Consider a situation when we randomly choose $(k-1)$ points in the interval $[0, 1-kc]$. So suppose these points when sorted in increasing order are $y_1, y_2, \ldots y_{k-1}$ and let $y_k = 1-kc$

Now consider $x_i = i \cdot c + y_i$.
We see that $x_i - x_{(i-1)} = c + (y_i - y_{i-1})$
$\geq c$

and $x_1 \geq c$

So randomly choosing $(k-1)$ points in the interval $[0, 1-kc]$ correspondingly generates randomly choosen $(k-1)$ points in the interval $[0, 1]$, in which between any 2 consecutive points dist $\geq c$.

So the probability is

$$= \frac{\text{Volume of } (k-1) \text{ dimensional cube of size } (1-kc)}{\text{Volume of } (k-1) \text{ dimensional cube of size } 1}$$

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So by scaling argument we can say answer is

$$= (1+kc)^{k-1} \quad \text{for } kc \leq 1$$
$$= 0 \quad \text{for } kc > 1$$