

INCREASING PEDIATRIC PRIMARY CARE PROVIDER WILLINGNESS TO USE  
VOMS: A THEORY OF PLANNED BEHAVIOR APPROACH

by

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As members of the DNP Project Committee, we certify that we have read the DNP project prepared by Elizabeth Arnold, titled Increasing Pediatric Primary Care Provider Willingness to Use VOMS: A Theory of Planned Behavior Approach, and recommend that it be accepted as fulfilling the DNP project requirement for the Degree of Doctor of Nursing Practice.

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## LAND ACKNOWLEDGEMENT

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

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## Abstract

**Background:** Concussions are common among the pediatric population and can cause a myriad of symptoms including vision and vestibular deficits. Even with the high occurrence of pediatric concussions, vestibular-ocular assessments are not routinely used in many primary care settings during post-concussion management. The Vestibular/Ocular Motor Screening (VOMS) is a brief, low-resource assessment tool that can inform clinical decision making during post-concussion follow-up visits.

**Purpose:** The purpose of this project was to determine whether a brief Theory of Planned Behavior (TPB) informed educational session would increase pediatric primary care providers' intentions to use the VOMS tool.

**Methods:** This single-site quality improvement project was conducted in a pediatric primary care clinic. A 30–45-minute educational session covered VOMS indications, administration, scoring, and interpretation. The participants received a quick guide, PowerPoint handout, detailed instructions and VOMS scoring sheet. Three providers completed pre- and post-education Likert surveys that included questions regarding comfort, familiarity, and confidence with VOMS. Content relevancy and intention to use VOMS were included in the post survey. Wilcoxon signed-ranks tests were used, with effect sizes calculated  $r$  as  $|Z|/\sqrt{N}$  where  $N$  is the number of non-zero pairs. Analyses were performed in SPSS, with the effect sizes computed in Excel.

**Results:** All outcomes moved in the desired direction. Comfort increased from  $M = 1.33$  ( $SD = 0.58$ ) to  $3.67$  ( $0.58$ ),  $Z = -1.63$ ,  $p = .102$ ,  $r \approx .94$ . Familiarity increased from  $2.00$  ( $0.00$ ) to  $3.67$  ( $0.58$ ),  $Z = -1.63$ ,  $P = .102$ ,  $r \approx .94$ . Confidence increased from  $3.00$  ( $0.00$ ) to  $4.00$  ( $1.00$ ) with

two improvements and one tie,  $Z = -1.34$ ,  $p = .180$ ,  $r \approx .95$ . (nonzero pairs  $N = 2$ ). Given the very small sample, tests were under-powered and non-significant (two-tailed  $p > .05$ ), but all changes were concordant with large effect sizes. Post-session items showed high perceived relevance ( $Mdn = 5$ ,  $M = 5.00$ ; 100% “Strongly agree”) and high intention to apply VOMS ( $Mdn = 5$ ;  $M = 4.67$ ; 66.7% “Strongly agree”, 33.3% “Agree”). No negative ranks were observed.

**Conclusions:** A brief, TPB-informed education was feasible, acceptable, and produced large, consistent improvements in determinants of VOMS use in a small sample. Immediate practice implications include maintaining VOMS reference materials and aids, maintaining a clinic VOMS champion, and adding EHR documentation fields to support documentation and fidelity. Future work should expand the sample, use exact nonparametric tests, explicitly measure TPB determinant of subjective norm, and track provider adoption of VOMS into their workflows.

## Background

Concussions are a common injury among children and adolescents, with incidence rates rising in recent years. In 2020, approximately 6.8% of children aged 0 to 17 reported symptoms indicative of a concussion, a figure that increases to 12.2% among adolescents aged 12 to 17 (Black & Zablotsky, 2021). Similarly, nearly 1 in 5 adolescents reported having experienced at least one concussion in their lifetime (Veliz et al., 2021). These figures highlight the significant burden of concussion in the pediatric population and the growing need for consistent, effective approaches to screening and management within primary care.

Mild traumatic brain injury (mTBI), or concussion, occurs when rapid-acceleration-deceleration forces causes diffuse neuronal depolarization. The resulting shifts in sodium and calcium require correction by ATP-dependent ion pumps and intracellular calcium-binding proteins. This surge in energy demand, together with mitochondrial calcium loading, impairs oxidative phosphorylation and increases production of reactive oxygen species (ROS). ROS then trigger pro-inflammatory signaling and glial activation, which in turn leads to neuroinflammation (Serpa, et al., 2021). Initial symptoms of concussion in pediatric patients often include headache, dizziness, fatigue, and cognitive difficulties such as slowed thinking or memory issues (Eisenberg et al., 2014). While physical symptoms often resolve within 24-48 hours, cognitive symptoms can persist for several weeks. In many cases, cognitive recovery occurs within 14 to 16 days, but a substantial subset of children experiences symptoms for over a month (Eisenberg et al., 2014). Pre-existing mental health conditions like anxiety, depression, and migraines have been shown to prolong recovery timelines (Rosenbaum et al., 2020). Furthermore, concussion is linked to increased risk of longer-term psychiatric conditions, including mood and anxiety

disorders (Sariaslan et al., 2016). The relationship between recovery duration and mental health burden is both mechanistic and contextual. Persistent neurometabolic network dysfunction from the concussion can produce symptoms like anxiety, low mood and insomnia, while the resulting withdrawal from school, sports and peers further elevates stress and focus on symptoms. Together, these processes reinforce one another and are associated with longer recovery durations (Howell et al., 2018; Lumba-Brown et al., 2018; Rosenbaum et al., 2020).

Successful recovery requires a careful balance of gradually increasing both cognitive and physical activity. Premature return to mentally demanding activities can exacerbate symptoms and prolong recovery (Davis et al., 2017). The American Academy of Pediatrics (AAP) emphasizes a stepwise, symptom-based approach for returning to school and sports, recommending the use of validated symptom screeners to guide clinical decision-making (Halstead et al., 2013; Halstead et al., 2018). These guidelines reinforce the importance of early identification, structured assessment, and patient-centered recovery planning.

Despite the growing awareness and guidance, many pediatric primary care providers report feeling unprepared to manage concussions. Zonfrillo et al. (2012) found that providers often lack education, time, and clarity regarding their role in concussion recovery. Many also believe it falls outside their scope of practice. Most children with concussion are followed in primary care, as opposed to subspecialty concussion clinics (Arbogast et al., 2016). Therefore, primary care clinicians have a responsibility when managing concussions for post-concussion symptom assessment, return to learn and play counseling, and referral when red flags emerge. Ensuring that primary care teams have the knowledge and tools to deliver this care is essential for safe, consistent and comprehensive concussion management.

Several validated tools are available to facilitate post-concussion screening and symptom monitoring in pediatric patients. The Post-Concussion Symptom Inventory (PCSI) and the Post-Concussion Symptom Scale (PCSS) are age-appropriate self-report tools widely recommended for assessing symptom severity. The PCSI is particularly suitable for children aged 5-12, while the PCSS is better suited for adolescents (Sady et al., 2014; Lovell et al., 2006; Committee on Sports-Related Concussions in Youth, 2014). Additional assessments like the Balance Error Scoring System (BESS) evaluate postural stability and are validated for children as young as five (Hansen et al., 2017). Because vestibular and ocular symptoms are both common and clinically meaningful after concussion this project places emphasis on the Vestibular/Ocular Motor Screening (VOMS). VOMS provides a brief screen of smooth pursuit, horizontal/vertical saccades, near point convergence, horizontal/vertical vestibular-ocular reflex, and visual motion sensitivity. After each subtest, the patient rates headache, dizziness, nausea and foggiess. The tool requires minimal equipment and integrates easily into primary care workflows (Kaae et al., 2022). Higher VOMS symptom scores have been associated with longer recovery periods, underscoring the value for its risk stratification and tailored concussion management counseling (Anzalone et al., 2017). Used alongside the PCSI/PCSS and BESS, VOMS helps primary care providers stage recovery and individualize return to learn and play plans.

Currently, a pediatric primary care clinic in Broken Arrow, Oklahoma does not routinely use standardized screenings or assessments when managing and evaluating patients who present post-concussion. Patients are seen by the providers after an initial visit at an emergency department or urgent care where they were diagnosed with a concussion. General guidance on return to school or sports may be given, but they do not conduct structured assessments or

evaluations to determine ongoing symptom severity or recovery stage. This gap presents an opportunity for improvement. Implementing a provider education initiative focused on post-concussion screening and assessment tools, such as the VOMS, has the potential to enhance early recognition, improve clinical consistency, and foster better outcomes for pediatric patients.

### **Theoretical Framework**

#### **Ajzen's Theory of Planned Behavior (TPB)**

This project was guided by Ajzen's Theory of Planned Behavior (TPB), which holds that a predictor of behavior is an individual's intention to perform it. Intention is shaped by three determinants which include attitude, subjective norm, and perceived behavioral control. Attitude includes perceived benefits and harms, subject norms include perceived expectations of leaders, peers and guidelines, and perceived behavioral control includes confidence and control over performing the behavior (Ajzen, 1991; Fishbein & Ajzen, 2010). TPB is often used in clinician education to explain and influence adoption of evidence-based practices.

The target behavior that the project aimed to influence was the routine use of standardized post-concussion assessment such as the VOMS during follow-up visits in primary care. The educational intervention matched with the TPB determinants as follows:

#### ***Attitude***

The session presented concise evidence that VOMS identifies common ocular-vestibular problems, supports safer return to lean and play decisions, and improves care consistency.

#### ***Subjective Norm***

Content highlighted relevant guidance (e.g., AAP clinical recommendations) and sets clear expectations for standardized assessment within the clinic.

### ***Perceived Behavioral Control***

Providers received step-by-step VOMS instructions, abnormal thresholds, and a one-page quick guide.

The primary outcome for this project was to create the intention in the providers to use the VOMS in post-concussion management visits. The educational intervention was designed to improve the attitude, subjective norm and PBC of the providers. Gains made in these areas signify a readiness to change and inform a subsequent implementation or QI phase for adoption into practice if the clinic desires to do so.

### **Purpose**

The purpose of this DNP project was to determine whether a brief Theory of Planned Behavior informed educational session focused on the Vestibular/Ocular Motor Screening (VOMS) increased pediatric primary care providers' intention to use the standardized post-concussion assessment during follow-up visits. A secondary aim of the project was to assess pre and post changes in TPD determinants including attitude, subjective norm, and perceived behavioral control that are expected to drive willingness to implement the assessment into future practice.

### **Methods**

#### **Site**

The project took place with permission at a pediatric primary clinic in Broken Arrow, Oklahoma. See Appendix A for Site Approval/Authorization letter from the clinic. This city as of July 1, 2024, has a population estimate of 122,756 (U.S. Census Bureau, 2024). This area is considered a suburb to the city of Tulsa. Using an environmental scan within a 20-mile radius

from the clinic, it is estimated that there are roughly 20 pediatric primary clinics, including group practices under hospital organizations, around the site location. See Appendix B for the clinic list.

### **Participants and Recruitment**

The participants for this project included pediatricians and pediatric nurse practitioners who are either employed by or contracted with the pediatric primary care practice where the project was implemented. These healthcare providers are responsible for evaluating and managing pediatric patients who may present with concussions or head injuries. Recruitment occurred via in-person communication. The invitation included a brief overview of the project, the purpose of the educational session, and a statement assuring providers that participation was voluntary, and that the data would remain anonymous. See Appendix C for a full written description of the invitation.

### **Intervention**

The intervention consisted of a one-time, in-person, structured educational session focused on evidence-based pediatric concussion assessment tools. The content included an overview of the Vestibular/Ocular Motor Screening (VOMS). The session was approximately 30 to 45 minutes in length and covered the clinical utility, interpretation, and application of the tool within a primary care setting when assessing a patient during a post-concussion visit. Resource materials and brief reference guides were provided to all participants. See Appendix D for materials.

## **Evaluation Measures**

To evaluate the effectiveness of the educational intervention, participants completed a Likert-scale survey before and after the session. The survey assessed:

- Confidence in assessing pediatric post-concussions symptoms
- Familiarity with the VOMS tool
- Comfort with the VOMS tool
- Relevancy to role as a pediatric provider
- Intent to incorporate tools into clinical practice

The structure and items of the survey were informed by existing literature on provider education and behavior change in clinical settings. Specifically, items were adapted from the Continuing Professional Development Reaction Questionnaire (CPD-RQ), which is a validated instrument designed to assess intention and determinants of behavior change in healthcare providers (Legare et al., 2014). Additionally, research by Ogren and Knobloch (2019) supports the value of concussion focused education in improving provider preparedness, confidence, and perceived relevance in primary care, which directly shaped the domains evaluated in this project's survey tool. All responses remained anonymous and were collected via paper. See Appendix E for the Likert surveys.

## **Analysis**

Descriptive statistics was used to summarize participant responses. To assess changes in Likert-scale responses from pre- to post-intervention, the Wilcoxon Signs-Ranks Test using SPSS software was applied. This nonparametric test is appropriate due to the ordinal nature of Likert data and the small sample size. Statistical significance was set at  $p < .05$ . The effect size,

using  $r$  as  $|Z|/\sqrt{N}$  where  $N$  is the number of non-zero pairs (i.e., positive + negative ranks; ties excluded), was calculated using Excel software. For questions that were only found on the post-education survey, descriptive statistics including mean, median, standard deviation, minimum and maximum was calculated. Data analysis was conducted using SPSS statistical software.

### **Ethical Considerations**

Participation was voluntary, and no identifying information was collected. Completion of the survey implied informed consent. Participants were informed that they may withdraw at any time without consequence. See Appendix F for the disclosure form.

### **IRB Review and Approval**

This project qualified as a quality improvement initiative. It was submitted for review and received formal exemption by the Institutional Review Board (IRB).

### **Results**

Three pediatric primary care providers completed the pre- and post-education Likert scale surveys ( $N = 3$ ). None of the participants left any answers blank.

Descriptive statistics for comfort levels using the VOMS tool are presented in Table 1.

**Table 1**

*Descriptive Statistics – Comfort Levels*

	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
Pre Comfort Level	3	1.33	.577	1	2
Post Comfort Level	3	3.67	.577	3	4

The comfort levels from before to after increased for the three participants, from 1.33 (*SD* 0.58) to 3.67 (*SD* 0.58). Pre-comfort levels ranged from 1 to 2, while post-comfort levels ranged from 3 to 4.

Table 2 shows the results of the Wilcoxon signed-rank test for comfort levels when using the VOMS.

**Table 2**

*Wilcoxon Sign Rank – Comfort Levels*

		<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>
Post Comfort Level	Negative Ranks	0	.00	.00
Pre Comfort Level	Positive Ranks	3	2.00	6.00
	Ties	0		
	Total	3		

The Wilcoxon test for comfort levels showed improvement for all respondents, with positive ranks = 3, and a mean rank of 2.00. Negative ranks = 0, and ties = 0.

Test results for comfort levels are shown in Table 3.

**Table 3**

*Test Statistics<sup>a</sup> – Comfort Levels*

<b>Post Comfort Level – Pre Comfort Level</b>	
Z	-1.633 <sup>b</sup>
Asymp. Sig. (2-tailed)	.102

<sup>a</sup>. Wilcoxon Signed Ranks Test

<sup>b</sup>. Based on negative ranks.

The comfort level test statistics indicated a  $Z$  value of -1.63, with an asymptotic two-tailed  $p$ -value of .102, and a calculated large effect size of  $r \approx .94$ .

Table 4 presents descriptive statistics for familiarity levels using the VOMS tool before and after education.

**Table 4**

*Descriptive Statistics – Familiarity Levels*

	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
Pre Familiarity Level	3	2.00	.000	2	2
Post Familiarity Level	3	3.67	.577	3	4

All three providers showed increased familiarity with using the VOMS tool, from a mean of 2.00 ( $SD = 0.00$ ) to 3.67 ( $SD \approx 0.58$ ). The minimum and maximum scores were both 2 on the pre-education survey, while post-education scores had a minimum of 3 and a maximum of 4.

The Wilcoxon signed-rank test for VOMS familiarity levels is presented in Table 5.

**Table 5**

*Wilcoxon Sign Ranks – Familiarity Levels*

		<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>
Post Familiarity Level –Pre Familiarity Level	Negative Ranks	0	.00	.00
	Positive Ranks	3	2.00	6.00
	Ties	0		
	Total	3		

All respondents improved their scores, with positive ranks = 3, and a mean rank of 2.00. Negative ranks and ties were both zero.

The test statistics for familiarity levels are presented in Table 6.

**Table 6***Test Statistics<sup>a</sup> – Familiarity Levels*

<b>Post Familiarity Level – Pre Familiarity Level</b>	
Z	-1.633 <sup>b</sup>
Asymp. Sig. (2-tailed)	.102

<sup>a</sup>. Wilcoxon Signed Ranks Test<sup>b</sup>. Based on negative ranks.

The test statistics for the familiarity level indicated a  $Z$  value of -1.63, an asymptotic two-tailed  $p$ -value of .102, and a substantial effect size determined at  $r \approx .94$ .

Table 7 shows descriptive statistics for confidence in assessing concussions.

**Table 7***Descriptive Statistics – Confidence Levels*

	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
Pre Confidence Level	3	3.00	.000	3	3
Post Confidence Level	3	4.00	1.000	3	5

All three providers initially had a mean score of 3 ( $SD = 0.00$ ). After education, their scores increased to a mean of 4 ( $SD = 1.00$ ), with the lowest score at 3 and the highest at 5.

Table 8 presents the results of the Wilcoxon signed-rank test for confidence levels.

**Table 8***Wilcoxon Sign Ranks – Confidence Levels*

	<b>N</b>	<b>Mean Rank</b>	<b>Sum of Ranks</b>
Post Confidence Level – Pre Confidence Level	Negative Ranks	0	.00
	Positive Ranks	2	1.50
	Ties	1	
	Total	3	3.00

Two respondents showed improvement, while one remained unchanged. The positive ranks totaled 2, with a mean rank of 1.50. There were no negative ranks, and one tie rank.

Test statistics for confidence levels are provided in Table 9.

**Table 9**

*Test Statistics<sup>a</sup> – Confidence Levels*

<b>Post Confidence Level – Pre Confidence Level</b>	
Z	-1.342 <sup>b</sup>
Asymp. Sig. (2-tailed)	.180

<sup>a</sup>. Wilcoxon Signed Ranks Test

<sup>b</sup>. Based on negative ranks.

The Z number was -1.34, and the asymptotic two-tailed p-value was .180. The effect size was large and calculated as at  $r \approx .95$ . The effect size was calculated using  $N = 2$  non-zero pairs.

Table 10 displays the statistical outcomes for content relevance and intention to apply, as measured by post-education Likert items.

**Table 10**

*Statistics – Content Relevancy and Intention to Apply*

		<b>Content Relevancy</b>	<b>Intention to Apply</b>
N	Valid	3	3
	Missing	0	0
Mean		5.00	4.67
Median		5.00	5.00
Std. Deviation		.000	.577
Minimum		5	4
Maximum		5	5

Post-education only Likert items showed high perceived relevance and intention to apply across all providers. Content relevance had a mean of 5.00 with a *SD* of 0.00, indicating a score of 5 across all responses, while intention to apply averaged 4.67 with a *SD*  $\approx$  0.58. The lowest intention to apply score was 4, and the highest was 5.

Table 11 presents the frequency of Likert item scores regarding the relevance of the educational session's content to their practice.

**Table 11**

*Frequency Table - Content Relevancy*

		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	Strongly Agree	3	100.0	100.0	100.0

All three providers agree that the content was relevant to their practice, with 100% responding that they “Strongly Agree”.

Table 12 presents the frequencies of the Likert item scores regarding providers' intention to incorporate the educational content into their practices.

**Table 12**

*Frequency Table - Intention to Apply*

		<b>Frequency</b>	<b>Percent</b>	<b>Valid Percent</b>	<b>Cumulative Percent</b>
Valid	Agree	1	33.3	33.3	33.3
	Strongly Agree	2	66.7	66.7	100.0
	Total	3	100.0	100.0	

Two providers “Strongly Agree” that they intend to apply the VOMS tool in practice, with one answering “Agree” on the Likert scales.

Due to the very small sample size, Wilcoxon tests lacked power and two-tailed  $p$  values were not significant ( $p > .05$ ) across outcomes. Results are shown descriptively, with effect sizes included.

### **Discussion**

Across all outcomes, scores shifted in the expected direction following the brief education, with comfort and familiarity improving for every provider and confidence improving for two of the three. Although inferential tests were underpowered with  $N = 3$  and yielded non-significant asymptotic  $p$  values, the pattern of unanimous or near-unanimous improvement and large effect sizes ( $|r| \approx .94-.95$ ) is practically meaningful. In very small samples, effect sizes can be imprecise. However, the consistency of positive ranks, no negative ranks, and only one tie, strengthens confidence that the session produced a real, favorable shift worthy of iterative scaling.

Findings align with the Theory of Planned Behavior. First, attitude toward the behavior was strongly favorable. All participants agreed the content was highly relevant, demonstrating a ceiling effect that suggest buy-in, but limits variability for analysis. Second, gains in comfort, familiarity, and confidence map directly to perceived behavioral control, indicating that the providers felt more able to perform VOMS and assess concussions correctly after training. Third, intention to use VOMS was high, as all agreed or strongly agreed, consistent with Theory of Planned Behavior's premise that improved attitudes and perceived control foster intention. Future cycles should measure subjective norm more explicitly. This could be done using Likert items such as "My clinic/peers expect me to document VOMS" as establishing perceived expectations can help translate intention into routine behaviors.

From a clinical standpoint, the intervention appeared feasible and acceptable. It was brief, required minimal equipment, and all participants completed evaluation without missed data. Immediate practice implications include maintaining reference materials at the clinic, creating a VOMS clinic champion, and electronic health record (EHR) support for documentation.

Together, these observations suggest that a short, clinic-based educational session can pragmatically increase readiness to adopt the VOMS in pediatric primary care, even if statistical significance is not demonstrable in such a small sample.

### **Alignment with DNP Essentials**

#### ***Essential I: Scientific Underpinnings for Practice***

This quality-improvement project applied a theory-driven approach, the Theory of Planned Behavior, to influence provider's intention to use the Vestibular/Ocular Motor Screening during post-concussion follow-up. Current concussion science (e.g., ocular-vestibular screening, near-point convergence, symptom provocation) was integrated into primary care decision-making and counseling to support evidence-based practice.

#### ***Essential II: Organizational Systems Leadership for Quality Improvement and Systems Thinking***

Clinic-level education and deployment of point-of-care tools (quick guide, scoring sheet, step-by-step instructions) were used to reduce practice variation and improve reliability. Increased intention to use VOMS reflects leadership in advancing standardization and quality at the system level.

***Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice***

Pre- and post- Likert surveys were used to evaluate the educational intervention, and appropriate descriptive statistics and nonparametric analyses (Wilcoxon signs-ranks with effect sizes) were conducted and interpreted transparently to inform improvement and future evaluation.

***Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care***

Small electronic health record integration such as VOMS charting fields is proposed to sustain practice change. Statistical software (SPSS, Excel) supported data management and analysis.

***Essential V: Health Care Policy for Advocacy in Health Care***

This project aligns clinic practice with external guidance (e.g., American Academy of Pediatrics return-to-learn/return-to-play recommendations) and supports development of a concise clinic policy or standard operating procedure that specifies VOMS indications and referral triggers.

***Essential VI: Interprofessional Collaboration for Improving Patient Population Health***

Although this project did not redesign roles or launch a multi-disciplinary protocol, it advances interprofessional collaboration by establishing a shared mental model for post-concussion assessment. The education introduced VOMS and concussion terminology along with documentation elements, which improves clarity and efficiency when providers consult with other healthcare professionals about post-concussion management.

## ***Essential VII: Clinical Prevention and Population Health for Improving the Nation's Health***

### ***Outcomes***

Standardized early ocular-vestibular screening in primary care aims to shorten symptom duration, reduce school disruption, and lower re-injury risk.

### ***Essential VIII: Advanced Nursing Practice***

The project advances advanced practice registered nurses' competencies by strengthening providers' comfort, familiarity, and confidence in administering and interpreting the VOMS tool.

### ***Sustainability***

To ensure the long-term impact of this educational intervention, sustainability efforts focus on maintaining provider knowledge, confidence, and consistent use of the VOMS beyond initial training. Although this project involved a single educational encounter, several strategies can promote continued integration of the VOMS assessment into routine pediatric post-concussion follow-up visits.

The PowerPoint slide deck, VOMS quick-reference guide, and scoring instructions will remain available at the clinic. These guides provide access to VOMS material and allow providers to quickly refresh the assessment and scoring method. A provider trained to perform VOMS can serve as a clinic champion to reinforce use through refresher courses at staff meetings, solicitation and sharing of feedback, and having availability for questions. Adding concise fields into the electronic health record (EHR) for the VOMS tool scoring and documentation will integrate it into the workflow and reduce provider reliance on memory, which supports fidelity to the assessment. Together, ready to access materials, a clinic champion,

and VOMS EHR fields, can help to sustain the educational gains and support reliable and ongoing use of the VOMS in the clinic's practice.

### **Limitations**

This project's very small sample ( $N = 3$ ) substantially limits statistical precision and generalizability. With such few paired observations, asymptotic Wilcoxon  $p$  values are underpowered and potentially inaccurate. Exact tests are preferable, and the findings should be interpreted descriptively. Although the observed effect sizes were large, they are unstable with small  $N$  because  $r$  inherits uncertainty from the  $Z$  statistic used to calculate it. In addition, one tie on the confidence Likert item reduced the Wilcoxon  $N$  for that outcome, further lowering power. Pre-education scores with zero variance and the same score of "strongly agree" on all the content relevancy Likert question also constrain detectable change.

The evaluation window was immediately post-session after a single educational exposure, providing no information on durability of gains or actual adoption in practice. Outcomes were self-reported Likert ratings, which can introduce measurement constraints and response bias. Because this was a single-site QI effort, site-specific culture or workflows may have influenced results.

Effect sizes are informative but unstable in very small samples. The Wilcoxon effect sizes are reported from the  $Z$  statistic, which can lead to overstating certainty about true population effect. The direction and consistency of the changes across measures are encouraging, but the magnitude of the effect should be treated as preliminary until able to be replicated with a larger cohort.

## **Conclusion**

This quality improvement project addressed a clear practice gap in pediatric post-concussion management by delivering a brief, theory-informed (Theory of Planned Behavior) education on the VOMS tool to pediatric primary care providers. Despite a very small sample ( $N = 3$ ) and underpowered inferential testing, all outcomes moved in the desired direction and effect sizes were large, indicating a meaningful, favorable shift in the providers' comfort and familiarity with the VOMS tool and confidence assessing pediatric concussions, alongside high perceived relevance and intention to use the tool. Taken together, the findings suggest that a short, clinic-based educational intervention is feasible, acceptable, and likely to increase readiness to adopt the VOMS tool in pediatric primary care.

## **Implications for Future Practice**

The findings from this study support near-term integration of the VOMS tool into routine post-concussion management follow-up as a standard element of assessment and counseling. Therefore, it is recommended that the clinic take actionable steps to implement the use of the VOMS tool such as maintaining accessibility within the clinic to VOMS reference materials, maintaining a clinic champion, as well as creating documentation and charting fields within the EHR for the VOMS assessment results. For future evaluations, sample size should be expanded as capacity allows, exact parametric tests should be used, and questions to measure subjective norms such as "my peers expect me to use the VOMS assessment" should be asked. Overall, the project provides an actionable foundation for embedding standardized use of the VOMS tool in primary care to support safer, more consistent post-concussion management.

**Appendix A**

**Site Approval/Authorization Letter**



# Broken Arrow Pediatrics

Carl Pfanstiel MD  
Kim Terry MD  
Lauryn Trepp APRN  
Whitney Kern APRN

September 25, 2025

Human Subjects Protection Program  
The University of Arizona  
845 N Park Ave., Suite 537A  
Tucson, AZ 85719

Please note that Ms. Elizabeth Arnold, University of Arizona Doctor of Nursing Practice student, has permission of the Broken Arrow Pediatrics Clinic to conduct a quality improvement project at our facility for her project, "Increasing Pediatric Primary Care Provider Willingness to Use VOMS: A Theory of Planned Behavior Approach".

Ms. Arnold will conduct a pre-survey, deliver an education presentation, then conduct a post-survey of health care providers at Broken Arrow Pediatrics Clinic. She will recruit providers through in-person invite. She will provide a verbal and written description of the project, what they will be asked to do, and the time involved. Ms. Martin's activities will be completed by *December 1st*.

Ms. Arnold has agreed to provide to my office a copy of the University of Arizona Determination before she recruits participants. She will also present aggregate results to the providers at their monthly staff meeting.

If there are any questions, please contact my office.

Signed,



Ph: (918) 258-1955 • Fax (918) 251-9802  
1220 North Elm Place • Broken Arrow, OK 74012

**Appendix B**

**List of Pediatric Primary Care Clinics**

**List of Pediatric Primary Care Clinics  
Within 20 Miles of 1220 N. Elm Pl, Broken Arrow, OK 74012**

<b>Clinic name</b>	<b>Street address</b>	<b>City</b>
Aspen Children's Clinic of Broken Arrow	3300 S Aspen Ave, Ste B	Broken Arrow
Bright Future Pediatrics — Broken Arrow	817 S Elm Pl, Ste 105–106	Broken Arrow
Bright Future Pediatrics — Downtown Bixby	19 E Dawes Ave, Ste A	Bixby
Bright Future Pediatrics — South Tulsa	7711 S 111th St S	Tulsa
Broken Arrow Pediatrics	1220 N Elm Pl	Broken Arrow
Healthy Kids Clinic (James A. Henley, DO)	4125 S Mingo Rd	Tulsa
OU Health — Schusterman Center Pediatric Clinic	4444 E 41st St	Tulsa
OU Health Physicians — Wayman Tisdale Pediatric Clinic	591 E 36th St N	Tulsa
OSU Pediatrics — Holliman Building	1705 E 19th St, Ste 600	Tulsa
Pediatric & Adolescent Care	2000 S Wheeling Ave, Ste 300	Tulsa
Pediatric Specialists of Tulsa	7412 S Yale Ave	Tulsa
Saint Francis Children's Physicians Pediatrics — Broken Arrow (Kenosha)	1801 E Kenosha St	Broken Arrow
Saint Francis Children's Physicians Pediatrics — Kelly Building	6565 S Yale Ave, Ste 902	Tulsa
Saint Francis Children's Physicians Pediatrics — Owasso (Collinsville)	11610 N 137th E Ave	Collinsville
Saint Francis Children's Physicians Pediatrics — South Memorial	10506 S Memorial Dr	Tulsa
Saint Francis Children's Physicians Pediatrics — Springer Building	6160 S Yale Ave	Tulsa
Saint Francis Children's Physicians Pediatrics — Tulsa Hills	7858 S Olympia Ave	Tulsa

<b>Clinic name</b>	<b>Street address</b>	<b>City</b>
South Tulsa Pediatrics	7512 E 91st St	Tulsa
Tulsa Pediatric Group	6465 S Yale Ave	Tulsa
Young People's Clinic / The Jenks House Pediatric Clinic	715 W Main St, Ste S	Jenks

**Appendix C**

**VOMS Education Session Description**

You are invited to participate in a quality improvement project research educational session conducted by Elizabeth Arnold, RN BSN, DNP PNP student at the University of Arizona. The purpose of this education session and study will be to evaluate whether a brief education session increases providers' intention to use the Vestibular/Ocular Motor Screening (VOMS) during post-concussion follow-up. The educational session will take 30-45 minutes. You will be asked to take a pre- and post- educational survey. The surveys measure your confidence, familiarity, comfort and intention to use the VOMS. Your responses will be anonymous and confidential. There is no compensation.

If you have any questions, please contact me in person at Broken Arrow Pediatrics, at [lizarnold8@arizona.edu](mailto:lizarnold8@arizona.edu) or 918-237-9515.

Thank you!

Liz Arnold

## **Appendix D**

### **Participant Materials (PowerPoint Presentation, Screening Tools and Handouts)**

# VOMS

Liz Arnold, RN  
DNP PNP Student University of Arizona

## Introduction

- 6.8% of children ages 0 to 17 in 2020 reported symptoms indicative of a concussion (Black & Zablotsky, 2021)
- Prolonged recoveries can lead to increased mood and anxiety disorders due to neurometabolic dysfunction and life disruptions (Howell et al., 2018; Lumba-Brown et al., 2018; Rosenbaum et al., 2020).
- American Academy of Pediatrics (AAP) provides the Return to Play and Return to School guidelines
  - Recommends use of validated symptom screeners to guide clinical decision making (Halstead et al., 2013)



## What is VOMS?

- Vestibular/Ocular Motor Screening (VOMS)
- Screens smooth pursuit, horizontal/vertical saccade, near point convergence, horizontal/vertical vestibular-ocular reflex, and visual motion sensitivity
- Patient rates headache, dizziness, nausea and foginess before and after each assessment

(Kaae et al., 2022)

## Why VOMS?

- Higher VOMS symptom scores have been associated with longer recovery periods (Amisano et al., 2017)
- Patients with concussions had consistently higher VOMS scores than non-concussed patients (Mucha et al., 2014)
- Can help determine if a patient is ready to increase activity according to the AAP's Return to Play and Return to School guidelines
- Can help to assess if patient needs referral out to specialist when recovering from a concussion



## Smooth Pursuit

- **Ability to follow a moving target**
- Examiner and patient are seated
  - Have patient focus on a target (like a finger or pencil) that is 3 ft away as the examiner moves the target 1.5 ft to right and then 1.5 ft to the left of midline (horizontal) for a total of x2 complete repetitions.
  - Repeat the process but with the targets 1.5 ft above midline, and 1.5 ft below midline (vertical).

(Mucha et al., 2014)

## Saccades

- **Assesses ability of eyes to move quickly between targets**
- Horizontal – examiner and patient are seated
  - 3 ft from patient, hold fingers 1.5 ft to the left and 1.5 ft to the right of midline
  - Instruct patient to move eyes from finger to finger as quick as possible for 10 repetitions
- Vertical – examiner and patient are seated
  - 3 ft from patient, hold fingers 1.5 ft above and 1.5 ft below midline
  - Instruct patient to move eyes from finger to finger as quick as possible for 10 repetitions

(Mucha et al., 2014)

## Convergence

- **Ability to look at a target without double vision**
- Patient and examiner seated
- Have patient focus on an object (like a finger or pencil) and move toward tip of patient's nose. Instruct patient to notify when they see two of the object, or outward deviation of an eye is noticed by the examiner. Measure the distance between the object and tip of nose. Repeat x3.
  - Abnormal is  $\geq 6$  cm

(Mucha et al., 2014)

## Vestibular-Ocular Reflex Test

- **Ability to stabilize vision as head moves**
- Patient and examiner are seated
- Hold target (such as a finger or pencil) 3 ft from patient
  - Horizontal – Patient rotates head horizontally while focusing on object x10 times
  - Vertical – Patient moves head up and down while focusing on object x10 times
- Wait 10 seconds after assessment to ask patient about headache, dizziness, nausea and foginess score

(Mucha et al., 2014)

## Visual Motion Sensitivity Test

- Ability to inhibit vestibular-induced eye movements
- Patient stands with feet shoulder width apart
- Patient holds arm out and focuses on thumb while moving head, eyes and trunk to the right and left x5 times  
(Mucha et al., 2014)

Test:	Tested?	Headache	Dizziness	Nausea	Fogginess	
Baseline (0-10)						
Smooth Pursuit						
Saccades - horizontal						
Saccades - vertical						
Convergence						3 ___ cm 2 ___ cm 3 ___ cm
VOR - horizontal						
VOR - vertical						
Visual Motion Sensitivity						

Adapted from Mucha, A., Collins, M. W., Ellis, R. J., Forman, J. M., Treisman Drake, C., DeWolf, R. M., Merchant, G., & Kotter, A. P. (2014). A first vestibulocyclear motor screening (VOMS) assessment to evaluate concussions: Preliminary findings. *The American Journal of Sports Medicine*, 42(10), 2429-2436. <https://doi.org/10.1177/0363546514264073>

## Scoring the assessments

## Scoring the Assessment

- Symptoms that increase by +2 or more indicate an abnormal assessment
  - Near point convergence measurements >6 cm are considered abnormal
- (Mucha et al., 2014)



## Case Study



15-year-old male was hit in the head with a baseball during a game. Patient briefly passed out and had urinary incontinence. He was able to walk off the field with assistance. He was taken to a local ER where he was diagnosed with an mTBI and a broken nose. He presented to primary care the following day for follow-up management



Vitals WNL, full, painless active ROM, eyes PERRL



Denies nausea, irritability, noise and light sensitivity. Positive for headache, dizziness, fogginess, difficulty concentrating, fatigue

- VOMS assessment results
  - Baseline scores – Headache 3, Dizziness 2, Nausea 0, Fogginess 3
  - Smooth pursuit – +0
  - Saccades – +0
  - Near point of convergence x3 – average 7.7 cm
  - Vestibular/ocular reflex – +3 Dizziness, +2 Fogginess
  - Visual Motor Sensitivity – +2 Dizziness

Case Study cont.

- **VOMS assessment**

- Smooth pursuit - +0
  - Saccades - +0
  - Near point of convergence x3 - **average 7.7 cm**
    - **Over 2.6 cm**
  - Vestibular/ocular reflex - +3 Dizziness, +2 Fogginess
    - **Symptom provocation 2,+2**
  - Visual Motor Sensitivity - +2 Dizziness
    - **Symptom provocation 2,+2**
- **Positive VOMS** = visual vestibular involvement
    - Return to play: Limit from playing & reassess when symptoms improve
    - Return to learn: Advise to take breaks every 30 minutes if reading is involved, or enlarge print
    - Referral to specialist if needed

Case Study cont.

Questions?

## References

- Angello, A. J., Byrnes, D., Coss, T., McGuffee, T., Pollock, S., Gertson, J. C., Jones, M. T., Rouse, R., Turner, S., & Oliver, J. M. (2021). A positive vestibular ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescents athletes. *The American Journal of Sports Medicine*, 49(10), 474–479. <https://doi.org/10.1177/0363546521100928>.
- Black, L. L., & Zablotsky, B. (2022). Concussions and brain injuries in children: United States, 2016–2019 (NHIS Data Brief No. 451). National Center for Health Statistics. <https://doi.org/10.1093/nchs/data.brief/451>.
- Holbrook, M. B., Molloy, K., Devens, C. D., Carl, R., Lee, M., Logan, K., Council on Sports Medicine and Fitness, & Council on School Health. (2012). Returning to learning following a concussion. *Pediatrics*, 129(2), 948–952. <https://doi.org/10.1542/peds.2011-2882>.
- Howell, D. R., Wilson, J. C., Kirkwood, M. W., & Gubertoff, J. A. (2018). Quality of life and symptom burden 3 months after concussion in children and adolescents. *Clinical Pediatrics*, 58(1), 44–49. <https://doi.org/10.1177/0271628417708498>.
- Kase, C., Colligan, K., Lu, K., & Chen, J. (2021). Vestibulo-ocular dysfunction in mTBI: Utility of the VOMS for evaluation and management – A review. *NeuroRehabilitation*, 48(3), 409–426. <https://doi.org/10.3233/nre-200264>.
- Lumbro Brown, A., Vayns, K. D., Sacramento, K., Beading, M. J., Hagenrich, F. M., Gray, D. A., Turner, M., Baroni, E. C., Santoran, S. J., Giza, C. C., Howell, M., Brownwald, C., Williamson, B., Gordon, W., Wright, D. W., Mian, N. S., Mihalov, K., Ewing-Cobbs, L., Duhaime, A., & Simons, S. D. (2018). Diagnosis and management of mild traumatic brain injury in children: A systematic review. *BMJ Pediatrics*, 12(15), e2018024. <https://doi.org/10.1136/bmjped-2018-024184>.
- Mucha, A., Collins, M. W., Eble, R. J., Farnan, J. M., Troutman-Dzauki, C., DeWitt, R. M., Marchetti, G., & Kontos, A. P. (2014). A brief vestibulo-ocular motor screening (VOMS) assessment to evaluate concussions: Preliminary findings. *The American Journal of Sports Medicine*, 42(14), 2479–2486. <https://doi.org/10.1177/0363546514134377>.
- Rosenbaum, P. E., Lacanotte, C., Chiraman, S. P. D., Heneg, S. A., & Rivers, P. F. (2022). Characteristics of pediatric mild traumatic brain injury and recovery in a concussion clinic population. *JAMA Network Open*, 5(10), e222943. <https://doi.org/10.1001/jamanetworkopen.2022.2943>.

### Vestibular/Ocular-Motor Screening (VOMS) for Concussion

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

#### Instructions:

**Interpretation:** This test is designed for use with subjects ages 9-40. When used with patients outside this age range, interpretation may vary. Abnormal findings or provocation of symptoms with any test may indicate dysfunction – and should trigger a referral to the appropriate health care professional for more detailed assessment and management.

**Equipment:** Tape measure (cm); Metronome; Target w/ 14 point font print.

**Baseline Symptoms** – Record: Headache, Dizziness, Nausea & Fogginess on 0-10 scale prior to beginning screening

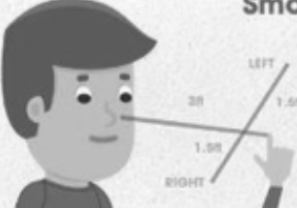
- Smooth Pursuits** - Test the ability to follow a slowly moving target. The patient and the examiner are seated. The examiner holds a fingertip at a distance of 3 ft. from the patient. The patient is instructed to maintain focus on the target as the examiner moves the target smoothly in the horizontal direction 1.5 ft. to the right and 1.5 ft. to the left of midline. One repetition is complete when the target moves back and forth to the starting position, and 2 repetitions are performed. The target should be moved at a rate requiring approximately 2 seconds to go fully from left to right and 2 seconds to go fully from right to left. The test is repeated with the examiner moving the target smoothly and slowly in the vertical direction 1.5 ft. above and 1.5 ft. below midline for 2 complete repetitions up and down. Again, the target should be moved at a rate requiring approximately 2 seconds to move the eyes fully upward and 2 seconds to move fully downward. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 1)
- Saccades** – Test the ability of the eyes to move quickly between targets. The patient and the examiner are seated.
  - Horizontal Saccades:** The examiner holds two single points (fingertips) horizontally at a distance of 3 ft. from the patient, and 1.5 ft. to the right and 1.5 ft. to the left of midline so that the patient must gaze 30 degrees to left and 30 degrees to the right. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 2)

- **Vertical Saccades:** Repeat the test with 2 points held vertically at a distance of 3 ft. from the patient, and 1.5 feet above and 1.5 feet below midline so that the patient must gaze 30 degrees upward and 30 degrees downward. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 3)
- **Convergence** – Measure the ability to view a near target without double vision. The patient is seated and wearing corrective lenses (if needed). The examiner is seated front of the patient and observes their eye movement during this test. The patient focuses on a small target (approximately 14 point font size) at arm's length and slowly brings it toward the tip of their nose. The patient is instructed to stop moving the target when they see two distinct images or when the examiner observes an outward deviation of one eye. Blurring of the image is ignored. The distance in cm. between target and the tip of nose is measured and recorded. This is repeated a total of 3 times with measures recorded each time. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. Abnormal: Near Point of convergence  $\geq 6$  cm from the tip of the nose. (Figure 4)
- **Vestibular-Ocular Reflex (VOR) Test** – Assess the ability to stabilize vision as the head moves. The patient and the examiner are seated. The examiner holds a target of approximately 14 point font size in front of the patient in midline at a distance of 3 ft.
  - **Horizontal VOR Test:** The patient is asked to rotate their head horizontally while maintaining focus on the target. The head is moved at an amplitude of 20 degrees to each side and a metronome is used to ensure the speed of rotation is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings 10 sec after the test is completed. (Figure 5)
  - **Vertical VOR Test:** The test is repeated with the patient moving their head vertically. The head is moved in an amplitude of 20 degrees up and 20 degrees down and a metronome is used to ensure the speed of movement is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings after the test. (Figure 6)
- **Visual Motion Sensitivity (VMS) Test** – Test visual motion sensitivity and the ability to inhibit vestibular-induced eye movements using vision. The patient stands with feet shoulder width apart, facing a busy area of the clinic. The examiner stands next to and slightly behind the patient, so that the patient is guarded but the movement can be performed freely. The patient holds arm outstretched and focuses on their thumb. Maintaining focus on their thumb, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left. A metronome is used to ensure the speed of rotation is maintained at 50 beats/min (one beat in each direction). One repetition is complete when the trunk rotates back and forth to the starting position, and 5 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 7)

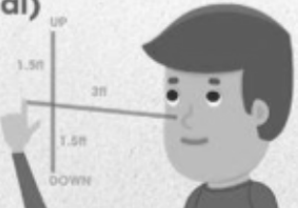
*Note.* Reproduced from Mucha et al., 2014, with permission. © 2014. Sage Publications. License on file.

# Vestibular/Ocular-Motor Screening (VOMS)


**Smooth Pursuits (Horizontal & Vertical)**  
Tests ability to follow a slowly moving target



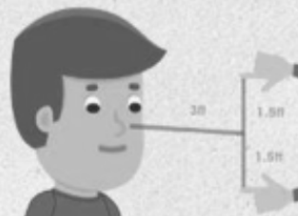
Both patient and clinician are seated  
Patient follows finger with eyes  
Do NOT move head, just eyes  
2 reps at rate of 2 sec / rep  
Rate symptoms (0-10)  
Complete for both horizontal & vertical



**Saccades (Horizontal & Vertical)**  
Tests ability of eyes to move quickly between targets




Both patient and clinician are seated  
Clinician holds fingers 3' apart  
Patient initially looks L-R  
Do NOT move head, just eyes  
10 reps as quickly as possible  
Rate symptoms (0-10)  
Repeat with patient looking Up-Down




**Convergence**  
Measures ability to view a near target without double vision

Patient holds target with 14-point font "X" at arms length  
Patient brings target toward eyes focusing on the "X"  
Stop when they see double  
Clinician measures distance from tip of nose to target (cm)  
Repeat 3x; record all 3  
Rate symptoms (0-10)



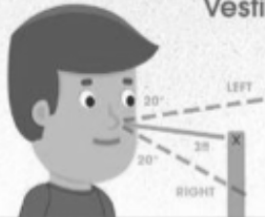
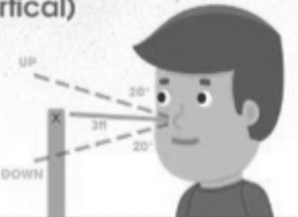
**Visual Motion Sensitivity**  
Tests visual motion sensitivity & ability to inhibit vestibular induced eye movements using vision

Patient holds arm outstretched in front with thumbs up  
Turn body as a unit to L-R 80 deg from midline focusing on thumb  
Use metronome 50 bpm  
Repeat 5 revolutions  
Rate symptoms (0-10)



**Vestibular-Ocular Reflex (Horizontal & Vertical)**  
Assess ability to stabilize vision as head moves

Clinician holds target 3' from patient's eye level  
Patient initially turns head L-R 10x  
Keep eyes focused on target  
Use metronome 180 bpm  
Wait 10 seconds  
Rate symptoms (0-10)  
Repeat with patient looking Up-Down

Visit [natafoundation.org/for-the-profession](http://natafoundation.org/for-the-profession) for more info including the NATA Foundation e-article on VOMS

- Collins MW, Kontos AP, Reynolds E, et al. A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion. *Knee Surg Sports Traumatol Arthrosc.* 2014;22:235-246.
- Khan S, Chang R. Anatomy of the vestibular system: a review. *NeuroRehabilitation.* 2013;32:437-443.
- Kontos AP, Sufirinko A, Elbin RJ, Puskar A, Collins MW. Reliability and associated risk factors for performance on the vestibular/ocular motor screening (VOMS) tool in healthy collegiate athletes. *Am J Sports Med.* 2016;44:1400-1406.
- Mucha A, Collins MW, et al. A brief vestibular/ocular motor screening (VOMS) assessment to evaluate concussions: preliminary findings. *Am J Sports Med.* 2014;42:2479-2486.



**Appendix E**  
**VOMS Educational Surveys**

***VOMS Concussion Assessment Education Survey Tool (Pre-Education)***

**Instructions:**

Please indicate your level of agreement with each of the following statements. Use the scale below:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

**Survey Questions**

1. I feel confident in assessing pediatric concussions. \_\_\_\_\_
2. I am familiar with the Vestibular/Ocular Motor (VOMS) tool. \_\_\_\_\_
3. I am comfortable using the Vestibular/Ocular Motor (VOMS) tool. \_\_\_\_\_

*Note:* This survey tool was developed by the project author and informed by concepts from Legare et al. (2014 and Ogren & Knobloch (2019).

***VOMS Concussion Assessment Education Survey Tool (Post-Education)***

This post-session survey is part of the same minimal risk study described on the pre-survey. Completion implies your consent to participate. You may skip any question or stop at any time.

**Instructions:**

Please indicate your level of agreement with each of the following statements. Use the scale below:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

**Survey Questions**

1. I feel confident in assessing pediatric concussions. \_\_\_\_\_
2. I am familiar with the Vestibular/Ocular Motor (VOMS) tool. \_\_\_\_\_
3. I am comfortable using the Vestibular/Ocular Motor (VOMS) tool. \_\_\_\_\_
4. This content is relevant to my role as a pediatric provider. \_\_\_\_\_
5. I intend to apply what I learned in clinical practice. \_\_\_\_\_

*Note:* This survey tool was developed by the project author and informed by concepts from Legare et al. (2014 and Ogren & Knobloch (2019).

**Appendix F**  
**Disclosure Form**

### **VOMS Education Disclosure**

**Principal Investigator** – Elizabeth Arnold, RN BSN, DNP PNP Student

**Purpose** – Evaluate whether a brief education session increases providers' willingness (intention) to use the Vestibular/Ocular Motor Screening (VOMS) during post-concussion follow-up.

**Procedures** – Brief pre-survey and a post-survey after the education session.

**Risks** – Minimal risk including 30-45 minutes of your time and possible unease about answering survey items. Steps to decrease risk include voluntary participation and implied consent.

**Benefits** – No direct benefit. Findings may improve education process, clinic process and personal practice.

**Voluntary** – Participation is voluntary. You may skip any question or stop at any time without penalty.

**Confidentiality** – No names or direct identifiers are collected. Paper surveys will be stored in a locked cabinet.

**Questions** – Contact principal investigator:

Email - [lizarnold8@arizona.edu](mailto:lizarnold8@arizona.edu)

Phone number – (918) 237-9515

**By returning the completed survey, you confirm you are >18 years old, have read this information, and agree to participate.**

**Appendix G**  
**Evidence Table**

Citation Information	Title of Document of Instrument	Type of Evidence	Main Outcomes of Findings	Relevance to Project
Ajzen, I. (1991). The theory of planned behavior. <i>Organizational Behavior and Human Decision Processes</i> , 50(2), 179–211. <a href="https://doi.org/10.1016/0749-5978(91)90020-T">https://doi.org/10.1016/0749-5978(91)90020-T</a>	The theory of planned behavior	Theoretical Framework – Level VII	Attitudes, norms, and perceived behavioral control shaped intention and performance.	Use for theoretical framework for education session
Anzalone, A. J., Blueitt, D., Case, T., McGuffin, T., Pollard, K., Garrison, J. C., Jones, M. T., Pavur, R., Turner, S., & Oliver, J. M. (2017). A positive vestibular/ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. <i>The American Journal of Sports Medicine</i> , 45(2), 474–479. <a href="https://doi.org/10.1177/0363546516668624">https://doi.org/10.1177/0363546516668624</a>	A Positive Vestibular/Ocular Motor Screening (VOMS) Is Associated With Increased Recovery Time After Sports-Related Concussion in Youth and	Quantitative observation cohort study	Abnormalities in any of the VOMS domains after concussion signify possible	-VOMS is a tool that can be used to help determine severity of concussion in the adolescent population -VOMS measures oculomotor function -Can help create plan of care for patients with concussions
Arbogast, K. B., Curry, A. E., Pfeiffer, M. R., Zonfrillo, M. R., Haarbauer-Krupa, J., Breiding, M. J., & Master, C. L. (2016). Point of health care entry for youth with concussion within a large pediatric care network. <i>JAMA Pediatrics</i> , 170(7), e160294. <a href="https://doi.org/10.1001/jamapediatrics.2016.0294">https://doi.org/10.1001/jamapediatrics.2016.0294</a>	Point of Health Care Entry for Youth With Concussion Within a Large Pediatric Care Network	Descriptive epidemiologic study	More than 75% of patients in the study had first concussion visit with primary vs. 10% in the ED	Primary care providers need to have knowledge of concussion pathophysiology, recovery, and proper assessment in following recover
Black, L. I., & Zablotsky, B. (2021). <i>Concussions and brain injuries in children: United States, 2020</i> (NCHS Data Brief No. 423). National Center for Health Statistics. <a href="https://dx.doi.org/10.15620/cdc:111174">https://dx.doi.org/10.15620/cdc:111174</a>	Concussions and Brain Injuries in Children: United States, 2020	Descriptive epidemiological report	-“6.8% of children in 2020 had reported symptoms of a concussion in their lifetime” (0 to 17) -0-5 2.0% -6 to 11 5.8% -12 to 17 12.2%	-frequency of concussions in pediatrics
Committee on Sports-Related Concussions in Youth, Board on Children, Youth, and Families, Institute of Medicine, & National Research Council. (2014). <i>Sports-related concussions in youth: Improving the science, changing the culture. Appendix C, Clinical evaluation tools</i> (R. Graham, F. P. Rivara, & M. A. Ford, Eds.). National Academies Press. <a href="https://www.ncbi.nlm.nih.gov/books/NBK185341/">https://www.ncbi.nlm.nih.gov/books/NBK185341/</a>	Sports-related concussions in youth: Improving the science, changing the culture. Appendix C, Clinical evaluation tools	Expert Consensus Report	-The Post Concussion Symptom (PCSI) is best for younger children -Research validated self-report screener -PCSS better for adolescents	Provides information on using the PCSI and PCSS for younger children and adolescents
Davis, G. A., Anderson, V., Babl, F. E., Gioia, G. A., Giza, C. C., Meehan, W., Moser, R. S., Purcell, L., Schatz, P., Schneider, K.	What is the difference in concussion management in	Systematic Review	-Children and adolescents can take up	-Importance of understanding the

Citation Information	Title of Document of Instrument	Type of Evidence	Main Outcomes of Findings	Relevance to Project
J., Takagi, M., Yeates, K. O., & Zemek, R. (2017). What is the difference in concussion management in children as compared with adults? A systematic review. <i>British Journal of Sports Medicine</i> , 51(12), 949–957. <a href="https://doi.org/10.1136/bjsports-2016-097415">https://doi.org/10.1136/bjsports-2016-097415</a>	children as compared with adults? A systematic review		to 4 weeks or occasionally more to recover from sports related concussions -Cognitive and physical rest should be followed with a gradual return to activity -moderate amounts of cognitive and physical activity after brief rest period can help recovery -Higher levels of cognitive activity can lengthen symptoms	process of concussions in the pediatric population and what is good management of symptoms
Eisenberg, M. A., Meehan, W. P., & Mannix, R. (2014). Duration and course of post-concussive symptoms. <i>Pediatrics</i> , 133(6), 999–1006. <a href="https://doi.org/10.1542/peds.2014-0158">https://doi.org/10.1542/peds.2014-0158</a>	Duration and course of post-concussive symptoms	Prospective cohort study – Level II	-Median recovery times post-concussion for children and prolonged symptoms	-Provides insight into recovery times and post-concussion management for children
Fishbein, M., & Ajzen, I. (2010). <i>Predicting and changing behavior: The reasoned action approach</i> . Psychology Press	Predicting and changing behavior: The reasoned action approach	Theoretical – Level VII	-Expands on the original Theory of Planned Behavior	-Provides more details and insight into the Theory of Planned Behavior and using it to change behaviors and attitudes toward new concepts
Halstead, M. E., McAvoy, K., Devore, C. D., Carl, R., Lee, M., Logan, K., Council on Sports Medicine and Fitness, & Council on School Health. (2013). Returning to learning following a concussion. <i>Pediatrics</i> , 132(5), 948–957. <a href="https://doi.org/10.1542/peds.2013-2867">https://doi.org/10.1542/peds.2013-2867</a>	Returning to learning following a concussion	Clinical report	-Explains stepwise approach to returning to school using validated symptom screeners	-Explains stepwise approach to returning to school
Halstead, M. E., Walter, K. D., Moffatt, K., & Council on Sports Medicine and Fitness. (2018). Sport-related concussion in children and adolescents. <i>Pediatrics</i> , 142(6), e20183074. <a href="https://doi.org/10.1542/peds.2018-3074">https://doi.org/10.1542/peds.2018-3074</a>	Sport-related concussion in children and adolescents	Clinical practice guideline and policy statement	-Explains stepwise approach to returning to sports using validated symptom screeners	-Explains stepwise approach to returning to sports

Citation Information	Title of Document of Instrument	Type of Evidence	Main Outcomes of Findings	Relevance to Project
<p>Hansen, C., Cushman, D., Chen, W., Bounsanga, J., &amp; Hung, M. (2017). Reliability testing of the Balance Error Scoring System in children between the ages of 5 and 14. <i>Clinical Journal of Sport Medicine</i>, 27(1), 64–68. <a href="https://doi.org/10.1097/JSM.0000000000000293">https://doi.org/10.1097/JSM.0000000000000293</a></p>	<p>Reliability Testing of the Balance Error Scoring System in Children Between the Ages of 5 and 14</p>	<p>Quantitative reliability study</p>	<p>-There was a 95% confidence interval for interrater, intratester, and test-retest comparisons for administrators of the BESS test to the pediatric population -The BESS test shows reliability and is validated to be used on children ages 5 to 14 for concussion symptoms</p>	<p>-Use of the BESS test in project implementation -BESS can be used to measure balance</p>
<p>Howell, D. R., Wilson, J. C., Kirkwood, M. W., &amp; Grubenhoff, J. A. (2018). Quality of life and symptom burden 1 month after concussion in children and adolescents. <i>Clinical Pediatrics</i>, 58(1), 42–49. <a href="https://doi.org/10.1177/0009922818806308">https://doi.org/10.1177/0009922818806308</a></p>	<p>Quality of Life and Symptom Burden 1 Month After Concussion in Children and Adolescents</p>	<p>Prospective study</p>	<p>-There is a decrease in quality of life with more symptoms</p>	<p>-Importance of assessing pediatric patients for concussions correctly</p>
<p>Kaae, C., Cadigan, K., Lai, K., &amp; Theis, J. (2022). Vestibulo-ocular dysfunction in mTBI: Utility of the VOMS for evaluation and management – A review. <i>NeuroRehabilitation</i>, 50(3), 279–296. <a href="https://doi.org/10.3233/NRE-228012">https://doi.org/10.3233/NRE-228012</a></p>	<p>). Vestibulo-ocular dysfunction in mTBI: Utility of the VOMS for evaluation and management – A review</p>	<p>Systematic literature review – Level V</p>	<p>-Reviews vestibulo-ocular dysfunction following mTBI and evaluates the clinical utility of the VOMS</p>	<p>-Validates use of VOMS as a post-concussion management tool</p>
<p>Karr, J. E., Zuccato, B. G., Ingram, E. O., McAuley, T. L., Merker, B., &amp; Abeare, C. A. (2023). The post-concussion symptom Scale: Normative data for adolescent student-athletes stratified by gender and preexisting conditions. <i>The American Journal of Sports Medicine</i>, 51(1), 225–236. <a href="https://doi.org/10.1177/03635465221137541">https://doi.org/10.1177/03635465221137541</a></p>	<p>The Post-Concussion Symptom Scale: Normative Data for Adolescent Student-Athletes Stratified by Gender and Preexisting Conditions</p>	<p>Cross-sectional descriptive study</p>	<p>-Females tended to show higher PCSS scores -Those with history of mental illness showed higher scores</p>	<p>-PCSS is a tool to use to help determine symptoms of concussion in the mental aspect</p>
<p>Lecci, L., Williams, M., Taravath, S., Frank, H. G., Dugan, K., Page, R., &amp; Keith, J. (2019). Validation of a concussion screening battery for use in medical settings: Predicting Centers for Disease Control concussion symptoms in children and adolescents. <i>Archives of Clinical Neuropsychology</i>, 35(3), 265–274. <a href="https://doi.org/10.1093/arclin/acz041">https://doi.org/10.1093/arclin/acz041</a></p>	<p>Validation of a Concussion Screening Battery for Use in Medical Settings: Predicting Centers for Disease Control Concussion Symptoms in Children and Adolescents</p>	<p>Prospective validation study</p>	<p>Neurocognitive and neurobehavioral screenings can predict CDC symptoms of concussion in the pediatric population -Used the full BESS, NIH 4-Meter Gait test, CPT 3</p>	<p>Validated concussion screenings can predict CDC defined symptoms of concussions in pediatric populations</p>
<p>Lovell, M. R., Iverson, G. L., Collins, M. W., Podell, K., Johnston, K. M., Pardini, D., Pardini, J., Norwig, J., &amp; Maroon, J. C. (2006). Measurement of symptoms following sports-related</p>	<p>Measurement of symptoms following sports-related concussion: reliability and</p>	<p>Quantitative psychometric validation study</p>	<p>-The post-concussion symptom scale showed consistent reliability in</p>	<p>-PCSS is a reliable tool to measure subjective symptoms of</p>

Citation Information	Title of Document of Instrument	Type of Evidence	Main Outcomes of Findings	Relevance to Project
concussion: Reliability and normative data for the Post-Concussion Scale. <i>Applied Neuropsychology</i> , 13(3), 166–174.	normative data for the post-concussion scale.		the adolescent population	concussions in adolescent patients
Lumba-Brown, A., Yeates, K. O., Sarmiento, K., Breiding, M. J., Haegerich, T. M., Gioia, G. A., Turner, M., Benzel, E. C., Suskauer, S. J., Giza, C. C., Joseph, M., Broomand, C., Weissman, B., Gordon, W., Wright, D. W., Moser, R. S., McAvoy, K., Ewing-Cobbs, L., Duhaime, A., ... Timmons, S. D. (2018). Diagnosis and management of mild traumatic brain injury in children: A systematic review. <i>JAMA Pediatrics</i> , 172(11), e182847. <a href="https://doi.org/10.1001/jamapediatrics.2018.2847">https://doi.org/10.1001/jamapediatrics.2018.2847</a>	Diagnosis and Management of Mild Traumatic Brain Injury in Children A Systematic Review	Systematic review	-Reviewed diagnosis, prognosis, management, and treatment of mTBI in pediatric populations. -Va	-Validated Vestibular/Ocular-Motor Screening assessment -Neurological and psychiatric problems beforehand can cause prolonged mTBI recovery.
Rosenbaum, P. E., Locandro, C., Chrisman, S. P. D., Herring, S. A., & Rivara, F. P. (2020). Characteristics of pediatric mild traumatic brain injury and recovery in a concussion clinic population. <i>JAMA Network Open</i> , 3(11), e2021463. <a href="https://doi.org/10.1001/jamanetworkopen.2020.21463">https://doi.org/10.1001/jamanetworkopen.2020.21463</a>	Characteristics of Pediatric Mild Traumatic Brain Injury and Recovery in a Concussion Clinic Population	Prospective Cohort Study	-Preexisting conditions like anxiety or depression, migraines cause slower recovery -Females recovered slower than males	-Useful to know mental health history when assessing pediatric patients for concussion symptoms and recovery stages
Sady, M. D., Vaughan, C. G., & Gioia, G. A. (2014). Psychometric characteristics of the post-concussion symptom inventory in children and adolescents. <i>Archives of Clinical Neuropsychology</i> , 29(4), 348–363. <a href="https://doi.org/10.1093/arclin/acu014pubmed.ncbi.nlm.nih.gov">https://doi.org/10.1093/arclin/acu014pubmed.ncbi.nlm.nih.gov</a>	Psychometric Characteristics of the Post concussion Symptom Inventory in Children and Adolescents	Quantitative descriptive – instrument validation	-The PCSI can accurately track symptoms following a concussion in ages 5 to 18 years	-Subjective validated tool to help measure concussion symptoms in the pediatric population
Sariaslan, A., Sharp, D. J., D'Onofrio, B. M., Larsson, H., & Fazel, S. (2016). Long-term outcomes associated with traumatic brain injury in childhood and adolescence: A nationwide Swedish cohort study of a wide range of medical and social outcomes. <i>PLOS Medicine</i> , 13(8), e1002103. <a href="https://doi.org/10.1371/journal.pmed.1002103">https://doi.org/10.1371/journal.pmed.1002103</a>	Long-Term Outcomes Associated with Traumatic Brain Injury in Childhood and Adolescence: A Nationwide Swedish Cohort Study of a Wide Range of Medical and Social Outcomes	Cohort study	-In a Swedish birth cohort 9.1% of the population had sustained a TBI by age 25 -Increased risk for psychological disorders	-Displays the importance of monitoring pediatric patients who have sustained concussions
Serpa, R. O., Ferguson, L., Larson, C., Bailard, J., Cooke, S., Greco, T., & Prins, M. L. (2021). Pathophysiology of pediatric traumatic brain injury. <i>Frontiers in Neurology</i> , 12, 696510. <a href="https://doi.org/10.3389/fneur.2021.696510">https://doi.org/10.3389/fneur.2021.696510</a>	Pathophysiology of pediatric traumatic brain injury	Literature Review	-Pathophysiological mechanisms of pediatric TBIs	-Supports background section and pathological and physiological explanation of concussions
Veliz, P., McCabe, S. E., Eckner, J. T., & Schulenberg, J. E. (2021). Trends in the prevalence of concussion reported by US	Trends in the Prevalence of Concussion Reported by US Adolescents, 2016-2020	Quantitative descriptive epidemiological	-Reports statistics on the number of	-frequency of concussion in adolescents

Citation Information	Title of Document of Instrument	Type of Evidence	Main Outcomes of Findings	Relevance to Project
adolescents, 2016–2020. <i>JAMA</i> , 325(17), 1789–1791. <a href="https://doi.org/10.1001/jama.2021.1538">https://doi.org/10.1001/jama.2021.1538</a>			adolescent concussions within a set time period	
Zonfrillo, M. R., Master, C. L., Grady, M. F., Winston, F. K., Callahan, J. M., & Arbogast, K. B. (2012). Pediatric providers' self-reported knowledge, practices, and attitudes about concussion. <i>Pediatrics</i> , 130(6), 1120–1125. <a href="https://doi.org.ezproxy2.library.arizona.edu/10.1542/peds.2012-1431">https://doi.org.ezproxy2.library.arizona.edu/10.1542/peds.2012-1431</a>	Pediatric providers' self-reported knowledge, practices, and attitudes about concussion	Cross-sectional survey	-Pediatric providers often felt inadequate training to educate, time to educate, and that it was not within their role to educate about concussions	-It is important to educate pediatric providers about concussion assessments and recovery
Eisenberg, M. A., Meehan, W. P., & Mannix, R. (2014). Duration and course of post-concussive symptoms. <i>Pediatrics</i> , 133(6), 999–1006. <a href="https://doi.org/10.1542/peds.2014-0158">https://doi.org/10.1542/peds.2014-0158</a>	Duration and Course of Post-Concussive Symptoms	Prospective cohort study	-Headache, fatigue, dizziness and trouble thinking were initial symptoms -Sleep disturbance, frustration, forgetfulness, and fatigue developed in follow-up period -Symptoms lasted around 14 to 16 days on average -20% of follow-up patients had symptoms beyond 1 month	-Symptoms from concussion can last up to a month and in some longer

## References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Anzalone, A. J., Blueitt, D., Case, T., McGuffin, T., Pollard, K., Garrison, J. C., Jones, M. T., Pavur, R., Turner, S., & Oliver, J. M. (2017). A positive vestibular/ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. *The American Journal of Sports Medicine*, 45(2), 474–479. <https://doi.org/10.1177/0363546516668624>
- Arbogast, K. B., Curry, A. E., Pfeiffer, M. R., Zonfrillo, M. R., Haarbauer-Krupa, J., Breiding, M. J., & Master, C. L. (2016). Point of health care entry for youth with concussion within a large pediatric care network. *JAMA Pediatrics*, 170(7), e160294. <https://doi.org/10.1001/jamapediatrics.2016.0294>
- Black, L. I., & Zablotsky, B. (2021). *Concussions and brain injuries in children: United States, 2020* (NCHS Data Brief No. 423). National Center for Health Statistics. <https://dx.doi.org/10.15620/cdc:111174>
- Committee on Sports-Related Concussions in Youth, Board on Children, Youth, and Families, Institute of Medicine, & National Research Council. (2014). *Sports-related concussions in youth: Improving the science, changing the culture. Appendix C, Clinical evaluation tools* (R. Graham, F. P. Rivara, & M. A. Ford, Eds.). National Academies Press. <https://www.ncbi.nlm.nih.gov/books/NBK185341/>
- Davis, G. A., Anderson, V., Babl, F. E., Gioia, G. A., Giza, C. C., Meehan, W., Moser, R. S., Purcell, L., Schatz, P., Schneider, K. J., Takagi, M., Yeates, K. O., & Zemek, R. (2017). What is the difference in concussion management in children as compared with adults? A systematic review. *British Journal of Sports Medicine*, 51(12), 949–957. <https://doi.org/10.1136/bjsports-2016-097415>
- Eisenberg, M. A., Meehan, W. P., & Mannix, R. (2014). Duration and course of post-concussive symptoms. *Pediatrics*, 133(6), 999–1006. <https://doi.org/10.1542/peds.2014-0158>
- Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Psychology Press.
- Halstead, M. E., McAvoy, K., Devore, C. D., Carl, R., Lee, M., Logan, K., Council on Sports Medicine and Fitness, & Council on School Health. (2013). Returning to learning following a concussion. *Pediatrics*, 132(5), 948–957. <https://doi.org/10.1542/peds.2013-2867>

- Halstead, M. E., Walter, K. D., Moffatt, K., & Council on Sports Medicine and Fitness. (2018). Sport-related concussion in children and adolescents. *Pediatrics*, *142*(6), e20183074. <https://doi.org/10.1542/peds.2018-3074>
- Hansen, C., Cushman, D., Chen, W., Bounsanga, J., & Hung, M. (2017). Reliability testing of the balance error scoring system in children between the ages of 5 and 14. *Clinical Journal of Sport Medicine*, *27*(1), 64–68. <https://doi.org/10.1097/JSM.0000000000000293>
- Howell, D. R., Wilson, J. C., Kirkwood, M. W., & Grubenhoff, J. A. (2018). Quality of life and symptom burden 1 month after concussion in children and adolescents. *Clinical Pediatrics*, *58*(1), 42–49. <https://doi.org/10.1177/0009922818806308>
- Institute for Healthcare Improvement. (IHI). (n.d.). *How to improve: Model for improvement: Testing changes*. <https://www.ihl.org/how-improve-model-improvement-testing-changes>
- Kaae, C., Cadigan, K., Lai, K., & Theis, J. (2022). Vestibulo-ocular dysfunction in mTBI: Utility of the VOMS for evaluation and management – A review. *Neuro Rehabilitation*, *50*(3), 279–296. <https://doi.org/10.3233/NRE-228012>
- Karr, J. E., Zuccato, B. G., Ingram, E. O., McAuley, T. L., Merker, B., & Abeare, C. A. (2023). The post-concussion symptom scale: Normative data for adolescent student-athletes stratified by gender and preexisting conditions. *The American Journal of Sports Medicine*, *51*(1), 225–236. <https://doi.org/10.1177/03635465221137541>
- Lecci, L., Williams, M., Taravath, S., Frank, H. G., Dugan, K., Page, R., & Keith, J. (2019). Validation of a concussion screening battery for use in medical settings: Predicting Centers for Disease Control concussion symptoms in children and adolescents. *Archives of Clinical Neuropsychology*, *35*(3), 265–274. <https://doi.org/10.1093/arclin/acz041>
- Legare, F., Borduas, F., Freitas, A., Jacques, A., Godin, G., Luconi, F., & Boucher, A. (2014). The continuing professional development reaction questionnaire (CPD-RQ): A tool to assess behavioral intention and its predictors in CPD activities. *Implementation Science*, *9*(1), 42. <https://doi.org/10.1186/1748-5908-9-42>
- Lovell, M. R., Iverson, G. L., Collins, M. W., Podell, K., Johnston, K. M., Pardini, D., Pardini, J., Norwig, J., & Maroon, J. C. (2006). Measurement of symptoms following sports related concussion: Reliability and normative data for the post-concussion scale. *Applied Neuropsychology*, *13*(3), 166–174.
- Lumba-Brown, A., Yeates, K. O., Sarmiento, K., Breiding, M. J., Haegerich, T. M., Gioia, G. A., Turner, M., Benzel, E. C., Suskauer, S. J., Giza, C. C., Joseph, M., Broomand, C., Weissman, B., Gordon, W., Wright, D. W., Moser, R. S., McAvoy, K., Ewing-Cobbs, L., Duhaime, A., ... Timmons, S. D. (2018). Diagnosis and management of mild traumatic brain injury in children: A systematic review. *JAMA Pediatrics*, *172*(11), e182847. <https://doi.org/10.1001/jamapediatrics.2018.2847>

- Mucha, A., Collins, M. W., Elbin, R. J., Furman, J. M., Troutman-Enseki, C., DeWolf, R. M., Marchetti, G., & Kontos, A. P. (2014). A brief vestibular/ocular motor screening (VOMS) assessment to evaluate concussions: Preliminary findings. *The American Journal of Sports Medicine*, 42(10), 2479–2486. <https://doi.org/10.1177/0363546514543775>
- Ogren, T. A., & Knobloch, A. C. (2019). The impact of a concussion clinic on family medicine resident education. *PRiMER*, 3, 12. <https://doi.org/10.22454/PRiMER.2019.465841>
- Rosenbaum, P. E., Locandro, C., Chrisman, S. P. D., Herring, S. A., & Rivara, F. P. (2020). Characteristics of pediatric mild traumatic brain injury and recovery in a concussion clinic population. *JAMA Network Open*, 3(11), e2021463. <https://doi.org/10.1001/jamanetworkopen.2020.21463>
- Sady, M. D., Vaughan, C. G., & Gioia, G. A. (2014). Psychometric characteristics of the post-concussion symptom inventory in children and adolescents. *Archives of Clinical Neuropsychology*, 29(4), 348-363. <https://doi.org/10.1093/arclin/acu014>
- Sariaslan, A., Sharp, D. J., D'Onofrio, B. M., Larsson, H., & Fazel, S. (2016). Long-term outcomes associated with traumatic brain injury in childhood and adolescence: A nationwide Swedish cohort study of a wide range of medical and social outcomes. *PLOS Medicine*, 13(8), e1002103. <https://doi.org/10.1371/journal.pmed.1002103>
- Serpa, R. O., Ferguson, L., Larson, C., Bailard, J., Cooke, S., Greco, T., & Prins, M. L. (2021). Pathophysiology of pediatric traumatic brain injury. *Frontiers in Neurology*, 12, 696510. <https://doi.org/10.3389/fneur.2021.696510>
- U.S. Census Bureau. (n.d.). *QuickFacts: Broken Arrow City, Oklahoma*. <https://www.census.gov/quickfacts/fact/table/brokenarrowcityoklahoma/PST12024>
- Veliz, P., McCabe, S. E., Eckner, J. T., & Schulenberg, J. E. (2021). Trends in the prevalence of concussion reported by US adolescents, 2016–2020. *JAMA*, 325(17), 1789-1791. <https://doi.org/10.1001/jama.2021.1538>
- Zonfrillo, M. R., Master, C. L., Grady, M. F., Winston, F. K., Callahan, J. M., & Arbogast, K. B. (2012). Pediatric providers' self-reported knowledge, practices, and attitudes about concussion. *Pediatrics*, 130(6), 1120–1125. <https://doi.org/10.1542/peds.2012-14>