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## Performance of the Rivermead Post-Concussion Questionnaire in a sample of people with traumatic brain injury living in Italy

The country-level incidence of traumatic brain injury (TBI) in Europe varies from 47.3 per 100,000 inhabitants to 694 per 100,000 inhabitants per year, mean age varies from 27 to 45 years.<sup>1</sup> Injury mechanisms include traffic accidents, falls, violence, sports collisions, home casualties, work fatalities, and suicides; regional patterns of TBI report a decrease of road accidents and an increase of events imputable to falling.<sup>1</sup> Most people who survive a TBI perceive good levels of quality of life, despite the initial severity degree and the numerous unmet rehabilitation needs.<sup>2</sup> Independence in common daily activities and self-awareness are key issues for well-being of people with TBI and should be addressed in neurorehabilitation settings.<sup>2</sup> More emphasis should be given also to the evaluation of impairments and the sharing of rehabilitation services within the boundary of highly specialized hospitals where trauma centers are allocated.<sup>3</sup> When referring to mid- and long-term outcomes of people with TBI, the assessment of cognitive symptoms is of importance to ascertain the burden of disability.<sup>4</sup> One of the most commonly used patient-reported outcome measure to evaluate cognitive symptoms of people with TBI is the Rivermead Post-Concussion Questionnaire (RPQ), a validated 16-item tool published in 1995, and whose aim is gathering information on symptoms deriving from cognitive, somatic and emotional complaints.<sup>5</sup> This tool has been listed in the Common Data Elements recommendations as a supplemental measure for head traumas<sup>6</sup> and, over time, was extensively translated and linguistically validated in several languages (English and non-English speaking countries), providing clinicians and researchers a tool to evaluate people with TBI.<sup>7</sup> In particular, after being validated by a British research group, it has been used in Netherlands/Belgium for adults who presented with a TBI by showing satisfactory properties,<sup>8</sup> and in Germany for adolescents after a TBI, exhibiting

its suitability also in this population.<sup>9</sup> However, the RPQ has not been psychometrically analyzed yet in the Italian clinical context, thus researchers and clinicians may be limited with sharing validated outcomes.

In this research letter we report the results of a cross-sectional study which investigated the psychometric properties (*i.e.*, internal consistency, test-retest reliability, and construct validity) of the RPQ in people with history of TBI. The study was approved by our Local Ethical Committee (PG/2022/1294, 26<sup>th</sup> Jan 2021, Hospital University, Cagliari, Italy) and was conducted according to the principles of the World Medical Association Declaration of Helsinki and its following amendments. A convenience sample of 18 adults admitted to the outpatient facility of the Neurorehabilitation Unit at the ARNAS G. Brotzu Hospital in Cagliari (Italy) and having suffered a severe TBI was included in this study (two females, aged 37.4.5±17.4 years, mean time from TBI 32.0±28.0, Body Mass Index 25.1±4.2). The performances of the RPQ questionnaire were compared to the Functional Independence Measure (FIM), which evaluates physical and cognitive disability and is composed by 18 items,<sup>10</sup> and to the Rivermead Mobility Index (RMI), which assesses functional mobility with particular focus on gait, balance, and transfers of persons and is made by 15 items.<sup>11</sup> In particular, distribution and floor/ceiling effects, internal consistency, test-retest reliability, sensitivity to change by the minimum detectable change (MDC), and construct validity were evaluated.

Table I shows the distribution of the RPQ in comparison with the other outcome measures. Table II shows day 1-15 test-retest reliability of RPQ.

Overall, the RPQ showed satisfactory reliability and validity in evaluating cognitive, somatic and emotional symptoms of people with TBI living in Italy, showing no floor/ceiling effects, achieving a good internal consistency (Cronbach's  $\alpha=0.89$ ) similar to previous studies,<sup>12</sup> and good inter-item relationship (average inter-item correlation was  $r=0.29$ ). Test-retest reliability of this tool was excellent (ICC=0.88; 95%CI: 0.68-0.95) as also the British developers found.<sup>5</sup> Items characterized by a high degree of test-retest reliability were those who people with TBI identify more clearly and experience most after the event,<sup>5</sup> such as "headaches," "feelings of dizziness," and "sleep disturbance." On the contrary, "fatigue, tiring more easily," and "restlessness," revealed low test-retest reliability: as previously stated by King *et al.*, this is probably due to the fact that these items are more difficult to distinguish.<sup>5</sup> We suppose that in the ontogenic development of cognition, a significant factor to consider is the presence of a "memory effect": this

TABLE I.—Distribution of RPQ, FIM and RMI scores.

Tool	Mean	SD	25 <sup>th</sup> percentile	50 <sup>th</sup> percentile	75 <sup>th</sup> percentile	Floor effect	Ceiling effect
RPQ (0-64)	15.9	11.6	5	15	24	0%	0%
FIM (18-126)	120.6	8.8	120	123	125	0%	22%
RMI (0-15)	13.8	2.1	13	14	15	0%	44%

RPQ: Rivermead Post-Concussion Questionnaire; FIM: Functional Independence Measure; RMI: Rivermead Mobility Index.

TABLE II.—Day 1-15 test-retest reliability of RPQ.

Items	ICC	95% CI
Item 1 - Headaches	0.97	0.93-0.99
Item 2 - Feelings of dizziness	0.90	0.72-96
Item 3 - Nausea and/or vomiting	0.33	-0.88-0.75
Item 4 - Noise sensitivity, easily upset by loud noise	0.77	0.40-0.91
Item 5 - Sleep disturbance	0.94	0.83-0.98
Item 6 - Fatigue, tiring more easily	0.49	-0.36-0.81
Item 7 - Being Irritable, easily angered	0.88	0.67-0.95
Item 8 - Feeling depressed or tearful	0.82	0.51-0.93
Item 9 - Feeling frustrated or impatient	0.87	0.66-0.95
Item 10 - Forgetfulness, poor memory	0.79	0.46-0.92
Item 11 - Poor concentration	0.87	0.66-95
Item 12 - Taking longer to think	0.59	-0.11-0.85
Item 13 - Blurred vision	0.76	0.37-0.91
Item 14 - Light sensitivity, easily upset by bright light	0.60	0.15-0.85
Item 15 - Double vision	0.00	-1.02-0.58
Item 16 - Restlessness	0.54	-0.26-0.83
RPQ total score	0.88	0.68-0.95

RPQ: Rivermead Post-Concussion Questionnaire.

effect plays a fundamental role in elementary sensations, while higher levels of cognitive operations involve the development of abstract concepts independent of direct experience. Test-retest reliability was not investigated in other north-European studies, and hence further comparisons cannot be made. SEM was about 6% points of the RPQ score (4 points out of 64), and this is again expected as test-retest reliability is excellent. We found that, at a 95% confidence level, an MDC of at least 11 points in the individual score is needed to reveal a true change in TBI people when the RPQ is used. A MDC was not calculated in the British study as well as in other north-European investigations and, therefore, comparisons cannot be done. The RPQ in Italian people with TBI is strongly related to the FIM ( $\rho=0.69$ ) and poorly related to the RMI ( $\rho=0.17$ ): this should not surprise as the FIM contains also a mental component.

This study has a number of limitations. First, our sample size was hindered by the constraints imposed by COVID-19 restrictions and subsequent reorganization within the hospital, which had an impact on the statistical confidence intervals and power of our study. Second, the relationships between the RPQ and physical (e.g. walking) and cognitive tests (e.g. evaluation of working memory, attention, or verbal fluency) were not considered. Third, some of the internationally most established measures used to conduct validation studies like the Short-Form Health Survey-36 were not used, but Italian researchers are recommended to analyze them in future studies.

In conclusion, the RPQ is reliable and valid in persons with TBI living in Italy. It can be recommended for clinical, rehabilitative and research purposes. Future studies may involve factor analysis of the RPQ in Italian persons with TBI, corroboration of our test-retest reliability and validity findings, longitudinal investigations to determine minimal important changes, and assessment of the RPQ in individuals with neurological diseases other than head traumas. These studies would enhance a better understanding of the RPQ's applicability, inform targeted interventions, and improve the management of cognitive, somatic and emotional symptoms.

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## References

1. Brazinova A, Rehorkikova V, Taylor MS, Buckova V, Majdan M, Psota M, *et al.* Epidemiology of Traumatic Brain Injury in Europe: A Living Systematic Review. *J Neurotrauma* 2021;38:1411-40.
2. Rauen K, Reichelt L, Probst P, Schäpers B, Müller F, Jahn K, *et al.* Quality of life up to 10 years after traumatic brain injury: a cross-sectional analysis. *Health Qual Life Outcomes* 2020;18:166.
3. Andelic N, Røe C, Tenovuo O, Azouvi P, Dawes H, Majdan M, *et al.* Unmet Rehabilitation Needs after Traumatic Brain Injury across Europe: results from the CENTER-TBI Study. *J Clin Med* 2021;10:1035.
4. Vanderploeg RD, Belanger HG, Curtiss G, Bowles AO, Cooper DB. Reconceptualizing rehabilitation of individuals with chronic symptoms following mild traumatic brain injury. *Rehabil Psychol* 2019;64:1-12.
5. King NS, Crawford S, Wenden FJ, Moss NE, Wade DT. The Rivermead Post Concussion Symptoms Questionnaire: a measure of symptoms commonly experienced after head injury and its reliability. *J Neurol* 1995;242:587-92.
6. NINDS Common Data Elements. 2024 [Internet]. Available from: <https://www.commondataelements.ninds.nih.gov> [cited 2024, Jun 6].
7. von Steinbuechel N, Rauen K, Krenz U, Wu YJ, Covic A, Plass AM, *et al.*; The Linguistic Validation Group Of Center-Tbi. Translation and Linguistic Validation of Outcome Instruments for Traumatic Brain Injury Research and Clinical Practice: A Step-by-Step Approach within the Observational CENTER-TBI Study. *J Clin Med* 2021;10:2863.
8. Plass AM, Van Praag D, Covic A, Gorbunova A, Real R, von Steinbuechel N; Dutch and Flemish CENTER TBI investigators. The psychometric validation of the Dutch version of the Rivermead Post-Concussion Symptoms Questionnaire (RPQ) after traumatic brain injury (TBI). *PLoS One* 2019;14:e0210138.
9. Bockhop F, Zeldovich M, Greving S, Krenz U, Cunitz K, Timmermann D, *et al.* Psychometric Properties of the German Version of the Rivermead Post-Concussion Symptoms Questionnaire in Adolescents after Traumatic Brain Injury and Their Proxies. *J Clin Med* 2022;12:319.
10. Franchignoni FP, Benevolo E, Zelaschi GP. Recovery from physical disability as evaluated by the Functional Independence Measure inpatient stroke rehabilitation. *Eura Medicophys* 1995;31:67-75.
11. Franchignoni F, Tesio L, Benevolo E, Ottonello M. Psychometric properties of the Rivermead Mobility Index in Italian stroke rehabilitation inpatients. *Clin Rehabil* 2003;17:273-82.
12. Plass AM, Van Praag D, Covic A, Gorbunova A, Real R, von Stein-

buechel N; Dutch and Flemish CENTER TBI investigators. The psychometric validation of the Dutch version of the Rivermead Post-Concussion Symptoms Questionnaire (RPQ) after traumatic brain injury (TBI). *PLoS One* 2019;14:e0210138.

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#### *Conflicts of interest*

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

#### *Authors' contributions*

Rosa Marcello and Laura Atzeni contributed equally to the paper. Rosa Marcello and Laura Atzeni contacted the participants, assessed the inclusion criteria, performed the data collection, and contribute in drafting the original work. Federico Arippa made substantial contributions on the work; contributed to the analysis, and interpretation of data for the work; drafted the work and finally revised it critically for important intellectual content; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Marco Monticone made substantial contributions to the conception and design of the work; supervised the data collection, analysis, and interpretation of data for the work; drafted the work and finally revised

it critically for important intellectual content; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final version of the manuscript.

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#### *History*

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