivity score[2], there were high correlations between the even and odd questions, respectively. Table 1 displays the frequency of each score (0 to 3, or "rarely" to "most often") for each of these remaining questions. Interestingly, Question 1 and 2 have the most responses to higher scores, while the others are largely dominated by lower scores. Both tables were formatted using the dplyr package in R.[3]

Score	Q1 Frequency	Q2 Frequency	Q4 Frequency	Q5 Frequency	Q6 Frequency	Q8 Frequency	Q14 Frequency
0	12	10	19	14	26	17	14
1	9	11	14	19	13	22	19
2	14	15	14	10	10	10	9
3	18	18	6	11	5	5	12
NA	26	25	26	25	25	25	25

Table 1: The frequency of behavior responses, on a scale of rarely to very often, to each of the remaining seven questions (the ones with normal distributions and no correlation with the other remaining questions).

Linear regression[1] was performed on each of the seven questions, with the question score used as a predictor for the total score. These were then ranked using AIC[6], with the results shown in Table 2. Question 1 was the best with Question 2 right behind it, meaning these questions are the best predictors for the total score. It is encouraging to see the top two questions come from different sections, as the odd questions examine Inattention and the even questions examine Hyperactivity behavior. Question 4 is next and as it is within 7 points of the first two models, we will include this question in further analysis too. Using the summary function in R[1], Question 1 was found to have a slope, or size, of 10.669, Question 2 has a slope of 11.841, and Question 4 has a size of 11.614.

Model	AICc	Delta_AICc	AICc_Weight	Cumulative_Weight
Q1	403.6019	0	0.502144	0.502144
Q2	403.7695	0.167557	0.461789	0.963934
Q4	409.9136	6.311735	0.021392	0.985326
Q8	411.9398	8.337885	0.007767	0.993093
Q5	412.322	8.720067	0.006416	0.999509
Q14	417.4808	13.87887	0.000486	0.999996
Q6	427.0494	23.44755	4.07E-06	1

Table 2: The AIC analysis of the seven remaining questions. Question 1 and 2 were about equally the best, while Question 4 was next with a difference of under 7 points.

While Question 1 and 2 had the highest frequencies for higher reported scores, and Question 4 had one of the lowest frequencies for higher scores, all three questions appear to be good predictors for the total raw score.

The graphs below then display the predicted total score as compared to the response for each of the top questions (Figures 2, 4, and 6) and the actual total scores as compared to the question score reported by the participants (Figures 3, 5, and 7)[7]. In all three questions, the upward trend in the actual data matched the positive slope graphed for the predicted scores. In concurrence with the way the total score is calculated as well, the higher the score on the individual question, the higher the total score.

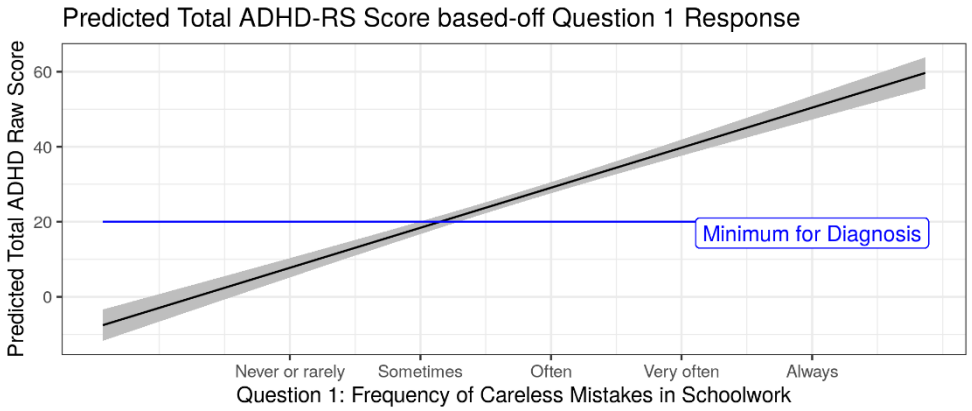

Figure 1: The predicted total score based off responses to Question 1.

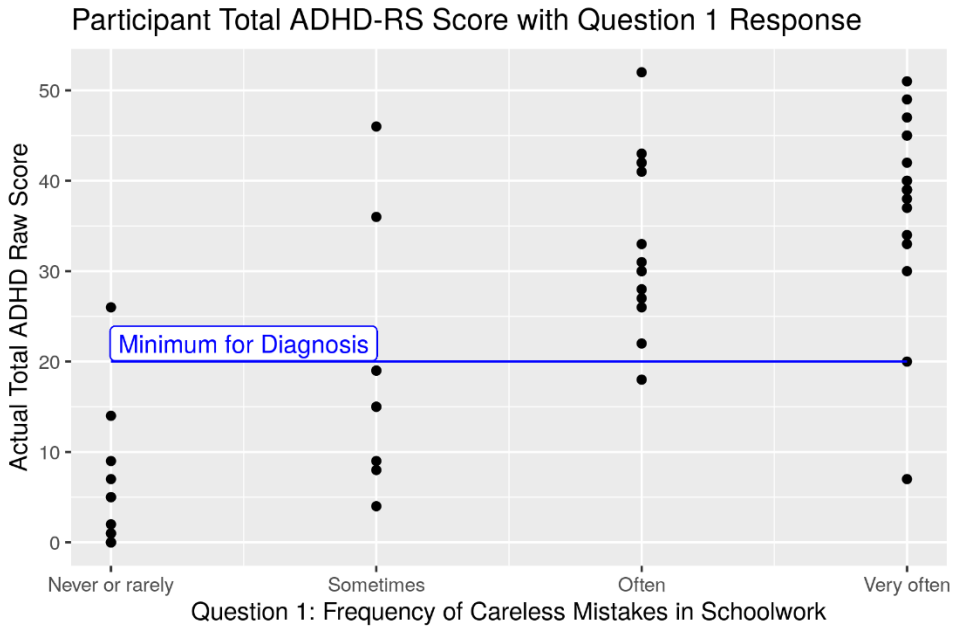

Figure 2: The actual total score as a function of the participants response to Question 1.

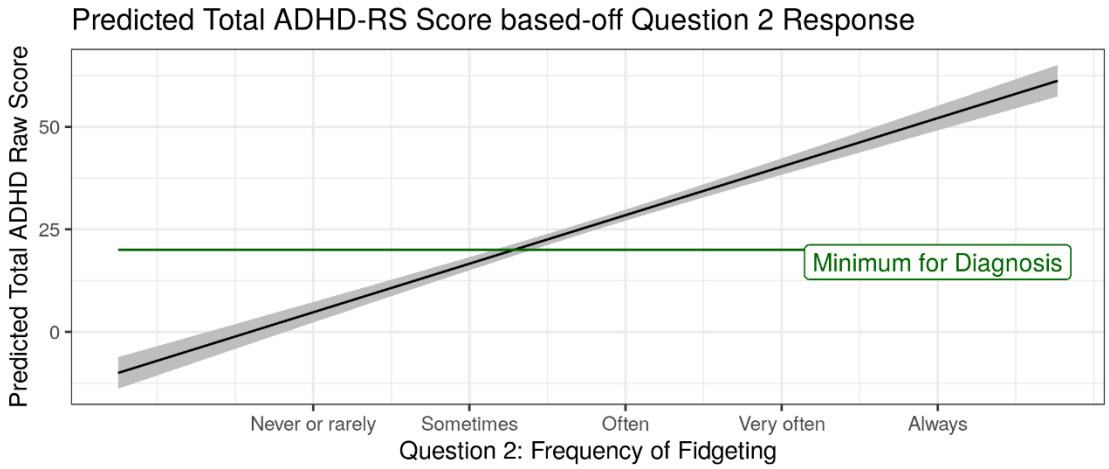

Figure 3: The predicted total score based off responses to Question 2.

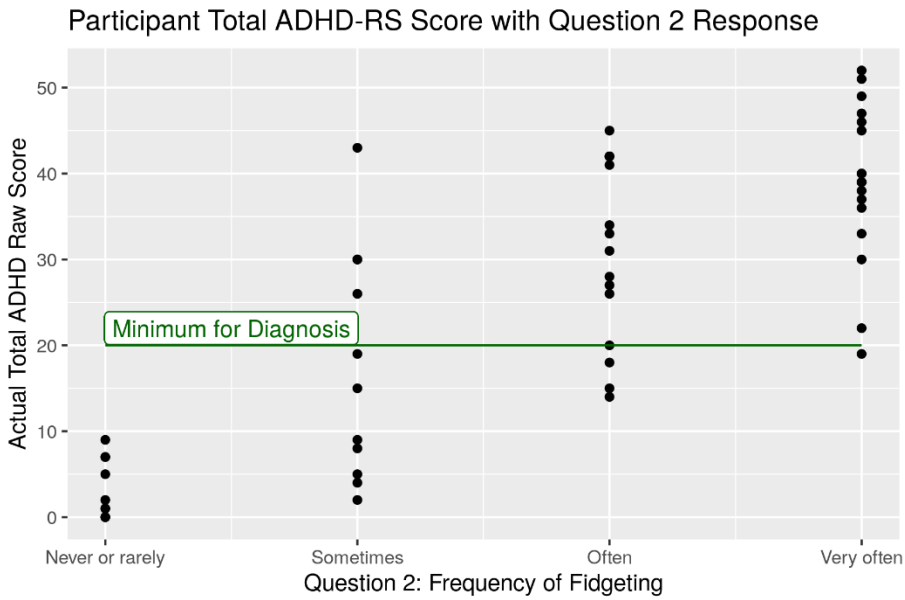

Figure 4: The actual total score as a function of the participants response to Question 2.

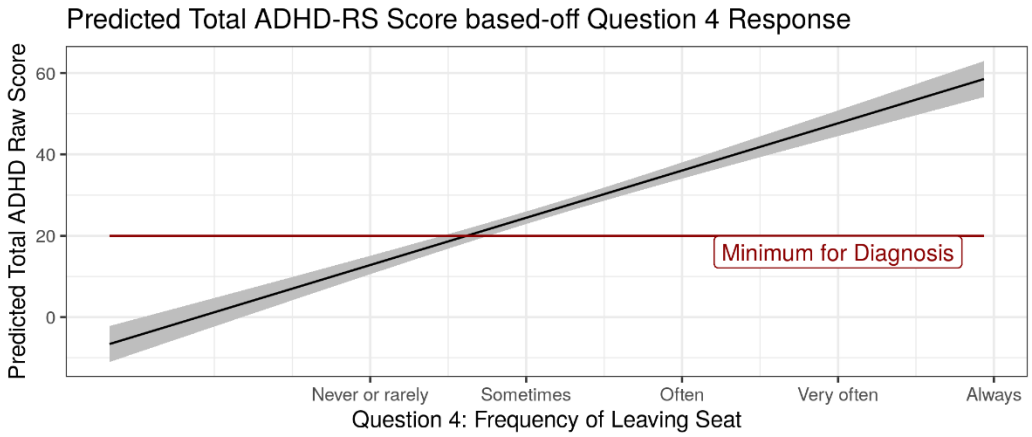

Figure 5: The predicted total score based off responses to Question 4.

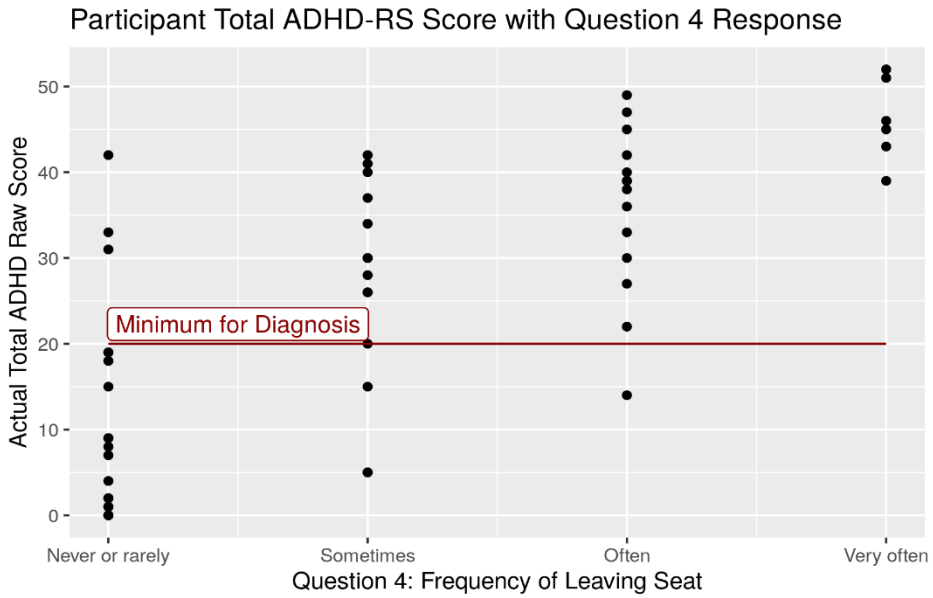

Figure 6: The actual total score as a function of the participants response to Question 4.

Discussion

As expected, the odd-numbered questions had high correlations with other odd-numbered questions (Inattention score) and the same trend occurred for the even-numbered questions (Hyperactivity-Impulsivity score). After creating linear models (with the question score as the predictor variable and total score being the response variable) and ranking them with AIC, Question 1, 2, and 4 were determined to best predict the total score for the participant. The higher the individual score on those questions, the higher the total ADHD raw score.

References

[1] R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

[2] DuPaul, G. J., Power, T. J., Anastopoulos, A. D., & Reid, R. (1998). ADHD Rating Scale IV: Checklists, norms, and clinical interpretation. New York: Guilford.

[3] Hadley Wickham, Romain François, Lionel Henry and Kirill Müller (2020). dplyr: A Grammar of Data Manipulation. R package version 1.0.2. https://CRAN.R-project.org/package=dplyr

[4] Masaaki Horikoshi and Yuan Tang (2016). ggfortify: Data Visualization Tools for Statistical Analysis Results. https://CRAN.R-project.org/package=ggfortify

[5] Brian G. Peterson and Peter Carl (2020). PerformanceAnalytics: Econometric Tools for Performance and Risk Analysis. R package version 2.0.4. https://CRAN.R-project.org/package=PerformanceAnalytics

[6] Marc J. Mazerolle (2020) AICcmodavg: Model selection and multimodel inference based on (Q)AIC(c). R package version 2.3-1. https://cran.r-project.org/package=AICcmodavg.

[7] H. Wickham. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2016.

[8] Booth J.R., Cooke G.E., Gayda J., Hammer R., Lytle M.N., Stein M.A., Tennekoon M. Working memory and reward in children with and without attention deficit hyperactivity disorder (ADHD) 2020. https://openneuro.org/datasets/ds002424/versions/1.1.1" rel="noopener nofollow noopener" title="External link: https://openneuro.org/datasets/ds002424/versions/1.1.1">https://openneuro.org/datasets/ds002424/versions/1.1.1