BRAIN INJURY VISION SYMPTOM SURVEY (BIVSS): PRELIMINARY COMPARISON DATA AND RASCH ANALYSIS

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ABSTRACT

The BIVSS is a 28-item scaled survey designed to query vision behaviors related to: clarity, comfort, diplopia, depth perception, dry-eye, peripheral vision, & reading with individuals who have suffered mild-to-moderate brain injury.

Anonymous BIVSS data were analyzed from 219 individuals (62 TBIs & 157 non-TBIs). TBI results significantly differed from non-TBIs. A raw BIVSS score of ≥45 was determined as discriminative of a significant visual problem for the 28-question survey.

TBI completion success:
• 93.5% of TBI subjects able to complete at least 27 questions

Non-TBI completion success:
• 100% of subjects able to complete all 28 questions

Rasch analysis identified 10 of the 28-questions as either redundant or as misfit. Analysis of the reduced set of 18-questions yielded excellent specificity (96%), good overall accuracy (90%), and moderate sensitivity (76%). For the 18-question reduced set, a raw score of ≥28 was determined as discriminative of a significant visual problem.

Whereas Univariate Rasch Analysis assumes only a single factor, Factor Analysis of the 28-item responses suggested up to 5-underlying dimensions potentially.

SUBJECTS & METHODS

-Anonymous BIVSS data were obtained from:
1) active-duty soldiers, &
2) TBIs participating in a support group, plus TBI patients of optometrists who attended the 2013 NORA meeting.
-Self-reported non-TBI optometry students from two different classes, served as controls. Newly matriculated 1st yr students & 3rd yr students (1-wk before NBEO examinations) completed BIVSS surveys.

Multivariate ANOVA & Rasch Analysis were used to analyze questionnaire results

BIVSS questionnaire (28-item full-length)

RESULTS

Total Scores (Raw Sums) of 28 BIVSS Questions
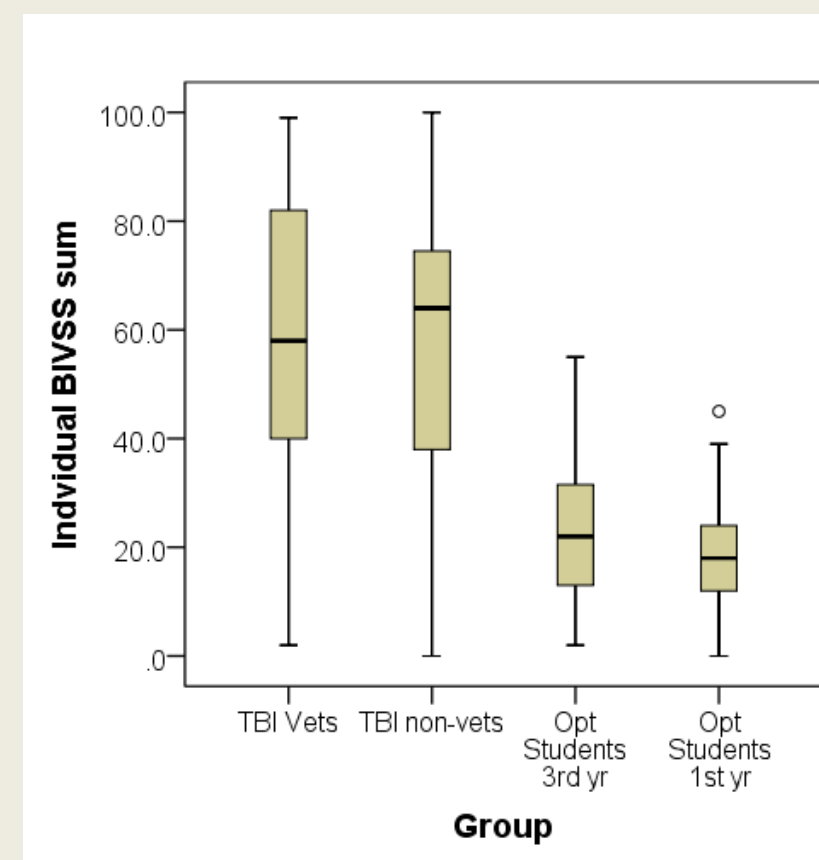
• Boxes represent the 25th to 75th percentiles. Bars in the center are the medians
• Little overlap between current TBI patients (vets and non-vets) and normal optometry students
• Overall non-parametric Kruskal Wallis comparison of 5 distributions was significant, p<.001
• 3rd years had a significantly different distributions than the 1st year optometry students (p=.035, Wilcoxon), but the median test was not significant between the two groups (p=.10).
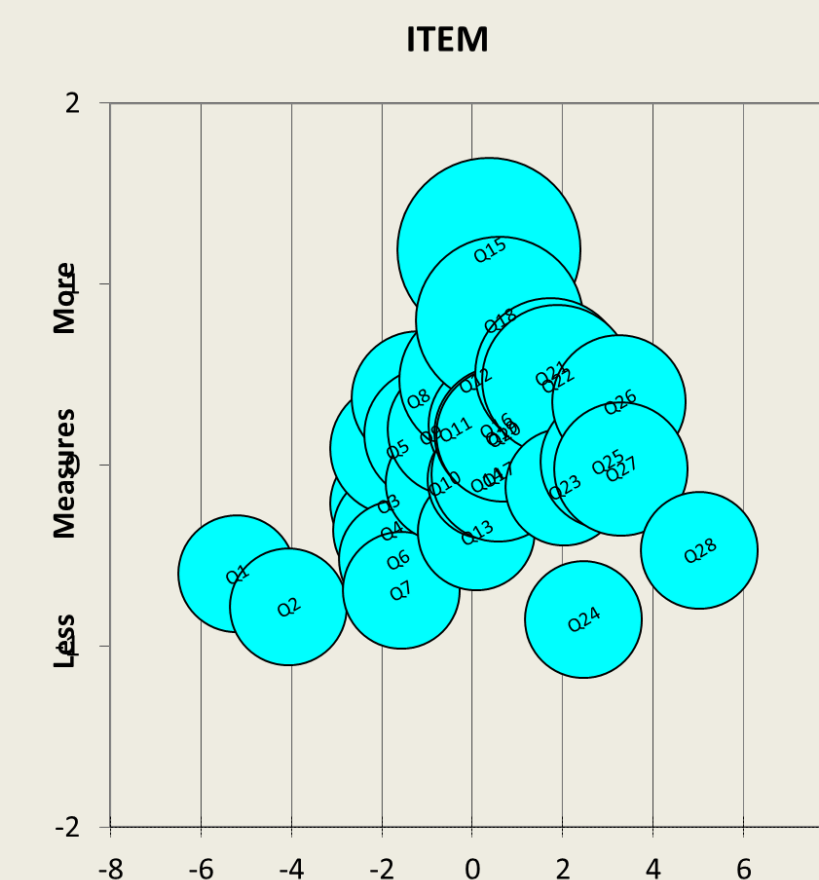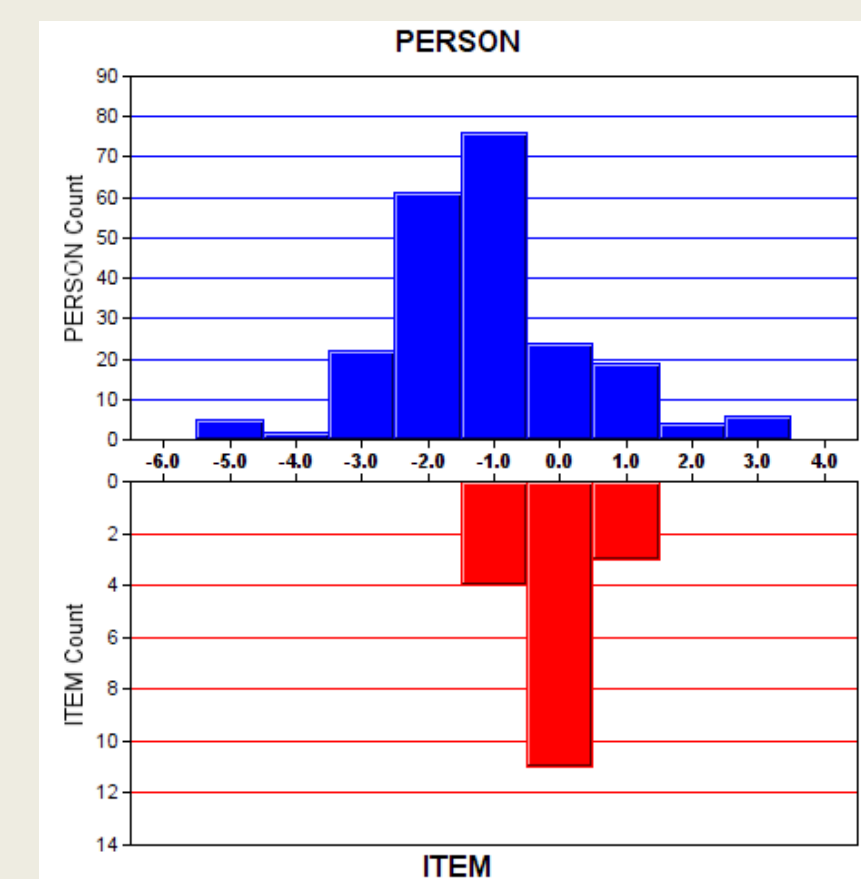
Rasch Analysis

Misfit Analysis

• 10 items were removed from the original scale to reveal a single dimension scale with item separation = 6.50 and a person separation of 2.94.

Final 18 questions
• Clarity of vision changes or fluctuates during the day
• Eye discomfort / sore eyes / eyestrain
• Headaches or dizziness after using eyes
• Eye fatigue / very tired after using eyes all day
• Feel "pulling" around the eyes
• Print moves in and out of focus when reading
• Normal indoor lighting is uncomfortable – too much glare
• Indoors fluorescent lighting is bothersome or annoying
• Clumsiness / misjudge where objects really are
• Lack of confidence walking / missing steps / stumbling
• Side vision distorted / objects move or change position
• What looks straight ahead--isn't always straight ahead
• Avoid crowds / can't tolerate "visually-busy" places
• Short attention span / easily distracted when reading
• Difficulty / slowness with reading and writing
• Poor reading comprehension / can't remember what was read
• Confusion of words / skip words during reading
• Lose place / have to use finger not to lose place when reading

Rasch analysis item and person distributions

• The Rasch analysis revealed a single dimension scale comprised of 18 items.
• Rasch analysis assumes questions/items fall along the dimension. The red histogram shows the distribution of questions on this dimension
• The blue histogram shows the distribution of people across the dimension. People on the left have few symptoms and people on the right have more severe symptoms.
• The scale is centered at the middle of the item distribution.
• The area where red and blue distributions overlap shows the highest point of scale discrimination.
• The scale does not discriminate between people with lower levels of symptoms.
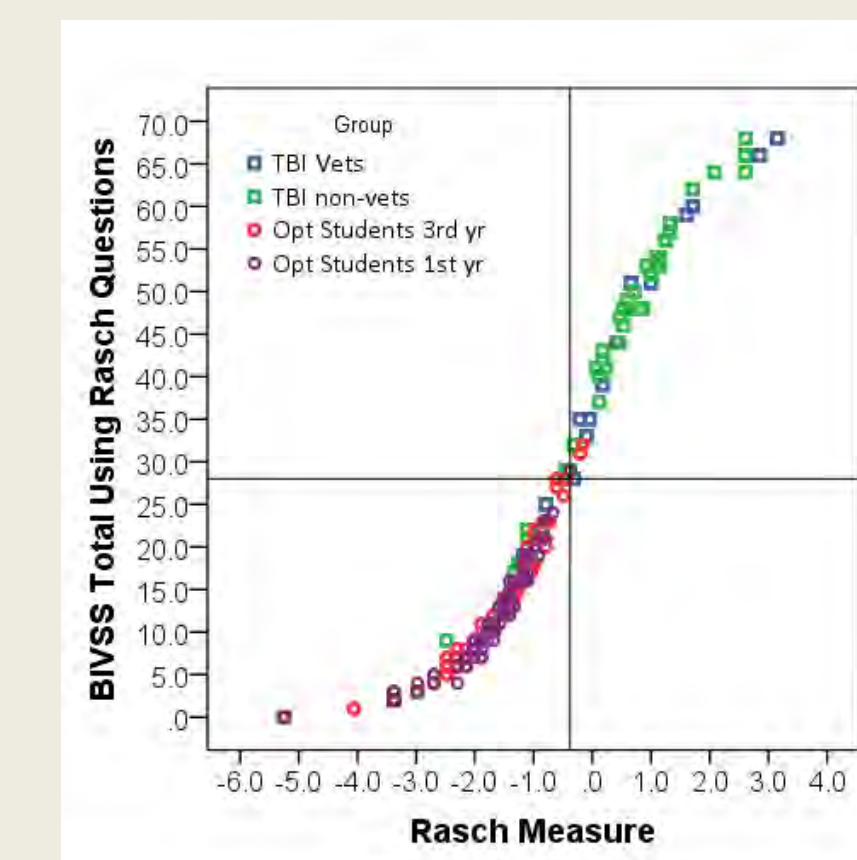
Logistic Model
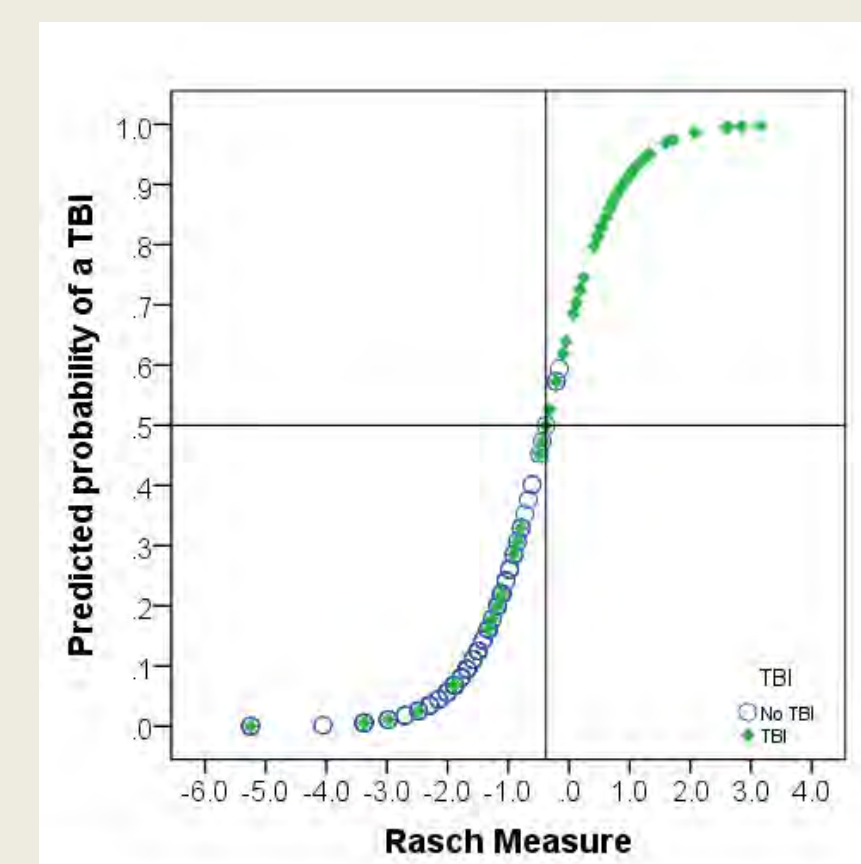
• Predicting TBI as a function of the 18 item Rasch scale with logistic regression

	B	S.E.
Rasch	1.734	.251
Constant	.657	.301

• p(TBI) = .5 = -Constant/B
  = -.657/1.734 = -.38
• The model was able to correctly assign 90% of the people to the correct categories.

RESULTS (cont)

### Relationship between the Rasch measure and the raw sum of the 18 question scale

A Rasch score of -.38 approximately equivalent to a BIVSS sum of 28 on the 18 item questionnaire.

|		No TBI	TBI	Total
Predicted	pNon TBI			
TBI Sum18	pTBI		6	47	53
Total		157	62	219

• Sensitivity = 76%
• Specificity = 96%
• Overall Accuracy = 90%
• We cannot compute positive predictive value because we do not know the prevalence of TBI. However, given the high specificity a high value on the BIVSS (>=28) is likely to reveal a vision problem.

Group Comparison for Total Sum of BIVSS for the Reduced Set of 18 Questions
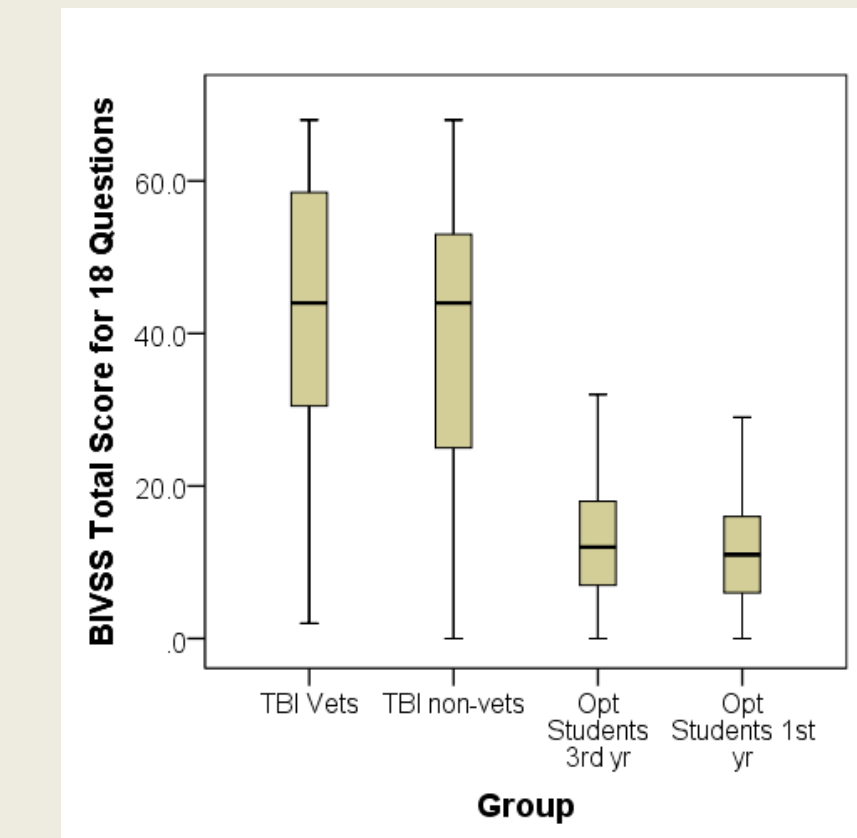

• The overall Kruskal Wallis non-parametric test was significant (p<.001)
• Neither the Wilcoxon (distributions) nor the median test indicated a difference between optometry student groups
• Neither the Wilcoxon (distributions) nor the median test indicated a difference between TBI patient groups.

Consideration of questions not included in the Rasch Primary Dimension
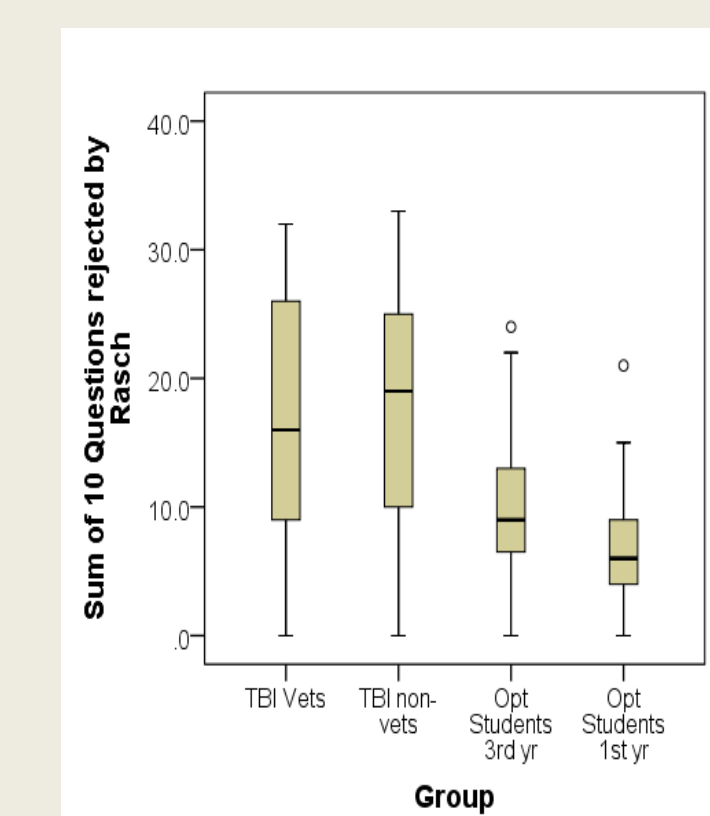
• Backward conditional stepwise logistic regression revealed 8 of the 10 questions contributed independently to discriminating 1st and 3rd year students
• A non-parametric median test between 1st and 3rd year was significant for the sum of all 10 questions (p<.006) and for the sum of the 8 significant questions (p<.005).
• Significant predictors of Opt Class
  Distance vision blurred and not clear -- even with lenses
  Near vision blurred and not clear -- even with lenses
  Poor night vision / can't see well to drive at night (p=.076)
  Double vision -- especially when tired
  Eyes feel "dry" and sting
  "Stare" into space without blinking
  Have to rub the eyes a lot
  Poor handwriting (spacing, size, legibility)
• Not significant
  Have to close or cover one eye to see clearly
  Outdoor light too bright -- have to use sunglasses
• The rejected questions are multidimensional and do a better job discriminating at the lower end of the symptom scale

BIVSS score as a function of years since injury
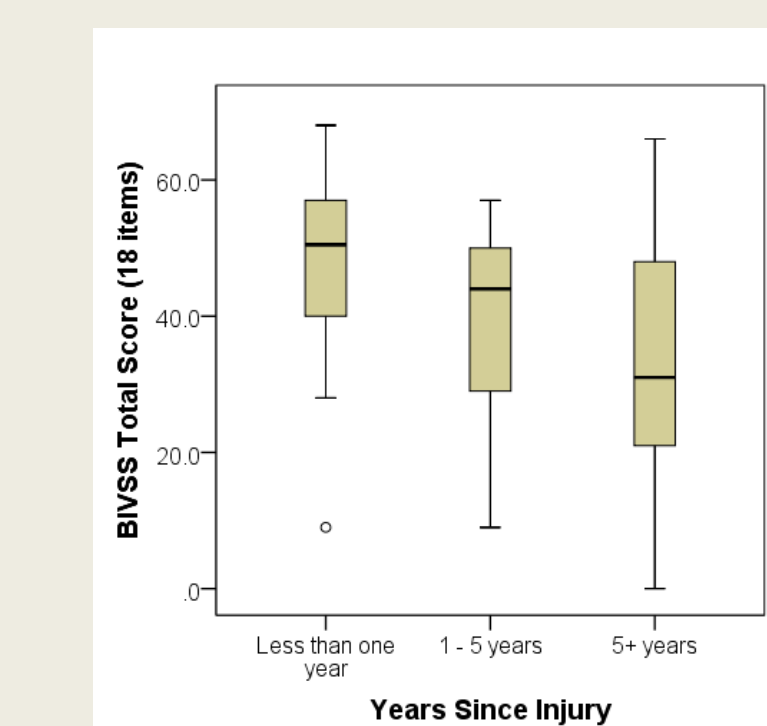
• Years since injury were available for most of the non-Vet TBI patients.
• There were 12 who had an injury within the last year; 10 with an injury 1-5 years; and 14 with injuries 5+ years
• The difference between years was not significant. This may well be a statistical power problem as there is a clear and plausible trend

CONCLUSIONS

Most all mild-to-moderate TBI can complete the BIVSS

There was significant mean score separation between TBI & non-TBI groups (on both 28 & 18-item versions)
• No diff between soldier vs. non-soldier TBI groups
• No diff btw 1st vs. 3rd yr. non-TBI opt students on 18-item BIVSS, but groups differed on 28-item BIVSS
  • 8/10 questions not included on abbreviated BIVSS contributed to discriminating 1st vs. 3rd yr. non-TBI opt student groups

BIVSS raw scores mirror Rasch computed scores, so use of raw scores may be clinically appropriate

Specificity = 96% / sensitivity = 76% / accuracy = 90%
The 18-item version better at discrimination with higher total scores, but less so with lower raw score totals
• Most likely to miss TBIs with low-level symptoms

The cutoff scores (indicating a significant vision problem) were 45 & 28 (for the full 28-item BIVSS & the 18-item reduced set, respectively)

Rasch analysis assumes a single dimension drives the responses to all of the questions. Factor analysis of the 28-item BIVSS results suggested multiple underlying factors may have contributed
• To confirm, a larger BIVSS TBI database is needed

BIVSS scores appear to trend downward as a function of time since the brain injury

Future research with the BIVSS is planned

DISCLAIMER

• The BIVSS appears to have a very clear association with TBI, but it is not diagnostic. There are other vision problems that may score high on the BIVSS
• We use the sum of the BIVSS as a convenient scoring method for clinicians after including questions based on Rasch analysis.
• There was missing data. Missing values were filled in by the integer of the mean of that question across subjects within a group and the mean of all the questions for that subject.

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