Making research data FAIR (Findable, Accessible, Interoperable, and Reusable) is critical to maximizing its impact. However, since the FAIR principles are designed as guidelines and do not specify implementation rules, it is difficult to verify the practice of these principles. Therefore, metrics and associated tools need to be developed to enable the assessment of FAIR compliance of services and datasets. Such practical solutions are important for many stakeholders to assess the quality of data-related services. They are important for selecting such services, but can also be used to iteratively improve data offerings, e.g., as part of FAIR advisory processes. With the increasing number of published datasets and the need to test them repeatedly, there is a growing body of literature that recognizes this importance of automated FAIR assessment tools. Our goal is to contribute to this area of FAIR through the development of an open source tool called F-UJI. F-UJI supports programmatic FAIR assessment of research data based on a set of core metrics against which the implementation of FAIR principles can be assessed. This paper presents the development and application of F-UJI and the underlying metrics. For each of the metrics, we have designed and implemented practical tests based on existing standards and best practices for research data. The tests are important to our expanded understanding of how to test FAIR metrics in practice that have not been fully addressed in previous work on FAIR data assessment. We demonstrate the use of the tool by assessing several multidisciplinary datasets from selected trusted digital repositories, followed by recommendations for improving the FAIRness of these datasets. We summarize the experience and lessons learned from the development and testing.