Comment on ,,On the Role of Locality Condition in Bell's Theorem"

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In his paper [H. Razmi, Int. J. Quant. Inf. **1**, 25 (2003)] Razmi derives a Bell-like inequality without imposing the locality condition. Then he shows violation of this inequality by certain quantum predictions. Here we point at a loophole in Razmi's proof, which invalidates his inequality.

Razmi studies a Bell type experiment. The source produces two spin $\frac{1}{2}$ particles in the singlet state $|\psi\rangle = \frac{1}{\sqrt{2}}(|\uparrow\downarrow\rangle - |\downarrow\uparrow\rangle)$. Each particle travels to space separated labs, where they are measured with one of two dichotomic (with outcomes ± 1) observables. The experiment is run n times. Razmi claims that, after excluding measurement of the same observable in both labs, the number of measurement outcomes, the product of which is equal to $+1$, m, is in the range

$$0 < m \leq n. \tag{1}$$

"This is because the special case $m = 0$ only corresponds to setting $\theta_A = \theta_B$". This claim is wrong. The singlet state is rotationally invariant, i.e. the two spins are antiparallel along whichever (the same in both labs) direction we choose to measure. In such a case the product of measurement outcomes is never equal to $+1$. Thus probability $P(+1) = 0$, what implies $m = 0$. If two different observables are measured then $P(+1) > 0$, but nevertheless the situation in which the product of measurement results is never equal to $+1$ cannot be excluded (i.e. m can be 0).

To illustrate this consider coin tosses. The probability of heads $P(\text{heads}) = \frac{1}{2} > 0$, but this does not guarantee that a finite sequence of trials in which not a single head appears is ruled out.

After the correction of (1) inequality (11) of Razmi is bounded by 0 and no conflict appears with the quantum inequality (16).

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[1] H. Razmi, Int. J. Quant. Inf. **1**, 25 (2003).