

## Postural torsion syndrome algorithm (PTSA) as a method to quantify musculoskeletal health and predict injury.

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### Abstract

**Introduction:** In Physical Therapy, developing proper preventive healthcare will require screening tools effective in identifying predictors of pain and injury. Postural Torsion Syndrome Algorithm (PTSA) is a musculoskeletal screening tool that uses a 5-point system measuring a specific angle of hypomobility in twenty key articulations on each side of the body. This measurable dysfunction can be used to predict injury and serve as a treatment guide justifying preventative care.

**Objective:** The goal of this research was to determine PTSA ability to assess and quantify musculoskeletal health and potential of injury.

**Method:** The subjects reported medical history, number of pathologies, severity of pain, and comorbidities. They were then assessed using PTSA. Severity of pain was graded as: 1 – Mild pain; 2 – Moderate; 3 – Severe. PTSA score of 70%, 65%, and 60% were used to find out the cut-off values and thus, the study subjects were divided into 2 groups, i.e.,  $\geq 70\%$  and  $< 70\%$ ,  $\geq 65\%$  and  $< 65\%$ , and  $\geq 60\%$  and  $< 60\%$ , respectively. Receiver Operating Characteristic (ROC) curve was used to find out the cut-off values of PTSA score, and thus, an appropriate sensitivity and specificity.

**Conclusion:** The present study reported inverse correlation between PTSA score for participants, number of pathologies, severity of pain, and comorbidities. In addition, sensitivity and specificity was found to be 100%. Future studies should be performed with larger number of subjects to prove PTSA assessment effectiveness in quantifying musculoskeletal health and potential of injury.

**Keywords:** Postural torsion syndrome, Postural torsion syndrome algorithm, Predictor of musculoskeletal health, Gravitational biology, Physical therapy assessment, Injury prevention, Physical therapy, Predictor of health.

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### Introduction

Currently in the United States healthcare model, treatment occurs after the patient becomes symptomatic. Waiting until we recognize the problem by patient complaints limits our capacity for quality physical and mental health. With this model, the US spends more on healthcare per capita than every other nation.

In Physical Therapy, developing proper preventive healthcare will require screening tools effective in identifying predictors of pain and injury. Our current tools render themselves ineffective, because they only measure function, which is too variable for accurate assessment [1]. Nevertheless, these inadequate tools are the standard practice for determining a need for skilled interventions and insurance coverage.

Musculoskeletal health depends upon the body's ability to support itself under gravity by way of efficient form. The loss of this efficiency results in a predictable collapse due to constant gravitational force, creating the foundation for Postural Torsion Syndrome Algorithm (PTSA). Gravitational biology dictates, "As a consequence, all biological processes are accustomed to the ever-present force of gravity and even small variations in this force can have significant impact on the health and function of organisms" [2,3]. These disease processes that result from a

failure in our Musculo-Skeletal System (MSS) are not limited to the MSS but will result in a myriad of pathologies affecting all other systems [4].

PTSA is a musculoskeletal screening tool that uses a 5-point system measuring a specific angle of hypomobility in twenty key articulations on each side of the body (Figure 1).

These articulations are susceptible to gravitational forces and can collapse when gravities forces exceed their thresholds for sustaining structural integrity [5]. As a result, these articulations are key drivers of posture and movement. Limitations can be measured in a way that reflects the group dysfunction of that region. This measurable dysfunction can be used to predict injury and serve as a treatment guide justifying preventative care (Figure 2) [6].

### Methodology

#### Design

Quantitative study.

#### Participants

This study recruited participants associated with AZA Health & Wellness LLC.

Hypomobility Scale	% Health	Hypomobility
0	100	Normal/NA
1	75	Minimal
2	50	Moderate
3	25	Significant
4	0	Immobile

*Figure 1: 5-point hypomobility scale.*

## Postural Torsion Syndrome Algorithm Scoring

**Musculoskeletal Health %** is an indicator of overall MSS health

- ▶ A **high %** indicates **good health** and decreased risk for an injury
- ▶ Inversely **low %** indicated **poor health** and increased risk of injury
- ▶ Based on hypomobility of 40 articulations (20 each side)
- ▶ Regions categorized as follows
  - ▶ Whole Body (40)
    - ▶ Lower Extremities (8/side)
    - ▶ Spine (4/side)
    - ▶ Upper Extremities (4/side)
    - ▶ Head (4/side)
  - ▶ Right and Left side (20/each)

*Figure 2: 5-point hypomobility scale interpretation.*

### Inclusion criteria

Participants between the ages of 34 to 73 with education appropriate to complete questionnaires.

### Exclusion criteria

Participants who were unable to complete questionnaires were excluded.

### Outcome measures

Participants complete information general health questionnaire listing medical history, body chart identifying symptomatic regions using pain scale 0-10, and assessed using PTSA.

### Procedure

The pilot study was completed at AZA Health & Wellness office in California, USA in February 2019. Participants completed questionnaire, body chart, and physical therapy functional outcome tools then submitted information to a 3<sup>rd</sup> party to prevent bias from Dr. Armia Abdo, DPT performing PTSA assessment. PTSA assessment was gathered and entered in an excel spreadsheet.

PTSA assessment was performed in supine for each posture driver by stabilizing the proximal segment was placed into a neutral position or close as possible and then stabilized. Distal segment was then into a down and in direction (flexion, adduction, and internal rotation) with amount of assistance graded using hypomobility scale (Table 1). Exceptions were noted for first 3 articulations of the foot given their orientation to midline; using flexion, abduction, and internal rotation. See 1.A for posture drivers assessed. Assessment was performed in order presented in graph.

### 1.A Posture drivers

#### Lower extremity (8/side):

- 1<sup>st</sup> MTP
- Naviculocuneiform
- Talocalcaneal
- Talocrural
- Distal Tibiofibular
- Proximal Tibiofibular
- Tibiofemoral
- Patellofemoral

#### Spine (4/side):

- Anterior Superior Iliac Spine on femur
- R7 costosternal
- R2 costosternal
- Sternoclavicular

#### Upper extremity (4/side):

- 1<sup>st</sup> MCP
- Distal radioulnar/scaphoid
- Proximal Radioulnar/humeral
- Glenohumeral

#### Head (4/side):

- C7 on T1
- C1 on C2
- Temporomandibular
- Pterion

Excel spread was sent for data analysis. Subjective information was consolidated into an excel spread sheet and sent for analysis.

After data analysis, correlation was examined between PTSA scores, pain severity, number of pathologies, and co morbidities. Sensitivity and specificity were also determined for PTSA scores for various cut off values.

### Data Analysis

The subjects were enquired about the number of pathologies, severity of pain, and comorbidities. They were then subjected to the standard questionnaires and final PTSA scores of Head, Arms, Spine, and Legs were calculated. For statistical analysis, the higher grade of pain was considered, i.e., whenever the pain was graded as minimal to moderate and moderate to severe, it was considered as moderate and severe, respectively. Similarly, severity of pain was graded as: 1-Mild pain; 2-Moderate; 3-Severe. PTSA score of 70%, 65% and 60% were used to find out the cut-off values and thus, the study subjects were divided into 2 groups, i.e.,  $\geq 70\%$  and  $<70\%$ ,  $\geq 65\%$  and  $<65\%$ , and  $\geq 60\%$  and  $<60\%$ , respectively. ROC curve was used to find out the cut-off values of PTSA score, and thus, an appropriate sensitivity and specificity.

## Results

The subjects were enquired about the number of pathologies, severity of pain, and comorbidities. They were then subjected to the standard questionnaires and final PTSA scores of Head, Arms, Spine, and Legs were calculated. For statistical analysis, the higher grade of pain was considered, i.e., whenever the pain was graded as minimal to moderate and moderate to severe, it was considered as moderate and severe, respectively. Similarly, severity of pain was graded as: 1-Mild pain; 2-Moderate; 3-Severe. PTSA score of 70%, 65%, and 60% were used to find out the cut-off values and thus, the study subjects were divided into 2 groups, i.e.,  $\geq 70\%$  and  $<70\%$ ,  $\geq 65\%$  and  $<65\%$ , and  $\geq 60\%$  and  $<60\%$  respectively. ROC curve was used to find out the cut-off values of PTSA score, and thus, an appropriate sensitivity and specificity

The present pilot study involved 9 subjects, of which 8 completed the questionnaire and their data is presented in following tables. Subjects with their PTSA scores, pathologies, pain severity, and comorbidities are summarized in Table 2.

Mean age of the study subjects was  $53 \pm 16.46$  years, and age ranged from 34 to 73 years. Men and women were equally distributed (1:1) (Table 3).

Maximum number of pathologies ( $3.38 \pm 2.92$ ) and maximum severity of pain (median=2) were observed in legs (Table 4).

PTSA scores were correlated with the severity of pain and it was observed that the PTSA scores were inversely correlated to the severity of pain i.e., as severity of pain decreases, PTSA score increases (Table 5). However, none of the PTSA scores were significantly correlated to severity of pain, except Arm PTSA score ( $p$ -value=0.002).

Similarly, various PTSA scores were correlated with the number of pathologies and it was observed that PTSA scores were inversely correlated to the number of pathologies (Table 6). However, none of the PTSA scores were significantly correlated to number of pathologies, except Arm PTSA score ( $p$ -value=0.013).

Moreover, PTSA scores were also observed to be inversely correlated to the number of pathologies (Table 7). However, in this case, both Spine ( $p$ -value=0.011) and Leg PTSA scores ( $p$ -value=0.008) were significantly correlated to the comorbidities.

After comparing hypomobility scale with PTSA score (%), it was observed that all the study subjects had minimal hypomobility (Table 1).

### Receiver operating characteristic (ROC) curve analysis

Spine ( $p$ -value=0.025), Leg ( $p$ -value=0.046), and Arm ( $p$ -value=0.025) PTSA scores had a sensitivity and specificity of

SUBJECT #	HEAD PATHOLOGIES	HEAD SCORE PTSA	SPINE PATHOLOGIES	SPINE SCORE PTSA	LEG PATHOLOGIES	LEG SCORE PTSA	ARM PATHOLOGIES	ARM SCORE PTSA
1	1 INTERMITTENT MODERATE PAIN	58.00%	1 INTERMITTENT MODERATE- SEVERE	73.00%	2 MODERATE PAIN	71.00%		75.00%
3	4 MINIMAL PAIN	55.00%	9 MINIMAL- MODERATE PAIN	45.00%	4 MINIMAL- MODERATE PAIN	56.00%	4 MINIMAL PAIN	68.00%
4	3 MINIMAL- MODERATE PAIN	55.00%	3 MINIMAL PAIN	65.00%	3 MINIMAL	68.00%	3 MINIMAL PAIN	68.00%
5	3 MINIMAL PAIN	60.00%	2 MINIMAL PAIN	70.00%	3 INTERMITTENT MINIMAL- MODERATE PAIN	74.00%	2 MINIMAL PAIN	68.00%
6	2 MINIMAL PAIN	65.00%	1 MINIMAL PAIN	70.00%	10 MINIMAL PAIN	60.00%	3 MINIMAL PAIN	55.00%
7	1 INTERMITTENT MODERATE PAIN	70.00%		65.00%	3 MODERATE PAIN	61.00%		90.00%
8	2 MINIMAL PAIN	65.00%	2 MINIMAL PAIN	63.00%		65.00%	1 MINIMAL PAIN	68.00%
9	1 MINIMAL PAIN	60.00%	3 MINIMAL- MODERATE PAIN	53.00%	2 MINIMAL- MODERATE PAIN	58.00%		70.00%
LEGEND					MEANING			
					<70% PTSA SCORE			
					OTHER SYSTEM DYSFUNCTION INVOLVED			

Table 1. Summary of subjects with their PTSA scores, pathologies, pain severity, and comorbidities.

Demographic parameters	N = 8
Age (Mean ± SD) (Years)	53 ± 16.46
Gender ratio (Male:Female)	1:1

**Table 2.** Demographic profile of the study subjects.

Characteristics	Head	Spine	Legs	Arms
Number of pathologies (Mean ± SD)	2.13 ± 1.13	2.63 ± 2.77	3.38 ± 2.92	1.63 ± 1.59
Severity of pain (Median)	1	1	2	1
Number of subjects with comorbidities	6/8 (75%)	4/8 (50%)	3/8 (37.5%)	2/8 (25%)

**Table 3.** Clinical characteristics of the study subjects.

Total no. of subjects with painful symptoms	PTSA Scores	Severity of pain	p-value
8/8	Head Score	- 0.115*	0.787
7/8	Spine Score	- 0.058*	0.891
7/8	Leg Score	- 0.069*	0.872
5/8	Arm Score	- 0.900*	0.002

\* - Spearman's correlation coefficient; p-value < 0.05 was considered as statistically significant.

**Table 4.** Correlation between various PTSA score and severity of pain.

Total no. of subjects with pathologies	PTSA Scores	No. of pathologies	p-value
8/8	Head Score	- 0.575#	0.136
7/8	Spine Score	- 0.693*	0.057
7/8	Leg Score	- 0.331*	0.423
5/8	Arm Score	- 0.817*	0.013

# - Pearson's correlation coefficient; \* - Spearman's correlation coefficient; p-value < 0.05 was considered as statistically significant.

**Table 5.** Correlation between various PTSA score and number of pathologies.

Total no. of subjects with comorbidities	PTSA Scores	Comorbidities	p-value
6/8	Head Score	- 0.257*	0.540
4/8	Spine Score	- 0.828*	0.011
3/8	Leg Score	- 0.845*	0.008
2/8	Arm Score	- 0.604*	0.113

\* - Spearman's correlation coefficient; p-value < 0.05 was considered as statistically significant.

**Table 6.** Correlation between various PTSA score and comorbidities.

Hypomobility scale	% Health	Hypomobility	Number of study subjects
0	76-100	NO	0
1	51-75	Minimal	8
2	26-50	Moderate	0
3	1-25	Significant	0
4	0	Immobile	0

**Table 7.** Distribution of study subjects based on hypomobility.

100% with cut-off values of 67.5, 69.5, and 69.0, respectively. Similarly, Head PTSA (p-value=0.025) score had a sensitivity and specificity of 100% with cut-off values of 62.5 (Table 8).

Thus, Spine, Leg, and Arm PTSA scores start revealing statistically significant cut-off value at a PTSA score of ≥ 70%. While, Head PTSA score start revealing statistically significant cut-off value at a PTSA score of ≥ 65%.

## Discussion

The goal of this research was to assess PTSA ability to assess and quantify musculoskeletal health and potential of injury. The results show an inverse correlation between PTSA score for participants, number of pathologies, severity of pain, and comorbidities. In addition, Spine (p-value=0.025), Leg (p-value=0.046), and Arm (p-value=0.025). PTSA scores

had a sensitivity and specificity of 100% with cut-off values of 67.5, 69.5, and 69.0 respectively. Similarly, Head PTSA (p-value=0.025) score had a sensitivity and specificity of 100% with cut-off values of 62.5. Thus, Spine, Leg, and Arm PTSA scores start revealing statistically significant cut-off value at a PTSA score of ≥ 70%. While, Head PTSA score starts revealing statistically significant cut-off value at a PTSA score of ≥ 65%.

The results of this research indicate value with PTSA scoring to identify when subjects will experience symptoms of musculoskeletal pain, severity of the pain, and co morbidities in region below the cut off value identified.

A limitation of the current study was the small sample size (8 participants), which limited the statistical power. Therefore, the results of the present study must be interpreted with caution.

Total no. of subjects	PTSA Score	Total no. of subjects with PTSA score more than or equal to indicated	Area under ROC curve	p-value	Cut-off value	Sensitivity	Specificity
<b>Head PTSA Score</b>							
8	≥ 70%	1	1.000	0.127	67.5	100%	100%
8	≥ 65%	3	1.000	0.025	62.5	100%	100%
8	≥ 60%	5	1.000	0.025	59.0	100%	100%
<b>Spine PTSA Score</b>							
8	≥ 70%	3	1.000	0.025	67.5	100%	100%
8	≥ 65%	5	1.000	0.025	64.0	100%	100%
8	≥ 60%	6	1.000	0.046	58.0	100%	100%
<b>Leg PTSA Score</b>							
8	≥ 70%	2	1.000	0.046	69.5	100%	100%
8	≥ 65%	4	1.000	0.021	63.0	100%	100%
8	≥ 60%	6	1.000	0.046	59.0	100%	100%
<b>Arm PTSA Score</b>							
8	≥ 70%	3	1.000	0.025	69.0	100%	100%
8	≥ 60% and ≥ 65%	7	1.000	0.127	61.5	100%	100%

p-value <0.05 was considered as statistically significant.

**Table 8.** Various PTSA scores and their ROC curves with sensitivity and specificity for each cut-off value.

## Conclusion

The present study reported correlation between PTSA score for participants, number of pathologies, severity of pain, and comorbidities. In addition, sensitivity and specificity was found to be 100%. Future studies should be performed with larger number of subjects to prove PTSA assessment effectiveness in quantifying musculoskeletal health and potential of injury.

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