An algebraic interpretation of the one-variable affine $q$-Krawtchouk polynomials is provided in the framework of the Schwinger realization of $\mathcal{U}_q(\mathfrak{sl}_2)$ involving two independent $q$-oscillators. The polynomials are shown to arise as matrix elements of unitary “$q$-rotation” operators expressed as $q$-exponentials in the $\mathcal{U}_q(\mathfrak{sl}_2)$ generators. The properties of the polynomials (orthogonality relation, generating function, recurrence relation, difference equation, raising/lowering relations) are derived by exploiting the algebraic setting. The results are extended to another family of polynomials, the quantum $q$-Krawtchouk polynomials, through a duality relation. (Received August 05, 2014)