Validating the perioperative thirst discomfort scale for measuring thirst discomfort prior to procedures

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### Abstract

**Introduction**

**Methods**

**Results**

**Conclusion**

Clinical trial number: Not applicable

Keywords: fasting, aspiration, patient safety, thirst, anesthesia, nursing, Mokken scale, scale development, item response theory

## Declarations

Availability of data and material (data transparency): All data used is available [here](https://aconway.dev/ptds).

Code availability: Code to reproduce the analyses is available [here](https://github.com/awconway/ptds).

Abbreviated title: Perioperative thirst discomfort scale

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# Introduction

Pre-procedure fasting has been historically implemented to reduce the risk of vomiting and aspiration pneumonia with general anaesthesia, or in case emergency intubation is required due to unexpected cardiac arrest.[1, 2] However, prolonged fluid restriction causes thirst symptoms to develop (e.g., dry mouth, swollen tongue), which can lead to great discomfort.[3] Current guidelines related to pre-procedure fasting for elective procedures recommend a minimum fasting period of 2 hours nil-per-os (NPO) for clear fluids.[4] Despite these recommendations, current practice is for patients undergoing surgical and other medical procedures that require sedation or anesthesia to receive standardized ‘nil-by-mouth’ fasting instructions at a pre-specified time interval before procedures. For example, ‘no eating or drinking after midnight’ is most common. This ‘standardized’ instruction will not be changed regardless of whether or not there are alterations in scheduling throughout the day that result in significant delays in procedure start time. As a result, fasting durations far exceed the recommended requirement for most patients undergoing medical and surgical procedures.[5–7] For example, in a recent study of 3641 fasting orders at a large academic institution in the USA, it was found that the median fasting duration was 12.8 hours, averaging 2 missed meals.[6]

As a direct result of prolonged pre-procedure fasting, symptoms of thirst discomfort have been reported as common and severe. In a qualitative study where 12 participants were interviewed from a tertiary hospital in Australia, surgical patients and patients who adhered to prolonged fasting instructions (e.g., NPO for two days) for tests, procedures or symptom management (e.g., bowel obstruction) described the discomfort from thirst symptoms to be more unbearable than hunger.[8] Similarly, Madsen et al. interviewed a convenience sample of 50 adult surgical patients who reported that thirst symptoms caused more discomfort than hunger, sleep, or anxiety related to the procedure.[3] However, thirst and its symptoms continue to be undervalued, under-reported and infrequently assessed by health care providers, including the nursing team.[9]

Despite the relevance and value of assessing thirst-discomfort of patients, the subjective experience of thirst presents challenges in developing a valid and reliable tool to succinctly and accurately measure its symptoms and level of discomfort prior to procedures. A thirst-discomfort scale for perioperative use was developed at a surgical centre affiliated with an accredited public hospital in Brazil.[10] The perioperative thirst-discomfort tool was developed in three stages, including face and content validation and reliability, and based on the Consensus-based Standards for the selection of health status Measurement Instruments (COSMIN) checklist.[11] Inter-rater reliability was tested through inter-observer equivalence where a pair of nurses independently, but simultaneously administered the scale among 70 patients. Six items on the scale had a weighted kappa coefficient of 1, while the item “I feel like drinking water” was 0.97.[10] Cronbach’s alpha was used to test the internal consistency of the scale with a value of 0.91.[10]

Although the Perioperative Thirst Discomfort Scale was developed in a different context (e.g., surgical use), it demonstrates strong potential for accurately assessing thirst-discomfort in patients before medical procedures more generally. For this reason, the aim of this study was to test the validity and reliability of the Perioperative Thirst Discomfort Scale for measuring thirst discomfort prior to procedures.

# Methods

## Study Design

This study used a prospective, observational design. No changes to usual clinical practice were made for this study in regard to pre-procedure fasting. Patients who were scheduled for a morning procedure were typically asked to remain nil-per-os (NPO) from midnight. Patients with afternoon procedures can have a small breakfast but must remain NPO from 6:00am on the day of the procedure. Ethics approved by….

## Participants

### Inclusion criteria

Adult patients undergoing an elective procedure in the Cardiac Catheterization Laboratories or in Interventional Radiology at the Toronto General Hospital were included.

### Exclusion criteria

1. Under 16 years of age
2. Undergoing an emergency procedure
3. Unable to understand or speak English and a translator is not immediately available
4. Nurse in pre-procedural bay considered that there was insufficient time prior to anticipated commencement of the procedure for participation in the study.

## Data collection

A Research Assistant administered a brief questionnaire prior to procedures. It comprised the following components:

* the Perioperative Thirst Discomfort Scale (7 items);
* a one-item global thirst discomfort rating;
* a one-item thirst intensity rating;
* an item to determine if the participant is currently on oxygen therapy;
* an item to evaluate the presence of pain;
* the time the patient last had any clear fluids;
* the time the patient last had any food;
* age, sex of patient and type of procedure to be performed.

*Seven-item Perioperative Thirst Discomfort Scale (PTDS-7)*

The PTDS-7 is a 7-item self-reported, composite score evaluating the severity of dry mouth, lips, and throat, thick tongue and saliva, a bad taste in the mouth, and a desire to drink water. The total score can range from 0 to 14, with 14 representing the “most extreme” intensity of discomfort related to perioperative thirst. This instrument was developed and validated for perioperative use in a surgical centre at a public hospital in Brazil. Face validation was conducted by group consisting of nurses with PhDs, new graduate nurses, and patients. Content validation was conducted by a team consisting of specialists with perioperative nursing experience related to thirst or instrument validation. The reliability of the scale was assessed through inter-observer equivalence by a research nurse and a staff nurse from the Post Anesthesia Care Unit among 70 patients pre and postoperatively in an anesthetic recovery room. The Cronbach alpha score was 0.91. The time taken to complete the Perioperative Thirst Discomfort Scale was not evaluated.

*Global thirst discomfort score*

Participants were asked to rate their overall level of thirst discomfort on a rating scale with score ranging from “extreme thirst discomfort” to “extreme comfort”.

*Thirst intensity rating*

Participants will be asked to rate the intensity of their thirst on a scale ranging from 0 to 10, where 0 represents “No thirst” and 10 represents “Most intense thirst”.

*Pain scale rating*

The experience of pain may influence the participant’s perception of thirst.[12] Participants were asked to rate their current level of pain on a scale of 0 to 10, where 0 represents “no pain” and 10 represents that their pain as “unimaginable/unspeakable”.

*Use of oxygen therapy*

The use of oxygen therapy (e.g., via nasal prongs) may contribute to the experience of thirst symptoms (e.g., dry mouth, dry throat).[13]. The RA recorded “yes” or “no” as to whether the participant was currently receiving oxygen therapy at the time the questionnaire was administered.

## Statistical analysis

Mokken scaling analyses properties of individual items as described by the item characteristic curve. Item characteristic curves show the association between the score on an item to the level of the latent trait being measured. Mokken scaling makes no assumptions about this association, apart from the assumption of monotone homogeneity. This means that when the trait increases, so does the item score. “Difficulty”, is a term used in Mokken Scale Analysis to refer to the extent to which items are endorsed by respondents. Items at the upper end of the range of the latent trait being more difficult. Items in a Mokken Scale are arranged along the latent trait in terms of their difficulty. The properties of items can be measured using the scalability coefficient, *H* (Loevinger’s coefficient). *H* measures the extent to which items are arranged as expeceted by their mean values along the latent trait. *H* > 0.3 is the minimum acceptable value, with values > 0.4 indicating a moderate scale and > 0.5 indicates a strong scale. Invariant item ordering, where where the order of items along the latent trait is the same for all respondents at all levels of the latent trait, is a desirable property of a Mokken Scale. It can be assessed mathematically to look for significant violations of this property. The accuracy of the invariant item ordering can also be assessed by calculating the HTRANS (HT) coefficient. Values of HT exceeding 0.3 indicates acceptable accuracy of invariant item ordering.

Mokken scale analysis was conducted in this study to explore whether there were hierarchical properties in participant ratings of thirst discomfort and to explore the dimensions of the PTDS. Mokken scale analysis proceeded by first checking the PTDS-7 scalability coefficients. If Hi was below 0.3 or if the lower limit of the 95% CI (confidence interval) for Hi was below 0.3, the item was excluded. Then, scale partitioning was carried out to explore the dimensions of the PTDS through increasing c (Lower bound c defines the minimum value of coefficients Hi in the Mokken scale by 0.05 increments).[14] Monotone homogeneity and invariant item ordering were investigated at the whole scale level, as no sub-scales were identified.

To assess invariant item ordering, crit values <40 were considered acceptable.[14]

Accuracy - Values below 0.3 are unacceptable and above 0.4 indicates moderate invariant item ordering.[15]

Construct validity was evaluated by using correlations to identify associations between scores on the Perioperative Thirst-Discomfort Scale and fasting duration. To demonstrate construct validity we hypothesised that higher scores on the Perioperative Thirst Discomfort Scale would be associated with greater fasting duration. Convergent validity was assessed by using Kendall’s tau to compare the Perioperative Thirst Discomfort Scale score with the global thirst discomfort score. Convergent validity was assessed by using the Spearman’s rank correlation to compare the Perioperative Thirst Discomfort Scale with the thirst intensity rating and pain scale rating. Chi-square analysis was used to evaluate the association between Perioperative Thirst Discomfort Scale score and use of oxygen supplementation.

# Results

## Participants

From November 2019 to March 2020, we screened 203 patients for inclusion in the study. A total of 198 were eligible and 193 chose to participate. A summary of participant characteristics is displayed in Table . The median age was 62 (IQR 48 - 72) and 58% (n=111) were female. 43% of patients were scheduled to have their procedure in the cardiac catheterization laboratory. A biopsy was the most common Interventional Radiology procedure (n=62; 32%), but a wide range of other procedures were included.

## Mokken scale analysis

No items required removal from the PTDS-7 based on the condition that scalability coefficients (Hi and lower bound of 95% CI) should be over 0.3 (Appendix Table ). We used a lower bound for *c*, starting from 0.05 and increasing to 0.80 in 0.05 increments, to explore the dimensionality of the PTDS. From 0.05 to 0.45, all of the items formed a single scale. The item, *‘I have a bad taste in my mouth’*, was excluded by selecting the remaining items which showed uni-dimensionality at a threshold level of .50. The 6 remaining items (PTDS-6) were further examined for the criteria of a Mokken scale and item invariant ordering. The PTDS-6 item set has a homogeneity value H(se) of 0.599, (0.034), which indicated a strong Mokken scale. Results indicated that there were no significant violations of the assumption of monotonicity (z-sig). As such, no items were removed based on this criteria.

### Invariant item ordering

Analysis of invariant item ordering for the PTDS-6 revealed violations for the dry throat/dry lips item pair (Appendix Table ). Although there were no *significant* intersections between items, due to the intersection between the dry throat and dry lips items, crit values were above 40. For this reason, we excluded one of these items (dry throat), and re-assessed the remaining 5 items for the assumptions of a Mokken scale. With the dry throat item removed, none of the items violated the assumption of invariant item ordering (Appendix Table ).

### Accuracy and reliability

The accuracy of the item ordering was found to be acceptable with a HT coefficient of 0.397. Scale reliability was adequate with a coefficient score (Rho) of 0.84.

### Item difficulty hierarchy

The most highly endorsed symptom (i.e. the least severe symptom of thirst discomfort in the PTDS-5) was being bothered by a desire to drink water (Table ). The least endorsed symptom (i.e. the most severe symptom of thirst discomfort in the PTDS-5) was being bothered by the perception of a ‘thick tongue’. The items in the PTDS-5 form a strong Mokken scale (Hs = 0.605), meaning it is a reliable and precise way to order patients according to their thirst discomfort.

## Construct validity

PTDS-5 and Age

PTDS-5 and Food/fluid duration

PTDS-5 and global thirst

PTDS-5 and thirst intensity

PTDS-5 and pain

# Discussion

The items in the PTDS-5 form a strong Mokken scale (Hs = 0.605), meaning it is a reliable and precise way to order patients according to their thirst discomfort. In addition, an acceptable accuracy for invariant item ordering was identified, meaning patients are likely to rank the PTDS-5 symptoms of thirst discomfort in the same way. Discuss clinical usefulness of the scale… Comment on the results for the item difficulty hierarchy (least severe symptom to most severe symptom).

Contrast with results of previous study…The perioperative thirst-discomfort tool has previously been used to determine the relationship between thirst intensity and thirst-discomfort in the immediate postoperative period during anesthesia recovery.[12] In a non-probabilistic sample of 203 adult participants awaiting elective, urgent and emergency surgeries, the investigators found no association between the fasting time, or patient age, and the intensity of thirst and degree of discomfort.[12] However, the mean fasting time among participants was quite high at 16.2 hours (SD 8.7 hours), which may have prevented the researchers from discerning correlation between fasting time and thirst as even with 8 hours of fasting all participants reported thirst.[12, 16] There was no correlation between age, and intensity of thirst and thirst-discomfort, but few elderly patients were recruited to the study with a mean age of 41.5 years old (SD 15.8 years).

* The dimensionality of the PTDS had not been performed prior to our study. A multi-dimensional solution was not apparent, although this was to be expected with the small number of items that were evaluated.
* Lack of association between PTDS-5 and fasting duration. As such it is important to assess thirst discomfort periodically, regardless of the duration of fasting. If thirst discomfort is present, and fasting is still indicated, interventions to alleviate symptoms should be implemented. It should be noted, though, that there is a lack of evidence regarding the efficacy of any such interventions…

## Limitations

* convenience sample (selection bias can not be ruled out)
* generalize to other procedural settings?
* Low amount of missing data
* Further research required to evaluate the minimal detectable difference in the PTDS-5 and the minimal clinically important difference…

## Conclusion

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# Figure legend

Fig. Association between PTDS-5 and thirst intensity

Fig. Association between PTDS-5 and global thirst rating

Fig. Association between PTDS-5 and duration of fasting

Table : Participant characteristics

| Characteristic | N = 1931 |
| --- | --- |
| *Age* | 62 (48, 72) |
| *Gender* |  |
| Male | 111 (58%) |
| Female | 80 (42%) |
| Prefer not to say | 1 (0.5%) |
| *Procedure* |  |
| Angiogram or Percutaneous Coronary Intervention (PCI) | 58 (30%) |
| Cardiac Implantable Electronic Device (CIED) | 15 (7.8%) |
| Electrophysiology Study (EPS) | 5 (2.6%) |
| Structural heart intervention | 5 (2.6%) |
| Vascular angiography or intervention | 17 (8.9%) |
| Biopsy | 62 (32%) |
| Port-a-cath | 4 (2.1%) |
| Gall bladder stone removal | 0 (0%) |
| Endovascular aneurysm repair (EVAR) | 0 (0%) |
| Radiofrequency ablation of a tumour (RFA) | 9 (4.7%) |
| Fistula repair/de-clotting | 0 (0%) |
| Vascular embolization (e.g., renal) | 1 (0.5%) |
| Other procedure | 16 (8.3%) |
| *Time since last clear fluids (hours)* | 9.5 (5.0, 13.0) |
| *Time since last food (hours)* | 13.0 (11.0, 15.0) |
| 1Statistics presented: median (IQR); n (%) | |

Table : Item hierarchy of the PTDS-5

| item | mean | Hi | se |
| --- | --- | --- | --- |
| I want to drink water | 2.10 | 0.56 | 0.054 |
| My mouth is dry | 1.80 | 0.62 | 0.044 |
| My lips are dry | 1.69 | 0.63 | 0.041 |
| My saliva is thick | 1.51 | 0.57 | 0.050 |
| My tongue is thick | 1.43 | 0.65 | 0.042 |

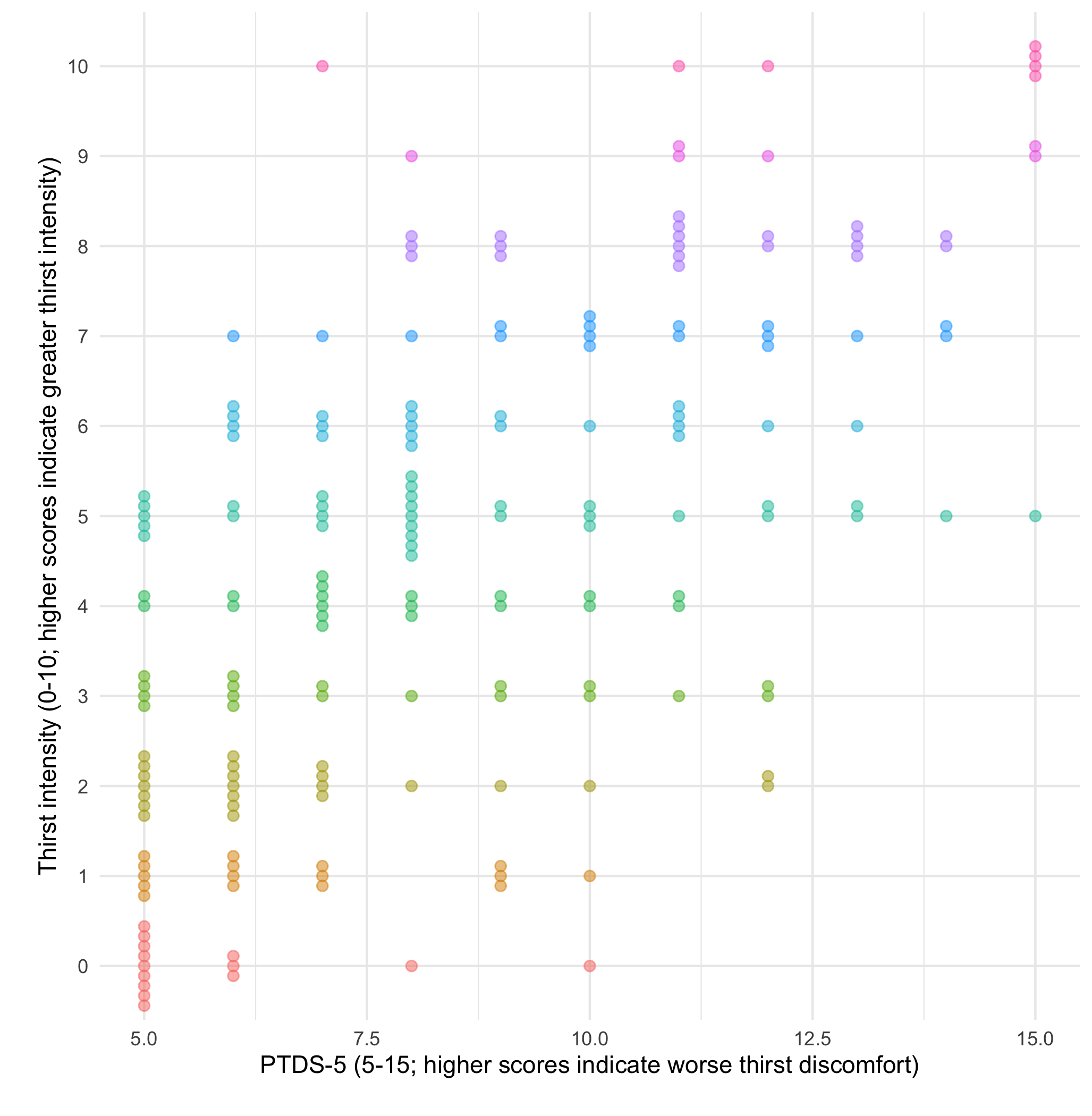


Figure : Association between PTDS-5 and thirst intensity. PTDS-5 score ranges from 5 to 15 with higher scores indicating worse thirst discomfort.

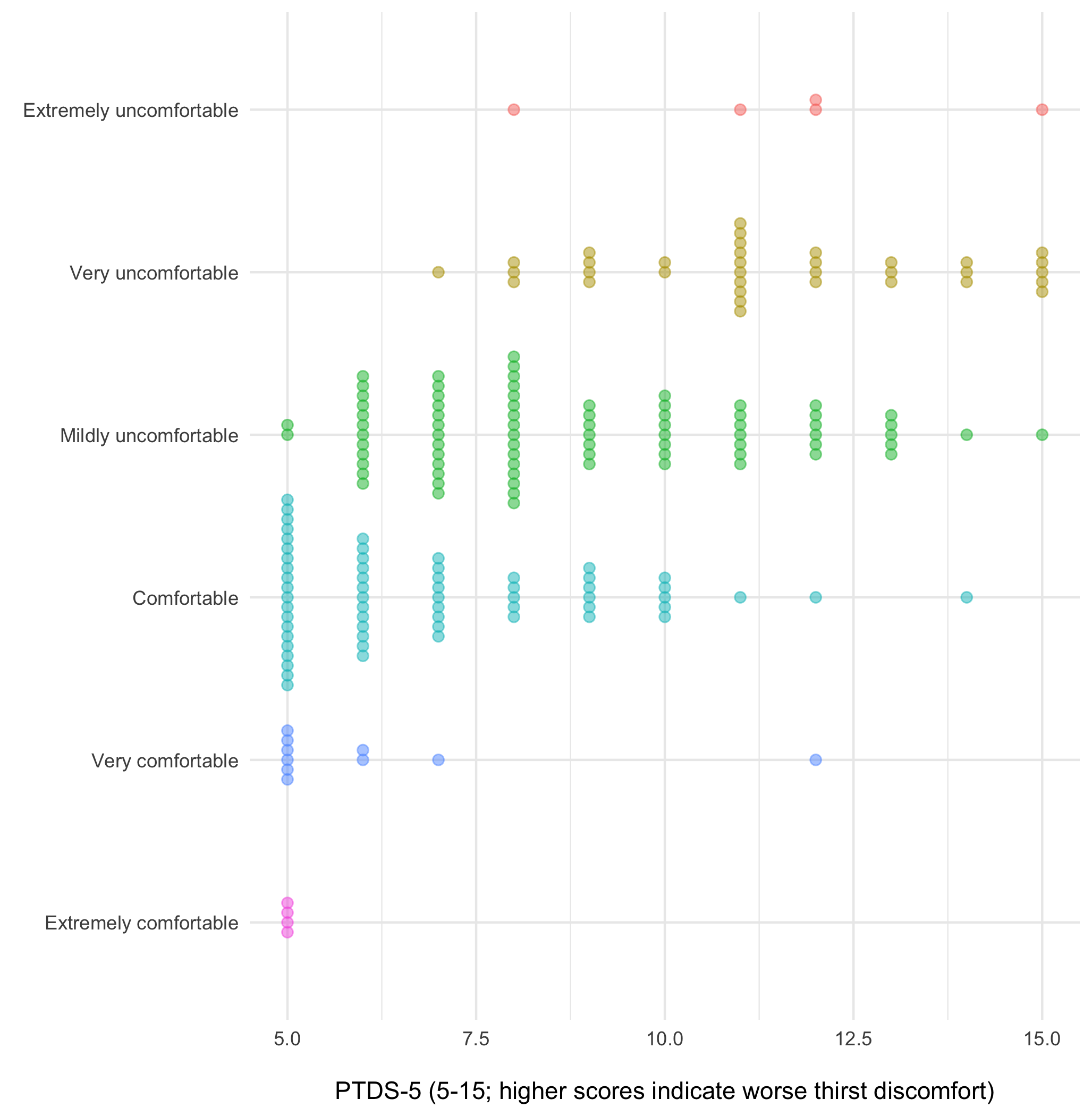


Figure : Association between PTDS-5 and global thirst rating

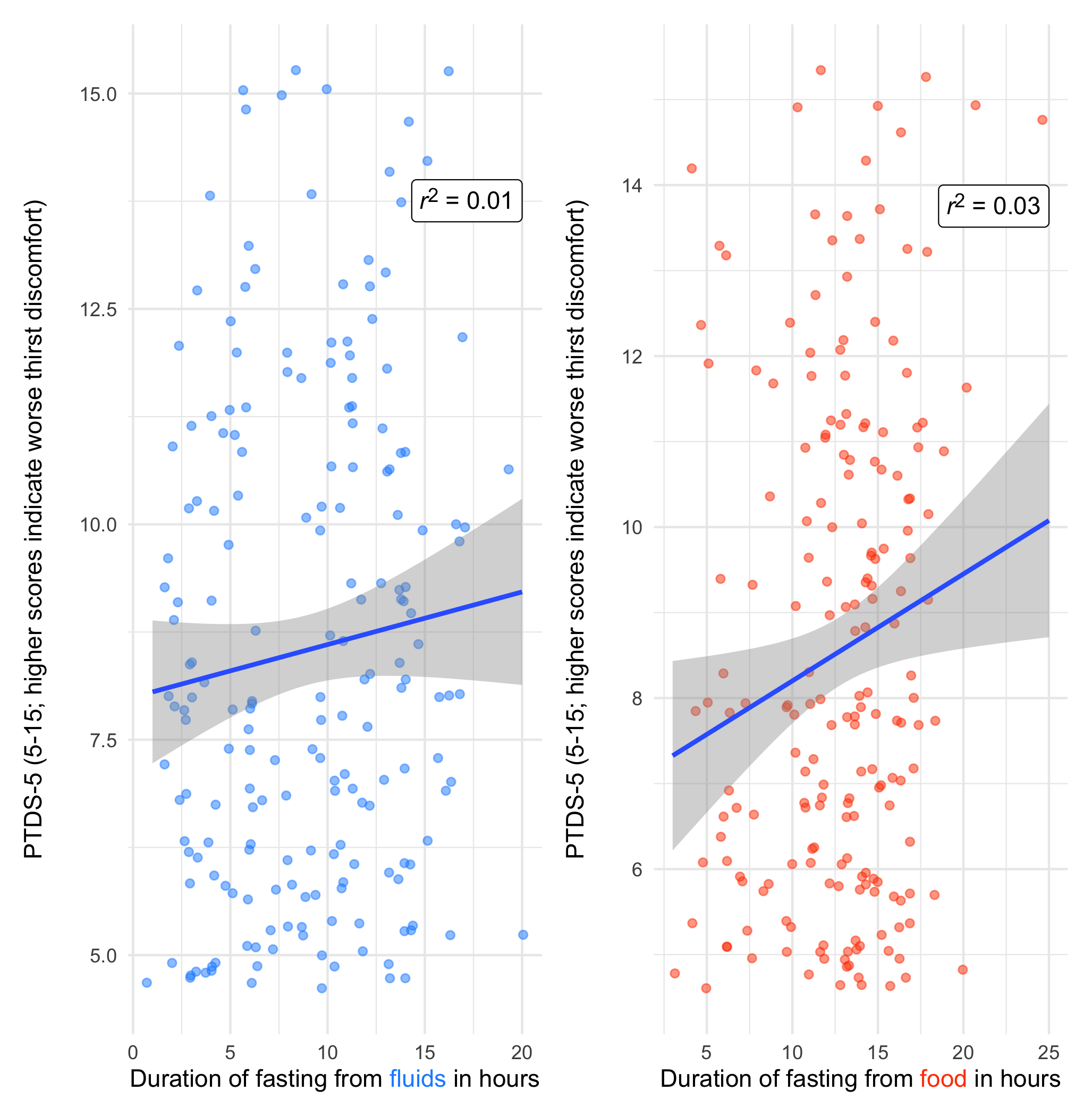


Figure : Association between PTDS-5 and duration of fasting

# Appendix

Appendix Table : Homogeneity values (and standard errors) for all items in the PTDS

| Item | Hi | SE |
| --- | --- | --- |
| My mouth is dry | 0.589 | 0.044 |
| My lips are dry | 0.556 | 0.041 |
| My tongue is thick | 0.605 | 0.044 |
| My saliva is thick | 0.567 | 0.043 |
| My throat is dry | 0.566 | 0.043 |
| I have a bad taste in my mouth | 0.457 | 0.056 |
| I want to drink water | 0.574 | 0.047 |

Appendix Table : monotonicity with default minsize

| item | ItemH | #ac | #vi | #vi/#ac | maxvi | sum | sum/#ac | zmax | #zsig | crit |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| My mouth is dry | 0.62 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My lips are dry | 0.60 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My tongue is thick | 0.63 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My saliva is thick | 0.57 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My throat is dry | 0.59 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I want to drink water | 0.59 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Appendix Table : aisp for increasing H thresholds (*c*)

| Item | 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 | 0.55 | 0.60 | 0.65 | 0.70 | 0.75 | 0.80 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| dry\_mouth | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 |
| dry\_lips | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 |
| thick\_tongue | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| thick\_saliva | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| dry\_throat | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 0 | 0 |
| bad\_taste | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| water | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 0 | 0 |

Appendix Table : Invariant item ordering for PTDS-6

| item | ItemH | #ac | #vi | #vi/#ac | maxvi | sum | sum/#ac | tmax | #tsig | crit |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| I want to drink water | 0.60 | 5 | 0 | 0.0 | 0.00 | 0.00 | 0.0000 | 0.00 | 0 | 0 |
| My mouth is dry | 0.62 | 5 | 0 | 0.0 | 0.00 | 0.00 | 0.0000 | 0.00 | 0 | 0 |
| My lips are dry | 0.59 | 5 | 1 | 0.2 | 0.09 | 0.09 | 0.0176 | 1.43 | 0 | 43 |
| My throat is dry | 0.60 | 5 | 1 | 0.2 | 0.09 | 0.09 | 0.0176 | 1.43 | 0 | 42 |
| My saliva is thick | 0.57 | 5 | 0 | 0.0 | 0.00 | 0.00 | 0.0000 | 0.00 | 0 | 0 |
| My tongue is thick | 0.63 | 5 | 0 | 0.0 | 0.00 | 0.00 | 0.0000 | 0.00 | 0 | 0 |

Appendix Table : Invariant item ordering for PTDS-5

| item | ItemH | #ac | #vi | #vi/#ac | maxvi | sum | sum/#ac | tmax | #tsig | crit |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| I want to drink water | 0.56 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My mouth is dry | 0.62 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My lips are dry | 0.63 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My saliva is thick | 0.57 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| My tongue is thick | 0.65 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |