

Power Analysis/Sample Size of Field-Based Mosquito Repellency Studies
EPA Office of Pesticide Programs
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Objective

To determine the sample size N such that mosquito repellency studies have sufficient power to obtain a given degree of **precision** in the estimate of median Complete Protection Time (mCPT). This precision – designated as “K” -- will be expressed as the ratio: 95% LCL_{mCPT}/estimated mCPT

The simulation used to estimate varying sample sizes will require that that 95% LCL_{mCPT}/estimated mCPT < K; such true **variation** of the Complete Protection Time (CPT) distribution will be expressed by the Weibull distribution family and a parameter, P5MR, defined as the 5th percentile/mCPT.

The model simulation was prepared in anticipation of receipt of a proposed mosquito repellency protocol concerning IR3535 to be reviewed by the HSRB at a future date. EPA anticipates that most, if not all, future mosquito repellency studies with similar study designs can likely use this approach – and the simulation results described here - to determine the required sample size to achieve the stated objectives.

In order to develop estimates of a required sample size for a mosquito repellency study to achieve certain stated efficacy criteria and estimate a complete protection time (CPT)¹, it is necessary to determine the distribution of mosquito repellent failure times (generally considered to be time to first landing with intent to bite). However, the underlying distribution of the CPT of a product being tested in a mosquito repellency study is not known prior to the testing phase. What is known about the distribution is that CPT values are (necessarily) non-negative and are (generally) right censored after 10 (or 12 hours) in most mosquito repellency studies. From past submitted studies that have been examined, the EPA has found CPTs display a left skewed distribution in some of the datasets.

On this basis, EPA assumed for this sample size determination exercise that a distribution of mosquito repellent failure times follows a Weibull distribution. A Weibull distribution is commonly used in reliability engineering and failure analysis, in survival analysis, in predicting delivery times, in weather forecasting and hydrology, and in extreme value prediction. Its utility in a wide variety of applications is due in part to its flexibility to take on a variety of shapes depending on the parameters selected to describe the distribution. Oftentimes, the Weibull plot is described by two parameters: κ (the “shape” parameter and sometimes referred to in some parameterizations as “a”) and λ (the scale parameter and sometimes referred to as “b”).² The PDF (probability density function) and CDF (cumulative distribution

¹ The Complete Protection Time (CPT) is defined as the time from initial application of the repellent by the test subject to the time of first confirmed landing with intent to bite (FCLIB). The FCLIB is considered to be when one landing is followed by another landing within 30 minutes. The first landing is confirmed by the second landing.

² A Weibull distribution can sometimes be described by 3 parameters, with a “location” parameter added as a third parameter to the “scale” and “shape” parameter of the 2-parameter Weibull distribution.

function) of the aforementioned two-parameter Weibull distribution are defined, respectively, as follows:

$$f(x, \kappa, \lambda) = \begin{cases} \frac{\kappa}{\lambda} \left(\frac{x}{\lambda}\right)^{\kappa-1} e^{-(x/\lambda)^\kappa} & x \geq 0, \\ 0 & x < 0 \end{cases}$$

$$F(x, \kappa, \lambda) = \begin{cases} 1 - e^{-(x/\lambda)^\kappa} & x \geq 0, \\ 0 & x < 0 \end{cases}$$

and are illustrated in the associated plots in Figures 1 and 2 for some illustrative κ and λ values.

Parameterizing the Weibull distribution in terms of κ and λ is, however, not necessarily intuitive with respect to studying – and judging -- the efficacy of skin-applied mosquito repellents as measured by CPT for individuals using the repellent in the field. Instead, it is more natural and desirable to be able to express the efficacy of the repellent in terms of both the expected precision of the estimated median CPT (mCPT) and in terms of the estimated variability of mCPT in (or across) the population. More specifically: the testing of a given repellent in the field should be able to generate a reasonably precise estimate of the mCPT that is expected to be generally close to what a sizable fraction of the population would be expected to experience (or, more accurately, a mCPT that only a small fraction of the population would ideally experience to be much shorter).

Following the above logic, we define the *precision of the CPT estimate* -- designated as “K” -- as follows:

$$K = 95\% \text{ LCL}_{\text{mCPT}} / \text{estimated mCPT}$$

where: mCPT= median complete protection time

95% LCL_{mCPT} = 95% lower confidence limit on the estimated mCPT

Similarly, the degree of variation of the CPT distribution in the population will be defined as the P5MR which we define here as the ratio between the mCPT of the 5th percentile of the population to the mCPT of the population:

$$\text{P5MR} = \text{CPT}_{5^{\text{th}} \text{ %ile}} / \text{mCPT}$$

where:

mCPT= median complete protection time

CPT_{5th %ile} = 5th percentile of the distribution of CPT

Re-parameterization of Standard Weibull Equation

While the above mCPT and P5MR parameterizations of the Weibull distribution are intuitively appealing for judging and evaluating repellent efficacy, they are non-standard parameterizations and it is necessary -- for comparison and simulation purposes -- to convert these to the more standard κ (shape)

and λ (scale) values. To do this, EPA developed an equation such that interconversion between the standard (κ (shape) and λ (scale)) parameterization of the Weibull to this alternate version (with the Weibull distribution instead expressed in terms of P5MR and mCPT). Briefly, the cumulative probability function of CPT is assumed to be a 2- parameter Weibull distribution:

$$P(CPT, \kappa, \lambda) = 1 - e^{-(CPT/\lambda)^\kappa}$$

Given that a value of the mCPT represents the median or 50th percentile of the CPT and the value of P5MR represents the ratio of the 5%-tile of the CPT distribution to the mCPT, we can develop the following two equations to represent the cumulative distribution functions at the median CPT and the 5th percentile CPT:

$$P(mCPT, \kappa, \lambda) = 1 - e^{-\left(\frac{mCPT}{\lambda}\right)^\kappa} = 0.5 \quad (\text{median})$$

$$P(P5MR \times mCPT, \kappa, \lambda) = 1 - e^{-\left(\frac{P5MR \times mCPT}{\lambda}\right)^\kappa} = 0.05 \quad (\text{5th percentile})$$

Algebraically solving the equations above (see Appendix 2 for full derivation), we develop expressions for κ and λ :

$$\kappa = \ln \left[\frac{\ln(0.95)}{\ln(0.5)} \right] / \ln(P5MR)$$

$$\lambda = e^{\frac{1}{\kappa}} \times \ln \left[-\frac{mCPT^\kappa}{\ln(0.5)} \right]$$

Table 1 below compares these two parameterizations for the example PDF and CDF distributions shown in Figures 1 and 2, respectively, for the κ and λ parameterizations shown there, illustrating the conversion to this new parameterization:

Table 1. Re-parameterization of Weibull Distribution Parameters from Traditional (κ, λ) to Revised (P5MR, mCPT) for Example Weibull Distributions Appearing in Figures 1 and 2.				
Parameterization Scheme				Description/Comments
Traditional		Revised		
Scale (λ) ^a	Shape (κ)	mCPT ^b	P5MR ^{c,d}	
1	0.5	0.480453	0.005476	- κ values of less than 1 indicate a failure rate decreases over time, and defective items fail early or are otherwise removed from the population.
1	1	0.693147	0.074001	- κ values equal to 1 indicate a constant failure rate over time possibly suggesting failure is due to random external events. - Here, the Weibull distribution reduces to the “exponential” distribution; - Note that mCPT here = 0.693 = $\ln(2)$
1	1.5	0.78322	0.176261	- κ values greater than 1 suggests that the failure rate increases over time, as when there is an “aging” process or components are more likely to fail over time.
1	5	0.92932	0.594083	

^a The Weibull scale parameter is the 63.2 percentile of the distribution. If the scale parameter is 1, then this means that 63.2% of the observed values will be smaller than 1. Note in the CDF in Figure 2, as a consequence, that all $\lambda=1$ distributions intersect at the 63.2 percentile.

^b $mCPT = \frac{[\ln(2) \cdot \exp(\kappa \cdot \ln(\lambda))]^{1/\kappa}}{\lambda}$

^c $P5MR = \exp(\ln(\ln(0.95))/\ln(0.5))/\kappa$

^d Note that as κ increases, the P5MR value becomes larger, indicating that the values at the 5th percentile approaches the values present at the 50th percentile, and the PDF becomes tighter and more peaked. κ values of between 3 and 4 often lead to distributions that appear normal.

An example of the (varied) kinds of distributional “shapes” associated with various parameterizations is shown in Figure 2 as histograms of the CPT. More specifically, Figure 2 presents the CPT distributions with different medians and values of P5MR (ratio 5%-tile/mCPT). These present the CPT distributions with different mCPTs (2-, 4-, 6-, and 8- hrs) and values of the P5MR ratio (P5MR= 0.2, 0.3, 0.4, and 0.6) for the (assumed) Weibull Distribution³. As seen in Figure 2, larger mCPTs are associated with a shift in the distribution toward the right. In addition -- and importantly -- smaller P5MR values in this range are associated with “flatter” distributions and larger P5MRs are associated with more “peaked” distributions, with these more peaked distributions showing a greater percentage of the distribution

³ Other simulations were performed for the lognormal, normal, and uniform distributions, with the latter one (particularly) done as a form of sensitivity analysis but these are not discussed in this report; the simulation outputs, however, are provided in Appendix 4. Note that the power estimates for a given sample size from the Weibull and Lognormal distributions are similar.

centered around the median. From a regulatory perspective, a CPT distribution with a larger P5MR is more desirable than a CPT distribution with smaller P5MR since this means that a greater percentage of the user population experiences an actual CPT closer to the (advertised) mCPT. Further, it could be argued from a public policy perspective that a large variability in CPT in the population for a given repellent is not a desirable characteristic, and does not accurately portray or indicate any “expected” mCPT on the part of the consumer.

OPP staff have judged what might be considered reasonable values for input parameters (precision of the estimated mCPT and variability in CPT in (or among) users of the tested product) in order to estimate required number of test subjects for the field exercise to achieve a desired set of aims regarding precision around the estimate of the mCPT. These judgments are based in part on available data and past experiences⁴ and in part on general thoughts regarding consumer expectations with respect to product efficacy. Specifically, EPA has estimated the power associated with various sample sizes where power -- as defined here -- is the probability that the ratio of the (95% LCL_{mCPT})/(estimated mCPT) is greater than a given acceptable K (a scalar which measures the precision of the estimates in estimating the mCPT). Such mosquito repellency study design power depends on:

- Number of test subjects
 - The larger the number of test subjects, the greater the power

- (The required) precision (K) for estimated mCPT
 - The precision of an estimated mCPT from a study is expressed by the value of the ratio 95% LCL_{mCPT}/estimated mCPT. The value of ratio is in the interval (0, 1).
 - K is the smallest acceptable value of the ratio 95% LCL_{mCPT}/estimated mCPT for a given trial to be considered a “success”, and conceptually represents an inverse of precision (“tightness”) in the estimate of the mCPT: a larger K represents a greater “tightness” around the estimated mCPT. As K is chosen to be smaller, there is a greater probability that ratio 95% LCL_{mCPT}/estimated mCPT > K (and the trial is considered to be a “success” in the power calculation)

- P5MR
 - P5MR = ratio of the 5th percentile/mCPT
 - As the variation (dispersion or spread) of the distribution of CPT in the population becomes smaller, the 95% confidence interval of the estimated mCPT also becomes narrower (i.e. the 95% LCL_{mCPT} is closer to the estimated mCPT and the mCPT is better estimated, *certeris paribus*). Therefore, a smaller variation in the distribution of CPT will result in a larger P5MR and a higher probability that the ratio 95% LCL_{mCPT}/estimated mCPT > K. A CPT distribution with greater P5MR is generally more desirable than a CPT distribution with smaller P5MR

Ideally, a mosquito repellency study will be designed to have a sufficient number of test subjects such that one can have reasonable assurance that there is adequate power (defined here as a high probability that the ratio 95% LCL/estimated mCPT > K) given a shape and spread of the CPT

⁴ See Appendix 2 for Weibull parameters fit to previous mosquito efficacy field data that the EPA has evaluated for a similar design and experimental set-up. In general, the values found in these (prior) studies support the values selected here to be used for the simulation

distribution in the population. This shape/spread of the CPT in the population is defined by the P5MR.

Brief Description of the Conduct of a Field Mosquitoes Repellent Study

In mosquito field repellency studies, test subjects are exposed in the field for 5-minute intervals immediately following product application and then for 5 minutes every 30 minutes until a “first confirmed landing” occurs. For subjects who receive confirmed landings, the CPTs are set as 0 if the first confirmed landing occurs during the first 5 minutes after application of the repellent; otherwise, the CPTs are rounded down to the nearest half hour (i.e., the starting time of the exposure period in which the first confirmed landing occurs). For those subjects for which there are no confirmed landings through the end of the testing day, CPTs are considered to be right censored at a time that is rounded down to the nearest half hour.

Description of (Computer) Simulation Procedure:

To simulate the field study trials, 4000 datasets were created with each dataset consisting of 10 data points (representing CPTs of 10 subjects) that were generated randomly from a Weibull distribution with a median CPT=2 and ratio of the 5%-tile/median P5MR= 0.2. If the randomly generated CPTs for the 10 subjects are $\leq 5, 6-35, 36-65, 66-95, \dots 576-605$ minutes, the CPTs are set to be 0-, 0.5-, 1-, 1.5- hours...10 hours, respectively, to simulate the study design in which each study participant is exposed for 5 of every 30 minutes until the first confirmed mosquito landing. If the randomly generated CPTs are greater than 10 hours (or 605 minutes), they are considered in the calculation to be (right) censored at 10 hours.

After generating the CPTs as described in the previous paragraph, the Kaplan Meier Estimator is used to estimate the mCPT and its 95% CI for each of the 4000 (10-person) datasets. The proportion of datasets in which the ratio of 95% LCL_{mCPT}/mCPT > K as 0.6 is considered to be the “power” of the study design. More specifically: if the value of 95% LCL/mCPT > 0.6 is considered a “success”, the power is calculated as the proportion of successes in the 4000 datasets consisting of 10 data points each.

The process described in previous paragraph is then repeated for each combination of different mCPT = 2, 4, 6, and 8 hours; P5MR = 0.2, 0.4, 0.5, 0.6, 0.7, and 0.8; sample size per dataset = 10, 11, 12 ... 20; and the lowest acceptable K = 0.6, 0.7, and 0.8; all assuming that CPT follows a Weibull distribution⁵.

⁵ Such calculations were similarly done for the lognormal distribution, normal distribution, and uniform distribution, but are not discussed further in this report. The SAS output from these calculations and various associated tables and graphs, however, is shown in Appendix 4 for completeness.

Results of Simulation

Tables 1, 2, and 3 present the power estimates from simulations in which the data were randomly generated from Weibull distributions for $K = 0.6, 0.7,$ and $0.8,$ respectively. These are shown for various values of mCPT (ranging from 2 to 8 hours), P5MR (ranging from 0.2 to 0.8), and Sample Size (ranging from 10 to 20). As described earlier, K reflects a measure the precision of the estimate of mCPT with larger K values representing tighter estimates. For example, the K value of 0.6 requires that the 95% LCL on a median protection of 10 hours be no less than 6 hours (for a “success”) while a K value of 0.8 requires that the 95% LCL on that same median protection time be no less than 8 hours. A required precision of a K of 0.8, then, requires a more precise estimate of the mCPT than a K of 0.6 for this trial to be considered a “success” in the power calculation.

Figures 4, 5, and 6 present visually the same results in Tables 1, 2, and 3 (as power curves rather than tables).

As can be seen within each Table or Figure, the power of a study to achieve a given acceptable ratio K value (e.g., 0.6, 0.7, or 0.8 representing $95\% \text{ LCL}_{\text{mCPT}}/\text{mCPT}$) value increases as the assumed P5MR value of the distribution increases (for example, from 0.2 to 0.8) or as the sample size increases (from 10 to 20). This is expected since a tighter (or more “peaked”) distributions (as evidenced by a larger P5MR value) will require fewer random “draws” to accurately estimate the mCPT. Across the Figures or Tables, we also see that as the acceptable K value increases from 0.6 to 0.8, the power of a study to achieve “ $95\% \text{ LCL}_{\text{mCPT}}/\text{mCPT} > K$ ” decreases since stricter requirements for a “success” are being levied.

The SAS Code used to generate the simulated data and the associated tables and graphs are presented in Appendix 3. Note - as described earlier - that simulations were also performed for the lognormal, normal, and uniform distributions, in part to serve as a sensitivity analysis and these are presented in the Appendix 4 for completeness, but are not discussed further here.

Figure 1. Probability Density Function (PDF) for Weibull Plot with λ (scale) =1 and κ (shape) ranging from 0.5 to 5

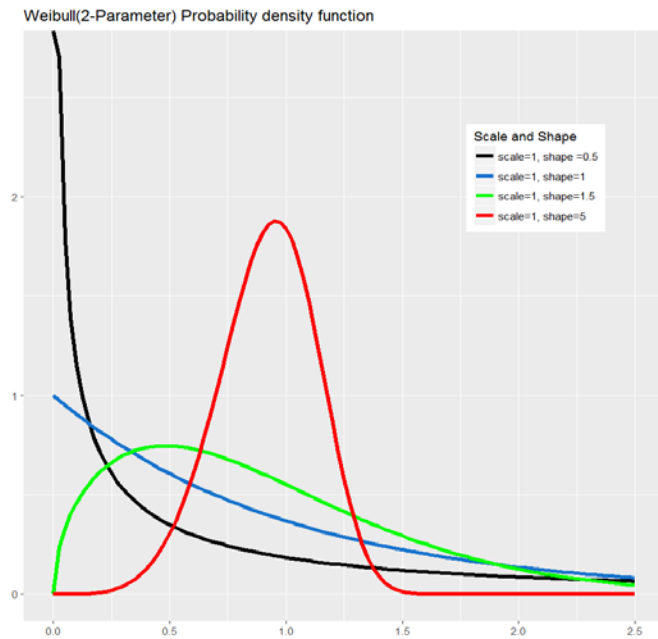


Figure 2. Cumulative Distribution Function (CDF) for Above Weibull PDF

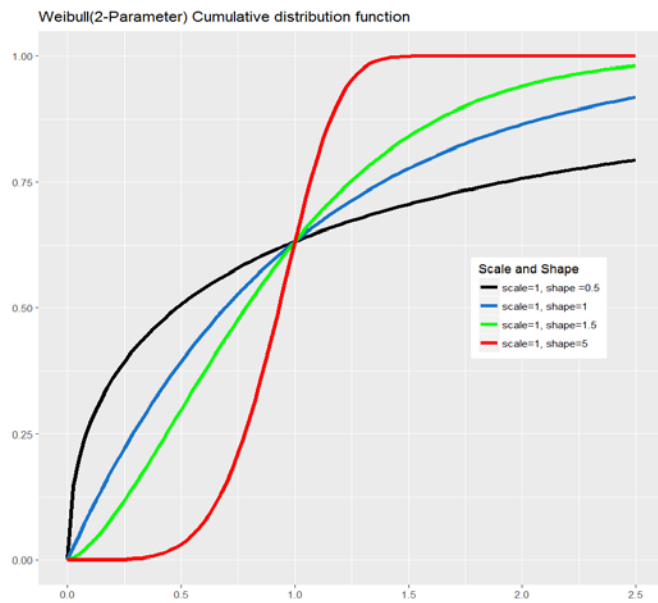


Figure 3: Histograms of CPT distributions for various CPTs and P5MRs (assume CPTs are Weibull distributions)

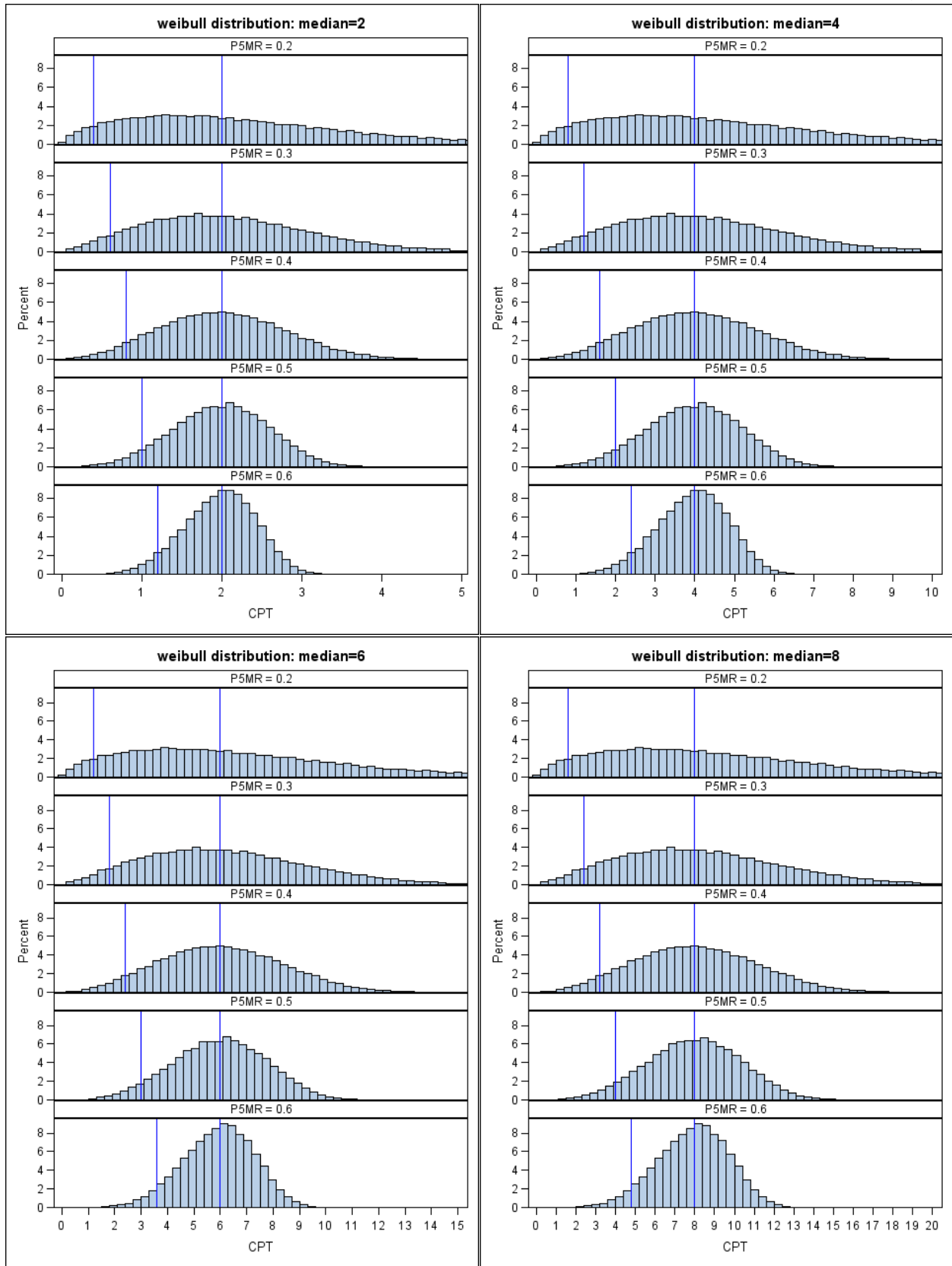


Table 1: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.6 (Weibull distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.071	0.291	0.207	0.473	0.362	0.369	0.502	0.494	0.637	0.626	0.521
	0.4	0.297	0.691	0.594	0.841	0.804	0.779	0.893	0.898	0.939	0.945	0.932
	0.5	0.498	0.850	0.802	0.942	0.938	0.921	0.968	0.977	0.964	0.982	0.986
	0.6	0.733	0.949	0.943	0.962	0.971	0.955	0.954	0.979	0.915	0.951	0.971
	0.7	0.893	0.945	0.955	0.875	0.918	0.852	0.855	0.893	0.810	0.859	0.886
	0.8	0.819	0.786	0.826	0.666	0.734	0.591	0.637	0.708	0.558	0.632	0.689
4	0.2	0.043	0.208	0.146	0.356	0.289	0.254	0.432	0.380	0.567	0.516	0.435
	0.4	0.241	0.595	0.521	0.783	0.737	0.709	0.849	0.842	0.930	0.920	0.884
	0.5	0.412	0.795	0.730	0.921	0.901	0.888	0.956	0.964	0.986	0.988	0.973
	0.6	0.648	0.938	0.899	0.987	0.980	0.976	0.995	0.997	0.997	0.999	0.998
	0.7	0.869	0.988	0.986	0.993	0.995	0.994	0.992	0.998	0.977	0.992	0.996
	0.8	0.975	0.982	0.987	0.948	0.970	0.949	0.934	0.968	0.887	0.932	0.954
6	0.2	0.075	0.204	0.153	0.339	0.280	0.252	0.426	0.369	0.557	0.490	0.424
	0.4	0.227	0.572	0.504	0.759	0.743	0.689	0.851	0.826	0.929	0.916	0.885
	0.5	0.408	0.779	0.729	0.914	0.905	0.873	0.963	0.958	0.987	0.981	0.978
	0.6	0.645	0.925	0.906	0.984	0.980	0.977	0.997	0.997	1.000	0.999	0.999
	0.7	0.874	0.990	0.988	0.998	0.999	0.999	1.000	1.000	0.999	1.000	1.000
	0.8	0.986	0.998	0.999	0.993	0.995	0.994	0.990	0.997	0.975	0.989	0.995
8	0.2	0.323	0.346	0.362	0.457	0.443	0.361	0.537	0.453	0.636	0.564	0.522
	0.4	0.314	0.586	0.552	0.769	0.753	0.700	0.858	0.836	0.934	0.919	0.891
	0.5	0.421	0.779	0.732	0.914	0.904	0.875	0.960	0.956	0.989	0.985	0.979
	0.6	0.638	0.927	0.906	0.983	0.979	0.974	0.997	0.997	1.000	0.999	1.000
	0.7	0.874	0.990	0.989	0.999	1.000	0.999	1.000	1.000	1.000	1.000	1.000
	0.8	0.985	0.999	1.000	0.997	1.000	0.999	0.998	1.000	0.994	0.998	0.999

NOTE: Yellow indicates power > 0.8; orange indicates power > 0.9; blue indicates unusual power when median complete protection time = 2 hours and P5MR = 0.8.

Table 2: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.7 (Weibull distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.022	0.096	0.066	0.199	0.121	0.128	0.217	0.211	0.304	0.299	0.222
	0.4	0.132	0.415	0.299	0.607	0.484	0.522	0.634	0.677	0.751	0.767	0.668
	0.5	0.267	0.633	0.516	0.789	0.697	0.748	0.803	0.851	0.868	0.895	0.838
	0.6	0.476	0.813	0.732	0.881	0.845	0.864	0.885	0.919	0.893	0.926	0.918
	0.7	0.694	0.895	0.876	0.861	0.889	0.847	0.850	0.888	0.799	0.837	0.888
	0.8	0.768	0.780	0.821	0.673	0.750	0.591	0.652	0.699	0.566	0.622	0.694
4	0.2	0.016	0.075	0.053	0.166	0.109	0.088	0.190	0.171	0.276	0.245	0.177
	0.4	0.103	0.332	0.267	0.517	0.452	0.402	0.620	0.555	0.752	0.681	0.638
	0.5	0.210	0.525	0.468	0.715	0.685	0.624	0.830	0.776	0.914	0.866	0.848
	0.6	0.402	0.736	0.714	0.886	0.880	0.833	0.955	0.923	0.979	0.966	0.969
	0.7	0.673	0.914	0.917	0.971	0.975	0.962	0.987	0.986	0.982	0.988	0.995
	0.8	0.927	0.970	0.987	0.945	0.971	0.946	0.931	0.955	0.892	0.922	0.958
6	0.2	0.047	0.083	0.066	0.158	0.105	0.083	0.174	0.150	0.247	0.218	0.149
	0.4	0.079	0.294	0.225	0.473	0.387	0.356	0.556	0.507	0.690	0.636	0.566
	0.5	0.172	0.483	0.406	0.679	0.622	0.573	0.779	0.735	0.887	0.841	0.806
	0.6	0.335	0.697	0.649	0.861	0.851	0.804	0.938	0.909	0.977	0.963	0.956
	0.7	0.607	0.894	0.885	0.975	0.970	0.958	0.994	0.989	0.997	0.996	0.997
	0.8	0.897	0.987	0.992	0.988	0.995	0.993	0.989	0.993	0.978	0.987	0.995
8	0.2	0.309	0.234	0.297	0.289	0.320	0.210	0.347	0.251	0.392	0.306	0.306
	0.4	0.180	0.321	0.294	0.497	0.435	0.379	0.598	0.521	0.726	0.654	0.592
	0.5	0.206	0.499	0.439	0.692	0.645	0.603	0.804	0.762	0.904	0.867	0.830
	0.6	0.357	0.731	0.684	0.892	0.872	0.831	0.957	0.933	0.983	0.978	0.966
	0.7	0.634	0.922	0.907	0.985	0.981	0.976	0.998	0.994	0.998	0.998	0.999
	0.8	0.913	0.996	0.995	0.999	0.999	0.998	0.997	1.000	0.994	0.997	0.999

NOTE: Yellow indicates power > 0.8; orange indicates power > 0.9; blue indicates unusual power when median complete protection time = 2 hours and P5MR = 0.8.

Table 3: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.8 (Weibull distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.007	0.032	0.027	0.064	0.044	0.027	0.079	0.061	0.115	0.088	0.071
	0.4	0.035	0.119	0.103	0.219	0.188	0.140	0.275	0.227	0.355	0.287	0.258
	0.5	0.068	0.210	0.185	0.339	0.297	0.251	0.418	0.364	0.506	0.460	0.425
	0.6	0.133	0.341	0.306	0.496	0.473	0.407	0.594	0.560	0.678	0.670	0.641
	0.7	0.251	0.561	0.532	0.679	0.692	0.598	0.753	0.753	0.749	0.775	0.809
	0.8	0.455	0.696	0.728	0.654	0.728	0.562	0.648	0.694	0.565	0.620	0.692
4	0.2	0.004	0.026	0.012	0.053	0.027	0.022	0.054	0.045	0.085	0.065	0.042
	0.4	0.026	0.093	0.080	0.186	0.151	0.103	0.254	0.182	0.346	0.245	0.228
	0.5	0.060	0.170	0.165	0.315	0.297	0.202	0.436	0.315	0.546	0.413	0.414
	0.6	0.135	0.317	0.320	0.494	0.499	0.374	0.650	0.529	0.760	0.643	0.639
	0.7	0.295	0.548	0.565	0.726	0.754	0.651	0.863	0.784	0.914	0.854	0.873
	0.8	0.619	0.828	0.867	0.884	0.923	0.864	0.913	0.922	0.886	0.909	0.947
6	0.2	0.038	0.033	0.027	0.055	0.037	0.027	0.053	0.033	0.076	0.058	0.039
	0.4	0.022	0.098	0.072	0.206	0.135	0.115	0.234	0.196	0.341	0.289	0.214
	0.5	0.054	0.205	0.154	0.364	0.281	0.248	0.438	0.382	0.567	0.493	0.425
	0.6	0.133	0.383	0.335	0.572	0.525	0.473	0.694	0.626	0.812	0.748	0.716
	0.7	0.316	0.646	0.614	0.819	0.818	0.750	0.918	0.874	0.965	0.943	0.938
	0.8	0.670	0.916	0.917	0.967	0.974	0.962	0.986	0.984	0.977	0.985	0.993
8	0.2	0.301	0.193	0.270	0.198	0.264	0.155	0.250	0.157	0.244	0.171	0.206
	0.4	0.122	0.136	0.141	0.227	0.182	0.142	0.267	0.208	0.340	0.292	0.229
	0.5	0.082	0.209	0.165	0.368	0.282	0.256	0.434	0.392	0.561	0.505	0.424
	0.6	0.124	0.390	0.321	0.588	0.514	0.490	0.688	0.655	0.823	0.779	0.710
	0.7	0.299	0.683	0.610	0.857	0.808	0.794	0.915	0.909	0.966	0.963	0.939
	0.8	0.644	0.940	0.909	0.989	0.978	0.981	0.994	0.995	0.993	0.995	0.998

NOTE: Yellow indicates power > 0.8; orange indicates power > 0.9.

Figure 4: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.6$ (Weibull distributions)

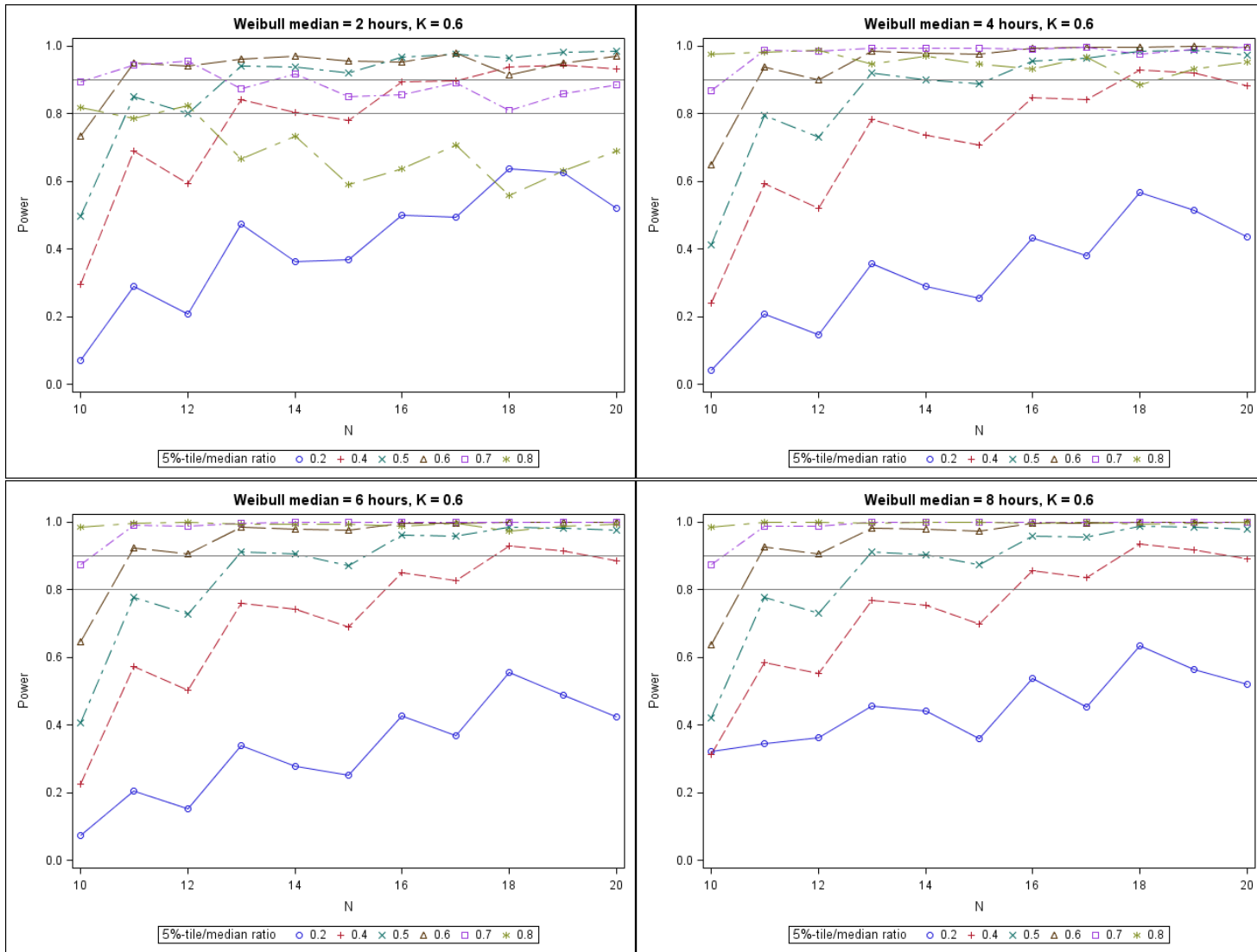


Figure 5: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.7$ (Weibull distributions)

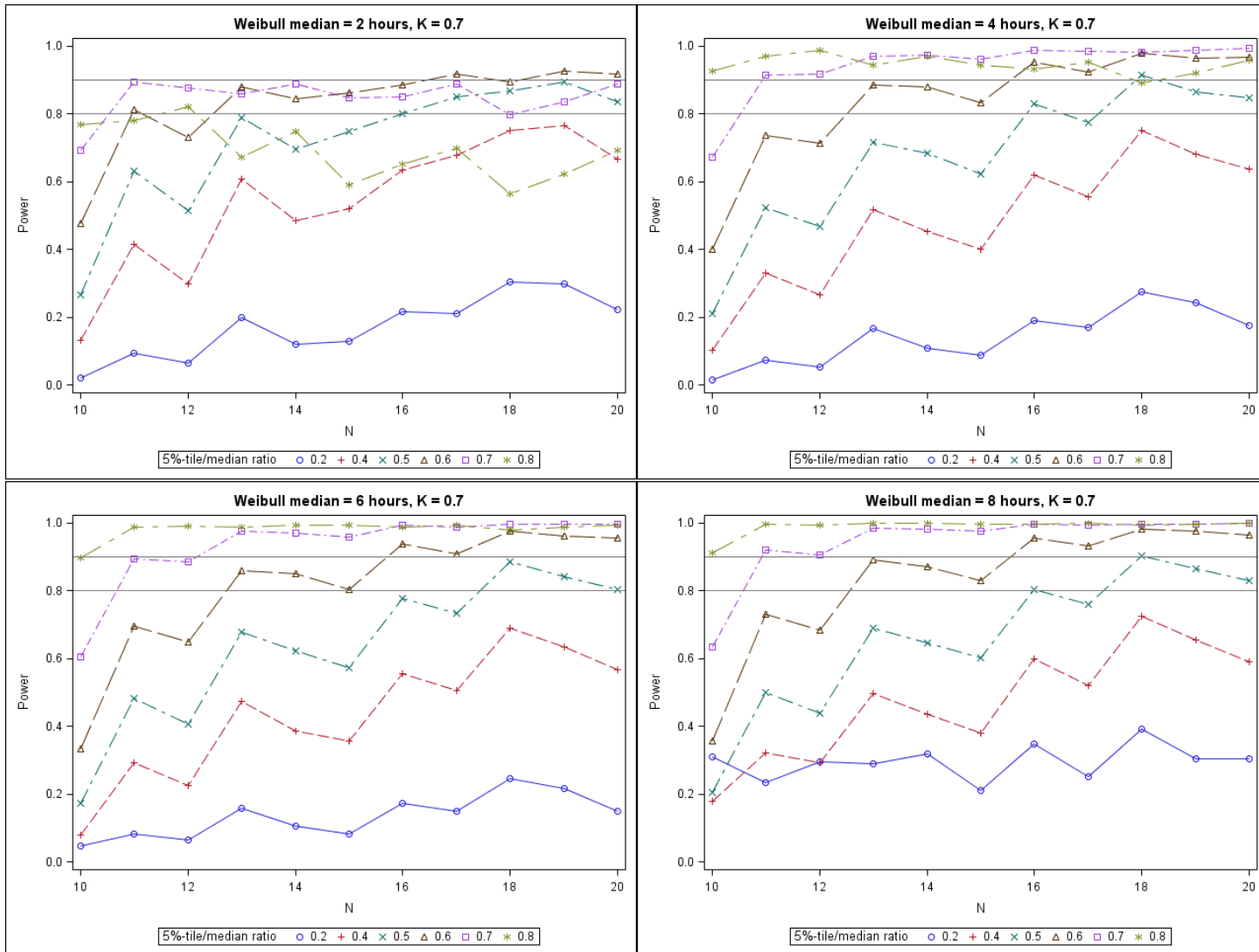
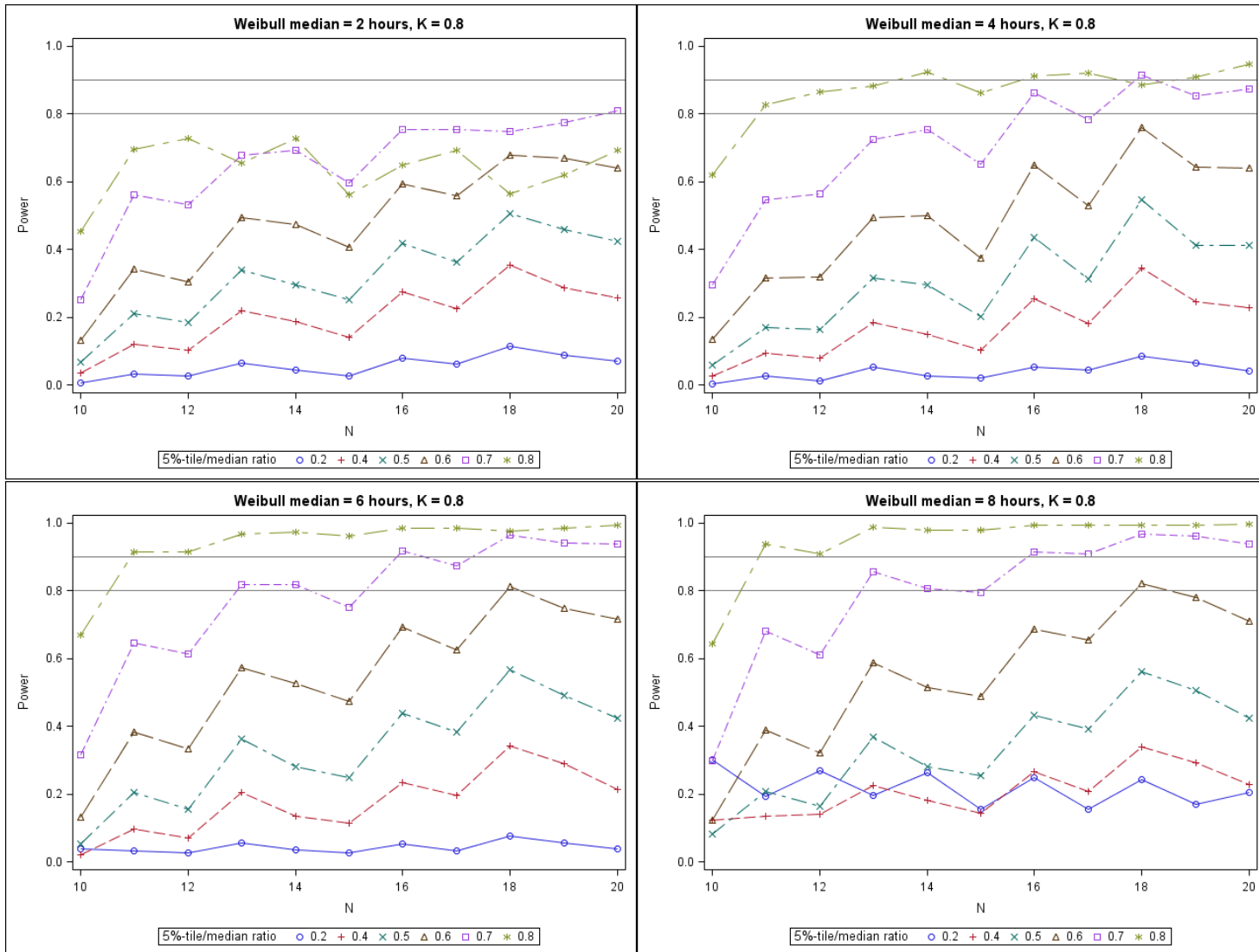


Figure 6: Power curves of study design when the lowest acceptable ratio 95% LCL_{mCPT}/mCPT = 0.8 (Weibull distributions)



APPENDIX 1

Re-parameterization of Standard Weibull Equation:

Given the definition of PDF and CDF from first principles:

$$P(mCPT, \kappa, \lambda) = 1 - e^{-\left(\frac{mCPT}{\lambda}\right)^\kappa} = 0.5 \quad (\text{median})$$

$$P(P5MR \times mCPT, \kappa, \lambda) = 1 - e^{-\left(\frac{P5MR \times mCPT}{\lambda}\right)^\kappa} = 0.05 \quad (\text{5th percentile})$$

Then:

$$e^{-\left(\frac{mCPT}{\lambda}\right)^\kappa} = 0.5 \quad (\text{median})$$

$$e^{-\left(\frac{P5MR \times mCPT}{\lambda}\right)^\kappa} = 0.95 \quad (\text{5th percentile})$$

and

$$-\left(\frac{mCPT}{\lambda}\right)^\kappa = \ln(0.5) \quad (1)$$

$$-\left(\frac{P5MR \times mCPT}{\lambda}\right)^\kappa = \ln(0.95) \quad (2)$$

Divide (2) by (1), we have:

$$\left[\frac{P5MR \times mCPT}{\lambda} \frac{\lambda}{mCPT} \right]^\kappa = \frac{\ln(0.95)}{\ln(0.5)}$$

$$\kappa = \ln \left[\frac{\ln(0.95)}{\ln(0.5)} \right] / \ln(P5MR) \quad (3)$$

From (1):

$$\left(\frac{mCPT}{\lambda}\right)^\kappa = -\ln(0.5)$$

$$\kappa \times \ln\left(\frac{mCPT}{\lambda}\right) = \ln[-\ln(0.5)]$$

$$\ln\left(\frac{mCPT}{\lambda}\right) = \frac{1}{\kappa} \ln[-\ln(0.5)]$$

$$\ln(mCPT) - \ln(\lambda) = \frac{1}{\kappa} \ln[-\ln(0.5)]$$

$$\begin{aligned} \ln(\lambda) &= \ln(mCPT) - \frac{1}{\kappa} \ln[-\ln(0.5)] \\ &= \frac{1}{\kappa} [\kappa \ln(mCPT) - \ln[-\ln(0.5)]] \\ &= \frac{1}{\kappa} [\ln(mCPT^\kappa) - \ln[-\ln(0.5)]] \\ &= \frac{1}{\kappa} \ln\left[-\frac{mCPT^\kappa}{\ln(0.5)}\right] \end{aligned}$$

$$\lambda = e^{\frac{1}{\kappa} \ln\left[-\frac{mCPT^\kappa}{\ln(0.5)}\right]} \quad (4)$$

So...

$$\kappa = \ln\left[\frac{\ln(0.95)}{\ln(0.5)}\right] / \ln(P5MR)$$

$$\lambda = e^{\frac{1}{\kappa} \times \ln\left[-\frac{mCPT^\kappa}{\ln(0.5)}\right]}$$

(As shown in the main text)

APPENDIX 2

Product	Location	Sample size	Est. mCPT (95% CI)	Ratio of 95% LCL/est. mCPT	Est. Weibull (shape κ ; scale λ)	Est. P5MR
<u>A</u>	1	10	7.5 (4.0, 8.0)	0.53	6.602; 7.777	0.674
	2	10	8.5 (4.5, 10.0)	0.53	5.855; 8.624	0.641
<u>B</u>	1	10	12.0 (6.0, 12.0)	0.50	4.311; 10.669	0.547
	2	10	12.0 (8.5, 12.0)	0.71	10.424; 11.516	0.779
<u>C</u>	1	10	7.5 (4.0, 9.0)	0.53	4.430; 8.146	0.556
	2	8	5.0 (2.5, 5.5)	0.50	5.318; 4.915	0.613
<u>D</u>	1	10	2.0 (1.5, 2.0)	0.75	7.004; 2.135	0.690
	2	10	2.5 (1.0, 3.5)	0.40	3.557; 2.8970	0.481
<u>E</u>	1	10	8.25 (6.0, 10.0)	0.73	7.609; 8.733	0.710
	2	10	8.0 (3.5, 8.5)	0.44	4.009; 7.442	0.522

APPENDIX 3

SAS codes

```
*=====*
* Programmer: James Nguyen, USEPA *
* * *
* Project: Mosquito Repellency Studies *
* * *
* Purpose: Power Analysis/sample size calculation *
* * *
* Description: *
* - distributions: Weibull, Normal, Lognormal, Uniform *
* - create histograms of the distributions *
* - SAS Procedures: PROC LIFETEST and PROC ICLIFETEST *
* * *
* Review Date: 4/10/2017 *
*=====*;
options formdlim=" " ps=90 ls=90 nonumber nodate;

libname MOS "C:\Users\JNguyen\Desktop\MOS";

%Macro distParam;
  if upcase(Distribution) = "WEIBULL" then do;
    * Weibull = f(x,a,b);
    a = log(log(0.95)/log(0.5))/log(P5MR); b = exp((1/a)*log(-
(MED**a)/log(0.5)));
  end;
  if upcase(Distribution) = "UNIFORM" then do;
    * uniform = U[a, b];
    a = MED*(0.5*P5MR - 0.05)/0.45; b = MED*2 - a;
  end;
  if upcase(Distribution) = "NORMAL" then do;
    *normal = N(a,b);
    a = MED; b = MED*(1-P5MR)/1.645;
  end;
  if upcase(Distribution) = "LOGNORMAL" then do;
    * lognormal = exp(N(a,b));
    a = log(MED); b = (log(MED)-log(MED*P5MR))/1.645;
  end;
%Mend;title;

%Macro generate;
  if upcase(Distribution) = "WEIBULL" then CPT = rand("Weibull", a, b);
  if upcase(Distribution) = "LOGNORMAL" then CPT = exp(rand("Normal", a, b));
  if upcase(Distribution) = "NORMAL" then CPT = rand("Normal", a, b);
  if upcase(Distribution) = "UNIFORM" then CPT = a + (b-a)*rand("Uniform");
%Mend;

%Macro Histogram(MED=, P5MRS=, dist=, seed=);

  %let N=1;
  %let P5MR&N = %nrquote(%scan(&P5MRS,&N, %str( )));
  %do %while (&&P5MR&N ^=);
    %let N=%eval(&N+1);
    %let P5MR&N = %nrquote(%scan(&P5MRS,&N, %str( )));
  %end;
  %let N=%eval(&N-1);

  Data Parameters;
    MED = &MED;
    %do i = 1 %to &N;
      P5MR = &&P5MR&i;
      P5 = MED*P5MR;
      output;
```

```

        %end;
        label MED = "P50";
run;

Data Parameters;
    set Parameters;
    Distribution = "&dist";
    %distParam;
run;

data simmer;
    call streaminit(&seed);
    set parameters;
    do i = 1 to 50000;
        %generate;
        output;
    end; *i;
    drop i a b;
run;

title "&dist distribution: median=&MED";
Proc SGPanel data = Simmer;
    panelby P5MR/rows=&N;
    Histogram CPT/binwidth=%sysevalf(2.5*&MED/50);
    refline P5 /axis=x lineattrs=(pattern=1 thickness=1 color=blue);
    refline MED/axis=x lineattrs=(pattern=1 thickness=1 color=blue);
    colaxis values = (0 to %sysevalf(2.5*&MED) by 1);
run;
Proc datasets nolist; save sasmacr; run;quit;
%Mend;title;

%Histogram(MED=2, P5MRS=0.2 0.3 0.4 0.5 0.6, dist=weibull, seed=279420);
%Histogram(MED=4, P5MRS=0.2 0.3 0.4 0.5 0.6, dist=weibull, seed=279420);
%Histogram(MED=6, P5MRS=0.2 0.3 0.4 0.5 0.6, dist=weibull, seed=279420);
%Histogram(MED=8, P5MRS=0.2 0.3 0.4 0.5 0.6, dist=weibull, seed=279420);
%Histogram(MED=10, P5MRS=0.2 0.3 0.4 0.5 0.6, dist=weibull, seed=279420);

%Macro Histogram1(MED=, P5MR=, seed=);

Data Parameters;
    MED = &MED;
    P5MR = &P5MR;
    P5 = MED*P5MR;

    do i = 1 to 4;
        if i = 1 then Distribution = "Lognormal";
        if i = 2 then Distribution = "Normal";
        if i = 3 then Distribution = "Uniform";
        if i = 4 then Distribution = "Weibull";
        %distParam;
        output;
    end;
    label MED = "P50" P5MR="5%-tile/median"; drop i;
run;

data simmer;
    call streaminit(&seed);
    set parameters;
    do i = 1 to 50000;
        %generate;
        output;
    end; *i;
    drop i a b;
run;

title "median=&MED P5MR=&P5MR" ;
Proc SGPanel data = Simmer;
    panelby Distribution/rows=4;

```

```

Histogram CPT/binwidth=%sysevalf(2.5*&MED/50);
refline P5 /axis=x lineattrs=(pattern=1 thickness=1 color=blue);
refline MED/axis=x lineattrs=(pattern=1 thickness=1 color=blue);
colaxis values = (0 to %sysevalf(2.5*&MED) by 1);

run;
Proc datasets nolist; save sasmacr; run;quit;
%Mend;title;

%Histogram1(MED=2, P5MR=0.2, seed=279420);
%Histogram1(MED=2, P5MR=0.4, seed=279420);
%Histogram1(MED=2, P5MR=0.5, seed=279420);
%Histogram1(MED=2, P5MR=0.6, seed=279420);
%Histogram1(MED=2, P5MR=0.7, seed=279420);

%Macro CPT;
CPT=CPT*60;
if CPT <= 5 then do;
    LT = 0; RT = 0; CPT= 0; censor = 0;
end;
else if CPT >= &maxT*60 then do;
    LT = &maxT*60; RT=. ; CPT=&maxT*60; censor = 1;
end;
else do;
    LT = 30*floor((CPT-5)/30)+5; RT = 30*ceil((CPT-5)/30); CPT = RT;
censor = 0;
end;

CPT = CPT/60;
LT = LT/60;
RT = RT/60;
%Mend;title;

%Macro power;
ods select none;
%if &censor=right %then %do;
    ods output Quartiles=MPT;
    Proc lifetest data = Simmer(keep=MED P5MR N Sim CPT Censor);
        by MED P5MR N Sim;
        time CPT*Censor(1);
    run;
%end;
%if &censor=interval %then %do;
    ods output quartiles=MPT;
    Proc iclifetest data = simmer(keep=MED P5MR N Sim LT RT) method=turnbull
impute(seed=1234);
        by MED P5MR N Sim;
        time (LT, RT);
    run;
%end;
ods select default;

Proc datasets nolist; delete simmer; run;quit;

Data MPT;
set MPT;
if percent = 50;
power = (LowerLimit >= &K*Estimate);
%if &censor=right %then %do; Censor = "right";%end;
%if &censor=interval %then %do; Censor = "interval"; %end;

run;

Proc SQL;
create table &dist&MED as
select Censor, MED, P5MR, N, avg(Power) as Power
from MPT
group by Censor, MED, P5MR, N;

quit;

```

```

%Mend;title;

%Macro Mosquito(med=, P5MRS=, nmin=,nmax=,maxT=,K=,dist=,censor=,NSim=, seed=);

    %let N=1;
    %let P5MR&N = %nrquote(%scan(&P5MRS,&N, %str( )));
    %do %while (&&P5MR&N ^=);
        %let N=%eval(&N+1);
        %let P5MR&N = %nrquote(%scan(&P5MRS,&N, %str( )));
    %end;
    %let N=%eval(&N-1);

%do i = 1 %to &N;

    %if &i = 1 %then %do; data All_&dist&MED; set _NULL_; run; %end;

    Data Parameters;
        MED = &MED;
        P5MR = &&P5MR&i;
        P5 = MED*P5MR;
        label MED = "median" P5MR="5%-tile/median ratio";
    run;

    Data Parameters;
        set Parameters;
        Distribution = "&dist";
        %distParam;
    run;

    data simmer;
        call streaminit(&seed);
        set Parameters;
        do N = &Nmin to &Nmax;
            do Sim = 1 to &NSim;
                do ID = 1 to N;
                    %generate;
                    output;
                end; *ID;
            end; *Sim;
        end; *N;
        drop a b;
    run;

    Data Simmer;
        set Simmer;
        %CPT;
    run;

    %power;

    Data All_&dist&MED;
        set All_&dist&MED &dist&MED;
    run;

    Proc datasets nolist; delete Parameters simmer MPT &dist&MED; quit;

%end;

Data MOS.&dist.&censor._MED&MED._K%sysevalf(100*&K);
    set All_&dist&MED;
run;

Proc datasets nolist; save sasmacr; run;quit;

%Mend;

dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.6, dist= weibull, censor=right, NSim=4000, seed=561);

```



```

dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Normal, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=4, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Normal, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=6, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Normal, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=8, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Normal, censor=right, NSim=4000, seed=352);

dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.6, dist= Uniform, censor=right, NSim=4000, seed=561);
dm log 'clear';%Mosquito(med=4, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.6, dist= Uniform, censor=right, NSim=4000, seed=561);
dm log 'clear';%Mosquito(med=6, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.6, dist= Uniform, censor=right, NSim=4000, seed=561);
dm log 'clear';%Mosquito(med=8, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.6, dist= Uniform, censor=right, NSim=4000, seed=561);

dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=4, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=6, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=8, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Uniform, censor=right, NSim=4000, seed=352);

dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=4, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=6, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Uniform, censor=right, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=8, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.8, dist= Uniform, censor=right, NSim=4000, seed=352);

/*
dm log 'clear';%Mosquito(med=2, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Weibull, censor=interval, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=4, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Weibull, censor=interval, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=6, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Weibull, censor=interval, NSim=4000, seed=352);
dm log 'clear';%Mosquito(med=8, P5MRS=0.2 0.4 0.5 0.6 0.7 0.8, nmin=10, nmax=20, maxT=10,
K = 0.7, dist= Weibull, censor=interval, NSim=4000, seed=352);
*/

*=====> Create Figures and Print Results;

libname MOS "C:\Users\JNguyen\Desktop\MOS";
%let folder=C:\Users\JNguyen\Desktop\MOS;

%Macro SGPLOT(distribution=, K=);
title "&distribution median = 2 hours, K = 0.&K";
Proc SGPLOT data = MOS.&distribution._right_med2_k&k.0;
scatter x = N y = Power/group = P5MR;
series x = N y = Power/group = P5MR;
refline 0.8 0.9/axis=y;
yaxis min=0 max=1;
run;

```



```

title "&distribution median = 4 hours, K = 0.&K";
Proc SGPLOT data = MOS.&distribution._right_med4_k&k.0;
  scatter x = N y = Power/group = P5MR;
  series x = N y = Power/group = P5MR;
  refline 0.8 0.9/axis=y;
  yaxis min=0 max=1;
run;
title "&distribution median = 6 hours, K = 0.&K";
Proc SGPLOT data = MOS.&distribution._right_med6_k&k.0;
  scatter x = N y = Power/group = P5MR;
  series x = N y = Power/group = P5MR;
  refline 0.8 0.9/axis=y;
  yaxis min=0 max=1;
run;
title "&distribution median = 8 hours, K = 0.&K";
Proc SGPLOT data = MOS.&distribution._right_med8_k&k.0;
  scatter x = N y = Power/group = P5MR;
  series x = N y = Power/group = P5MR;
  refline 0.8 0.9/axis=y;
  yaxis min=0 max=1;
run;
%Mend;

%Macro print(distribution=, K=);
  data &distribution._K&K;
    set MOS.&distribution._right_med2_k&k.0
        MOS.&distribution._right_med4_k&k.0
        MOS.&distribution._right_med6_k&k.0
        MOS.&distribution._right_med8_k&k.0;
  run;
  Proc transpose data = &distribution._K&K out = &distribution._K&K(drop=_NAME_);
    by MED P5MR;
    ID N;
    var Power;
  run;
  title "&distribution K=0.&K.0";
  Proc print data = &distribution._K&K noobs label; format _: 6.3; run;
%Mend;

%SGPLOT(distribution=Weibull, K=6);
%SGPLOT(distribution=Weibull, K=7);
%SGPLOT(distribution=Weibull, K=8);

%SGPLOT(distribution=Lognormal, K=6);
%SGPLOT(distribution=Lognormal, K=7);
%SGPLOT(distribution=Lognormal, K=8);

%SGPLOT(distribution=Normal, K=6);
%SGPLOT(distribution=Normal, K=7);
%SGPLOT(distribution=Normal, K=8);

%SGPLOT(distribution=Uniform, K=6);
%SGPLOT(distribution=Uniform, K=7);
%SGPLOT(distribution=Uniform, K=8);

ods rtf file = "&folder\&dist Median=&MED K=&K..rtf" bodytitle;
%print(distribution=Weibull, K=6);
%print(distribution=Weibull, K=7);
%print(distribution=Weibull, K=8);

%print(distribution=Lognormal, K=6);
%print(distribution=Lognormal, K=7);
%print(distribution=Lognormal, K=8);

%print(distribution=Normal, K=6);
%print(distribution=Normal, K=7);
%print(distribution=Normal, K=8);

```

```
%print(distribution=Uniform, K=6);  
%print(distribution=Uniform, K=7);  
%print(distribution=Uniform, K=8);  
ods rtf close;
```

APPENDIX 4

Table 4-1. Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.6 (Lognormal distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.045	0.223	0.126	0.344	0.239	0.257	0.355	0.362	0.440	0.467	0.353
	0.4	0.236	0.580	0.476	0.776	0.666	0.678	0.815	0.812	0.900	0.903	0.869
	0.5	0.449	0.820	0.770	0.937	0.902	0.899	0.958	0.962	0.982	0.985	0.984
	0.6	0.768	0.969	0.955	0.979	0.988	0.980	0.980	0.991	0.963	0.981	0.988
	0.7	0.964	0.971	0.985	0.933	0.961	0.931	0.926	0.948	0.886	0.915	0.940
	0.8	0.894	0.867	0.914	0.801	0.851	0.761	0.797	0.839	0.743	0.792	0.827
4	0.2	0.048	0.169	0.103	0.259	0.188	0.162	0.295	0.254	0.381	0.343	0.279
	0.4	0.176	0.472	0.411	0.682	0.595	0.578	0.749	0.735	0.851	0.844	0.796
	0.5	0.367	0.729	0.662	0.895	0.834	0.828	0.924	0.927	0.973	0.972	0.960
	0.6	0.638	0.932	0.896	0.984	0.977	0.972	0.989	0.992	0.998	0.999	0.997
	0.7	0.919	0.996	0.991	0.999	0.999	0.998	0.997	0.999	0.995	0.998	0.999
	0.8	0.994	0.992	0.997	0.976	0.990	0.981	0.971	0.984	0.949	0.971	0.979
6	0.2	0.175	0.207	0.202	0.283	0.240	0.199	0.343	0.266	0.417	0.355	0.304
	0.4	0.180	0.474	0.400	0.677	0.600	0.561	0.751	0.706	0.845	0.827	0.794
	0.5	0.360	0.703	0.665	0.876	0.826	0.804	0.930	0.916	0.971	0.963	0.956
	0.6	0.635	0.917	0.900	0.982	0.976	0.964	0.992	0.993	0.999	0.998	0.999
	0.7	0.922	0.994	0.993	1.000	0.999	0.999	1.000	1.000	0.999	1.000	1.000
	0.8	0.999	0.999	1.000	0.998	0.999	0.998	0.996	0.999	0.993	0.998	0.999
8	0.2	0.408	0.389	0.438	0.449	0.470	0.371	0.535	0.418	0.594	0.501	0.487
	0.4	0.378	0.567	0.551	0.739	0.697	0.635	0.813	0.766	0.886	0.864	0.842
	0.5	0.469	0.742	0.731	0.898	0.868	0.831	0.942	0.924	0.979	0.967	0.963
	0.6	0.680	0.923	0.919	0.987	0.983	0.966	0.994	0.992	0.998	0.999	0.998
	0.7	0.929	0.994	0.994	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000
	0.8	0.999	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.999	1.000	1.000

Table 4-2: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.7 (Lognormal distribution)												
Median (hours)	PSM R	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.008	0.048	0.034	0.110	0.070	0.063	0.117	0.106	0.172	0.159	0.106
	0.4	0.072	0.285	0.197	0.465	0.355	0.390	0.489	0.530	0.608	0.619	0.519
	0.5	0.197	0.529	0.419	0.697	0.591	0.641	0.699	0.750	0.783	0.811	0.720
	0.6	0.440	0.749	0.648	0.856	0.775	0.816	0.844	0.893	0.877	0.907	0.874
	0.7	0.677	0.878	0.831	0.896	0.895	0.870	0.886	0.933	0.855	0.909	0.926
	0.8	0.800	0.866	0.905	0.796	0.849	0.744	0.795	0.843	0.737	0.786	0.837
4	0.2	0.024	0.056	0.037	0.110	0.064	0.058	0.107	0.093	0.160	0.139	0.090
	0.4	0.057	0.227	0.173	0.411	0.312	0.297	0.462	0.423	0.593	0.541	0.469
	0.5	0.157	0.430	0.368	0.627	0.561	0.521	0.714	0.669	0.819	0.765	0.745
	0.6	0.353	0.666	0.643	0.838	0.827	0.769	0.909	0.890	0.958	0.928	0.935
	0.7	0.692	0.894	0.906	0.966	0.970	0.945	0.988	0.983	0.992	0.993	0.996
	0.8	0.954	0.986	0.993	0.977	0.991	0.979	0.970	0.985	0.945	0.965	0.982
6	0.2	0.161	0.128	0.142	0.153	0.149	0.099	0.165	0.118	0.200	0.163	0.121
	0.4	0.068	0.210	0.157	0.368	0.279	0.258	0.402	0.361	0.542	0.487	0.403
	0.5	0.127	0.379	0.300	0.591	0.487	0.466	0.646	0.614	0.775	0.727	0.669
	0.6	0.284	0.623	0.559	0.809	0.773	0.735	0.880	0.867	0.941	0.912	0.914
	0.7	0.608	0.879	0.873	0.964	0.959	0.944	0.988	0.981	0.997	0.995	0.997
	0.8	0.941	0.993	0.996	0.996	0.999	0.998	0.998	0.999	0.995	0.997	0.999
8	0.2	0.394	0.311	0.381	0.331	0.382	0.274	0.390	0.296	0.407	0.320	0.333
	0.4	0.273	0.317	0.326	0.461	0.415	0.331	0.525	0.432	0.628	0.540	0.500
	0.5	0.260	0.439	0.406	0.621	0.577	0.504	0.712	0.650	0.824	0.771	0.731
	0.6	0.362	0.663	0.617	0.844	0.822	0.775	0.904	0.891	0.959	0.941	0.933
	0.7	0.653	0.905	0.898	0.979	0.975	0.972	0.993	0.992	0.999	0.999	0.998
	0.8	0.959	0.999	0.998	0.999	1.000	1.000	1.000	1.000	0.999	1.000	1.000

Table 4-3 Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.8 (Lognormal distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.005	0.022	0.020	0.043	0.031	0.019	0.050	0.032	0.074	0.044	0.033
	0.4	0.021	0.067	0.062	0.144	0.117	0.087	0.178	0.134	0.252	0.193	0.164
	0.5	0.043	0.142	0.125	0.253	0.212	0.157	0.288	0.246	0.378	0.334	0.283
	0.6	0.094	0.253	0.219	0.414	0.364	0.301	0.487	0.448	0.571	0.549	0.510
	0.7	0.210	0.491	0.465	0.661	0.649	0.571	0.734	0.750	0.771	0.797	0.809
	0.8	0.534	0.794	0.824	0.780	0.833	0.723	0.792	0.839	0.736	0.785	0.836
4	0.2	0.019	0.022	0.014	0.042	0.025	0.021	0.029	0.028	0.048	0.046	0.019
	0.4	0.014	0.073	0.044	0.146	0.101	0.075	0.155	0.119	0.228	0.173	0.140
	0.5	0.036	0.129	0.109	0.237	0.207	0.151	0.311	0.226	0.412	0.300	0.303
	0.6	0.095	0.253	0.256	0.399	0.404	0.297	0.540	0.409	0.654	0.513	0.532
	0.7	0.258	0.462	0.496	0.649	0.666	0.558	0.782	0.688	0.861	0.770	0.801
	0.8	0.623	0.779	0.834	0.880	0.914	0.845	0.926	0.914	0.923	0.916	0.951
6	0.2	0.157	0.098	0.119	0.088	0.108	0.061	0.095	0.054	0.096	0.066	0.061
	0.4	0.028	0.068	0.046	0.138	0.092	0.073	0.144	0.125	0.203	0.184	0.121
	0.5	0.033	0.141	0.094	0.266	0.187	0.176	0.292	0.257	0.408	0.355	0.285
	0.6	0.078	0.292	0.228	0.469	0.397	0.358	0.541	0.482	0.680	0.606	0.560
	0.7	0.253	0.552	0.513	0.737	0.721	0.655	0.839	0.799	0.917	0.862	0.877
	0.8	0.680	0.882	0.904	0.962	0.971	0.946	0.989	0.982	0.992	0.992	0.996
8	0.2	0.392	0.279	0.366	0.270	0.348	0.244	0.332	0.245	0.315	0.234	0.289
	0.4	0.240	0.194	0.230	0.235	0.245	0.169	0.267	0.193	0.305	0.237	0.214
	0.5	0.173	0.203	0.193	0.301	0.266	0.195	0.337	0.275	0.435	0.368	0.306
	0.6	0.145	0.301	0.251	0.495	0.414	0.369	0.538	0.516	0.680	0.639	0.558
	0.7	0.250	0.588	0.502	0.773	0.714	0.707	0.837	0.841	0.916	0.888	0.876
	0.8	0.660	0.910	0.901	0.978	0.973	0.971	0.993	0.990	0.998	0.998	0.997

Table 4-4: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.6 (Normal distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.139	0.454	0.358	0.655	0.556	0.540	0.722	0.701	0.824	0.820	0.770
	0.4	0.326	0.711	0.653	0.877	0.825	0.818	0.916	0.912	0.960	0.962	0.952
	0.5	0.506	0.858	0.833	0.946	0.934	0.922	0.966	0.974	0.967	0.981	0.985
	0.6	0.730	0.951	0.949	0.963	0.978	0.962	0.958	0.979	0.934	0.957	0.969
	0.7	0.925	0.957	0.976	0.908	0.940	0.901	0.900	0.923	0.842	0.882	0.915
	0.8	0.875	0.846	0.899	0.768	0.821	0.723	0.760	0.812	0.695	0.753	0.791
4	0.2	0.098	0.360	0.291	0.569	0.476	0.448	0.646	0.618	0.775	0.757	0.692
	0.4	0.253	0.635	0.562	0.838	0.764	0.749	0.880	0.874	0.950	0.949	0.926
	0.5	0.415	0.800	0.747	0.938	0.901	0.899	0.965	0.960	0.989	0.990	0.982
	0.6	0.638	0.936	0.913	0.991	0.983	0.975	0.992	0.994	0.996	0.998	0.999
	0.7	0.888	0.993	0.987	0.996	0.998	0.995	0.994	0.998	0.988	0.996	0.997
	0.8	0.991	0.988	0.995	0.967	0.983	0.973	0.959	0.980	0.934	0.958	0.970
6	0.2	0.088	0.344	0.272	0.552	0.461	0.426	0.648	0.594	0.777	0.743	0.693
	0.4	0.246	0.607	0.558	0.820	0.761	0.719	0.889	0.864	0.956	0.936	0.932
	0.5	0.408	0.780	0.745	0.930	0.905	0.876	0.966	0.955	0.990	0.986	0.984
	0.6	0.638	0.927	0.918	0.987	0.982	0.973	0.996	0.995	1.000	0.998	1.000
	0.7	0.893	0.993	0.992	1.000	0.999	0.998	1.000	1.000	0.999	1.000	1.000
	0.8	0.997	0.999	0.999	0.996	0.998	0.997	0.994	0.998	0.988	0.996	0.997
8	0.2	0.231	0.395	0.362	0.574	0.504	0.459	0.667	0.605	0.780	0.756	0.705
	0.4	0.303	0.618	0.578	0.821	0.765	0.723	0.891	0.860	0.959	0.941	0.934
	0.5	0.422	0.785	0.759	0.933	0.910	0.879	0.967	0.956	0.991	0.986	0.987
	0.6	0.646	0.927	0.920	0.989	0.984	0.972	0.997	0.994	1.000	0.999	0.999
	0.7	0.896	0.992	0.991	1.000	1.000	0.998	1.000	1.000	1.000	1.000	1.000
	0.8	0.997	1.000	1.000	1.000	1.000	0.999	0.999	1.000	0.998	0.999	1.000

Table 4-5: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.7 (Normal distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.044	0.216	0.143	0.390	0.287	0.293	0.429	0.441	0.566	0.559	0.450
	0.4	0.136	0.465	0.347	0.662	0.549	0.592	0.684	0.727	0.790	0.813	0.728
	0.5	0.262	0.627	0.521	0.803	0.710	0.744	0.801	0.857	0.857	0.892	0.840
	0.6	0.460	0.796	0.712	0.891	0.836	0.854	0.877	0.925	0.883	0.920	0.916
	0.7	0.690	0.885	0.860	0.882	0.895	0.855	0.867	0.915	0.822	0.879	0.908
	0.8	0.795	0.843	0.886	0.761	0.819	0.706	0.759	0.811	0.689	0.743	0.801
4	0.2	0.033	0.175	0.130	0.340	0.257	0.216	0.405	0.346	0.535	0.469	0.413
	0.4	0.111	0.369	0.317	0.581	0.516	0.466	0.683	0.622	0.811	0.746	0.709
	0.5	0.214	0.526	0.475	0.742	0.704	0.643	0.833	0.797	0.915	0.871	0.870
	0.6	0.391	0.718	0.697	0.882	0.881	0.821	0.944	0.925	0.976	0.957	0.964
	0.7	0.683	0.905	0.915	0.971	0.979	0.957	0.990	0.988	0.990	0.993	0.996
	0.8	0.940	0.983	0.993	0.966	0.984	0.968	0.961	0.978	0.926	0.957	0.973
6	0.2	0.028	0.153	0.105	0.300	0.215	0.191	0.345	0.301	0.483	0.426	0.347
	0.4	0.085	0.328	0.259	0.550	0.455	0.416	0.619	0.580	0.754	0.708	0.646
	0.5	0.174	0.486	0.416	0.710	0.648	0.600	0.794	0.764	0.886	0.851	0.827
	0.6	0.334	0.681	0.635	0.863	0.837	0.798	0.927	0.914	0.970	0.951	0.952
	0.7	0.607	0.892	0.885	0.971	0.969	0.958	0.991	0.989	0.997	0.996	0.998
	0.8	0.925	0.991	0.995	0.994	0.999	0.996	0.997	0.998	0.992	0.996	0.998
8	0.2	0.185	0.222	0.214	0.351	0.296	0.231	0.416	0.335	0.522	0.448	0.390
	0.4	0.162	0.350	0.308	0.560	0.492	0.428	0.653	0.603	0.784	0.730	0.680
	0.5	0.205	0.494	0.439	0.726	0.678	0.621	0.809	0.785	0.909	0.875	0.851
	0.6	0.358	0.713	0.662	0.890	0.870	0.835	0.945	0.932	0.981	0.971	0.970
	0.7	0.642	0.916	0.902	0.985	0.980	0.980	0.996	0.996	0.999	0.999	0.998
	0.8	0.943	0.998	0.998	0.999	1.000	0.999	1.000	1.000	0.998	0.999	1.000

Table 4-6: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.8 (Normal distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.013	0.069	0.049	0.142	0.109	0.081	0.176	0.136	0.250	0.193	0.154
	0.4	0.032	0.142	0.120	0.259	0.214	0.167	0.311	0.259	0.401	0.352	0.305
	0.5	0.067	0.210	0.183	0.355	0.314	0.245	0.426	0.382	0.504	0.469	0.433
	0.6	0.116	0.328	0.291	0.502	0.464	0.387	0.578	0.559	0.661	0.650	0.628
	0.7	0.239	0.537	0.508	0.683	0.685	0.601	0.741	0.776	0.760	0.799	0.824
	0.8	0.512	0.768	0.801	0.745	0.802	0.685	0.756	0.807	0.689	0.741	0.800
4	0.2	0.008	0.051	0.035	0.112	0.084	0.055	0.140	0.098	0.208	0.138	0.123
	0.4	0.029	0.114	0.093	0.224	0.192	0.133	0.304	0.214	0.420	0.293	0.295
	0.5	0.055	0.182	0.169	0.320	0.305	0.221	0.451	0.323	0.572	0.432	0.443
	0.6	0.118	0.289	0.310	0.479	0.484	0.363	0.633	0.503	0.750	0.620	0.632
	0.7	0.271	0.512	0.528	0.695	0.720	0.616	0.827	0.744	0.892	0.824	0.853
	0.8	0.618	0.800	0.844	0.892	0.923	0.854	0.927	0.925	0.911	0.920	0.952
6	0.2	0.005	0.051	0.031	0.115	0.070	0.054	0.129	0.104	0.196	0.155	0.105
	0.4	0.022	0.120	0.088	0.247	0.179	0.159	0.297	0.247	0.410	0.347	0.287
	0.5	0.044	0.206	0.163	0.377	0.297	0.265	0.453	0.389	0.584	0.509	0.457
	0.6	0.111	0.357	0.307	0.558	0.502	0.444	0.664	0.600	0.799	0.721	0.691
	0.7	0.285	0.605	0.573	0.796	0.786	0.716	0.885	0.861	0.949	0.907	0.921
	0.8	0.680	0.898	0.913	0.968	0.977	0.955	0.990	0.986	0.990	0.993	0.996
8	0.2	0.164	0.131	0.143	0.164	0.163	0.101	0.190	0.135	0.245	0.177	0.146
	0.4	0.097	0.152	0.128	0.260	0.204	0.158	0.298	0.248	0.411	0.353	0.283
	0.5	0.082	0.213	0.171	0.389	0.303	0.265	0.440	0.401	0.589	0.536	0.445
	0.6	0.119	0.362	0.290	0.591	0.496	0.465	0.660	0.635	0.789	0.759	0.695
	0.7	0.273	0.638	0.564	0.827	0.773	0.760	0.887	0.891	0.945	0.933	0.918
	0.8	0.658	0.923	0.909	0.983	0.976	0.978	0.995	0.995	0.998	0.998	0.998

Table 4-7: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.6 (Uniform distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.059	0.266	0.177	0.434	0.319	0.331	0.471	0.450	0.576	0.586	0.491
	0.4	0.242	0.561	0.468	0.727	0.657	0.664	0.792	0.772	0.876	0.870	0.824
	0.5	0.429	0.788	0.736	0.923	0.880	0.889	0.955	0.949	0.981	0.982	0.974
	0.6	0.987	0.995	0.994	0.995	0.995	0.993	0.990	0.998	0.981	0.990	0.996
	0.7	0.996	0.990	0.994	0.970	0.981	0.968	0.960	0.977	0.931	0.961	0.975
	0.8	0.900	0.904	0.934	0.851	0.886	0.793	0.849	0.875	0.813	0.851	0.883
4	0.2	0.038	0.183	0.126	0.336	0.253	0.226	0.385	0.340	0.499	0.467	0.397
	0.4	0.175	0.446	0.372	0.641	0.577	0.547	0.723	0.675	0.814	0.807	0.743
	0.5	0.357	0.681	0.627	0.851	0.796	0.802	0.906	0.883	0.947	0.948	0.917
	0.6	0.693	0.919	0.876	0.975	0.956	0.960	0.986	0.984	0.996	0.996	0.991
	0.7	1.000	1.000	1.000	1.000	1.000	0.999	0.999	1.000	0.999	0.999	1.000
	0.8	0.999	0.997	1.000	0.996	0.996	0.994	0.990	0.998	0.981	0.990	0.996
6	0.2	0.037	0.161	0.114	0.313	0.228	0.198	0.368	0.312	0.485	0.442	0.384
	0.4	0.159	0.437	0.359	0.626	0.559	0.541	0.722	0.660	0.819	0.784	0.740
	0.5	0.371	0.653	0.620	0.823	0.797	0.766	0.895	0.853	0.946	0.930	0.910
	0.6	0.674	0.899	0.879	0.971	0.960	0.951	0.987	0.985	0.996	0.996	0.992
	0.7	0.970	0.998	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	0.8	1.000	1.000	1.000	1.000	1.000	0.999	0.999	1.000	0.999	0.999	1.000
8	0.2	0.291	0.302	0.323	0.423	0.390	0.299	0.499	0.375	0.564	0.491	0.458
	0.4	0.314	0.493	0.463	0.665	0.625	0.561	0.747	0.668	0.834	0.796	0.751
	0.5	0.452	0.687	0.668	0.835	0.813	0.784	0.905	0.872	0.949	0.934	0.918
	0.6	0.744	0.903	0.902	0.968	0.965	0.952	0.991	0.983	0.995	0.995	0.992
	0.7	0.977	0.998	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	0.8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 4-8: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.7 (Uniform distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.016	0.079	0.052	0.168	0.117	0.098	0.184	0.186	0.277	0.267	0.197
	0.4	0.073	0.242	0.172	0.417	0.310	0.335	0.445	0.489	0.570	0.601	0.491
	0.5	0.180	0.470	0.371	0.645	0.540	0.584	0.662	0.711	0.725	0.780	0.683
	0.6	0.543	0.731	0.636	0.803	0.711	0.767	0.783	0.839	0.826	0.874	0.808
	0.7	0.624	0.847	0.757	0.890	0.853	0.855	0.885	0.914	0.896	0.931	0.918
	0.8	0.820	0.904	0.914	0.845	0.885	0.803	0.841	0.882	0.813	0.856	0.882
4	0.2	0.014	0.066	0.041	0.145	0.100	0.073	0.162	0.145	0.266	0.220	0.155
	0.4	0.055	0.203	0.148	0.351	0.285	0.251	0.425	0.379	0.557	0.494	0.432
	0.5	0.136	0.365	0.305	0.551	0.499	0.442	0.648	0.594	0.746	0.690	0.655
	0.6	0.354	0.600	0.572	0.750	0.761	0.670	0.854	0.807	0.908	0.872	0.874
	0.7	0.782	0.850	0.876	0.934	0.947	0.896	0.973	0.954	0.989	0.976	0.980
	0.8	1.000	0.999	1.000	0.994	0.995	0.995	0.992	0.995	0.984	0.991	0.996
6	0.2	0.016	0.055	0.035	0.129	0.079	0.062	0.141	0.120	0.224	0.190	0.125
	0.4	0.045	0.180	0.118	0.313	0.244	0.209	0.367	0.334	0.493	0.450	0.371
	0.5	0.116	0.330	0.252	0.496	0.421	0.384	0.572	0.525	0.672	0.638	0.581
	0.6	0.280	0.549	0.493	0.713	0.683	0.616	0.799	0.764	0.875	0.848	0.828
	0.7	0.665	0.839	0.846	0.931	0.933	0.896	0.970	0.956	0.992	0.979	0.982
	0.8	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	0.999	1.000	1.000
8	0.2	0.268	0.210	0.267	0.257	0.268	0.179	0.297	0.215	0.358	0.267	0.244
	0.4	0.203	0.248	0.240	0.367	0.331	0.245	0.434	0.367	0.542	0.467	0.400
	0.5	0.203	0.356	0.318	0.513	0.467	0.394	0.615	0.554	0.713	0.660	0.612
	0.6	0.338	0.576	0.550	0.741	0.722	0.661	0.838	0.806	0.902	0.877	0.854
	0.7	0.693	0.892	0.882	0.959	0.956	0.942	0.982	0.980	0.995	0.990	0.990
	0.8	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 4-9: Results of power analysis when the lowest acceptable ratio 95% LCL _{mCPT} /mCPT = 0.8 (Uniform distribution)												
Median (hours)	P5MR	Sample size										
		_10	_11	_12	_13	_14	_15	_16	_17	_18	_19	_20
2	0.2	0.009	0.031	0.023	0.065	0.053	0.031	0.081	0.051	0.120	0.091	0.070
	0.4	0.027	0.070	0.057	0.144	0.113	0.084	0.178	0.128	0.253	0.190	0.162
	0.5	0.047	0.121	0.119	0.227	0.192	0.142	0.275	0.211	0.344	0.278	0.246
	0.6	0.131	0.205	0.200	0.313	0.283	0.221	0.375	0.322	0.476	0.409	0.373
	0.7	0.142	0.364	0.315	0.530	0.483	0.418	0.609	0.595	0.703	0.692	0.651
	0.8	0.641	0.864	0.871	0.837	0.879	0.795	0.841	0.880	0.813	0.856	0.882
4	0.2	0.003	0.017	0.009	0.048	0.024	0.019	0.050	0.038	0.081	0.063	0.033
	0.4	0.013	0.061	0.038	0.121	0.090	0.066	0.138	0.103	0.205	0.160	0.122
	0.5	0.031	0.112	0.080	0.195	0.159	0.114	0.249	0.185	0.342	0.251	0.231
	0.6	0.092	0.198	0.194	0.309	0.325	0.211	0.428	0.317	0.528	0.403	0.428
	0.7	0.303	0.374	0.415	0.523	0.564	0.428	0.673	0.562	0.755	0.654	0.675
	0.8	0.766	0.735	0.806	0.805	0.860	0.769	0.902	0.839	0.916	0.874	0.899
6	0.2	0.006	0.015	0.009	0.041	0.019	0.017	0.042	0.029	0.069	0.054	0.029
	0.4	0.010	0.049	0.028	0.110	0.069	0.050	0.120	0.101	0.189	0.160	0.106
	0.5	0.026	0.101	0.065	0.197	0.142	0.114	0.214	0.201	0.327	0.284	0.219
	0.6	0.074	0.238	0.164	0.368	0.298	0.271	0.421	0.382	0.541	0.480	0.426
	0.7	0.246	0.461	0.422	0.608	0.611	0.521	0.732	0.656	0.808	0.751	0.748
	0.8	0.773	0.824	0.860	0.913	0.939	0.880	0.966	0.940	0.986	0.970	0.978
8	0.2	0.261	0.178	0.247	0.181	0.220	0.141	0.215	0.139	0.214	0.146	0.159
	0.4	0.175	0.129	0.162	0.175	0.176	0.100	0.203	0.141	0.245	0.184	0.143
	0.5	0.134	0.144	0.135	0.214	0.185	0.128	0.253	0.206	0.338	0.282	0.223
	0.6	0.119	0.224	0.182	0.354	0.289	0.254	0.418	0.378	0.529	0.492	0.407
	0.7	0.223	0.485	0.419	0.652	0.594	0.564	0.730	0.701	0.803	0.794	0.748
	0.8	0.679	0.868	0.851	0.939	0.942	0.916	0.976	0.968	0.991	0.984	0.987

Figure 4-1: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.6$ (Lognormal distributions)

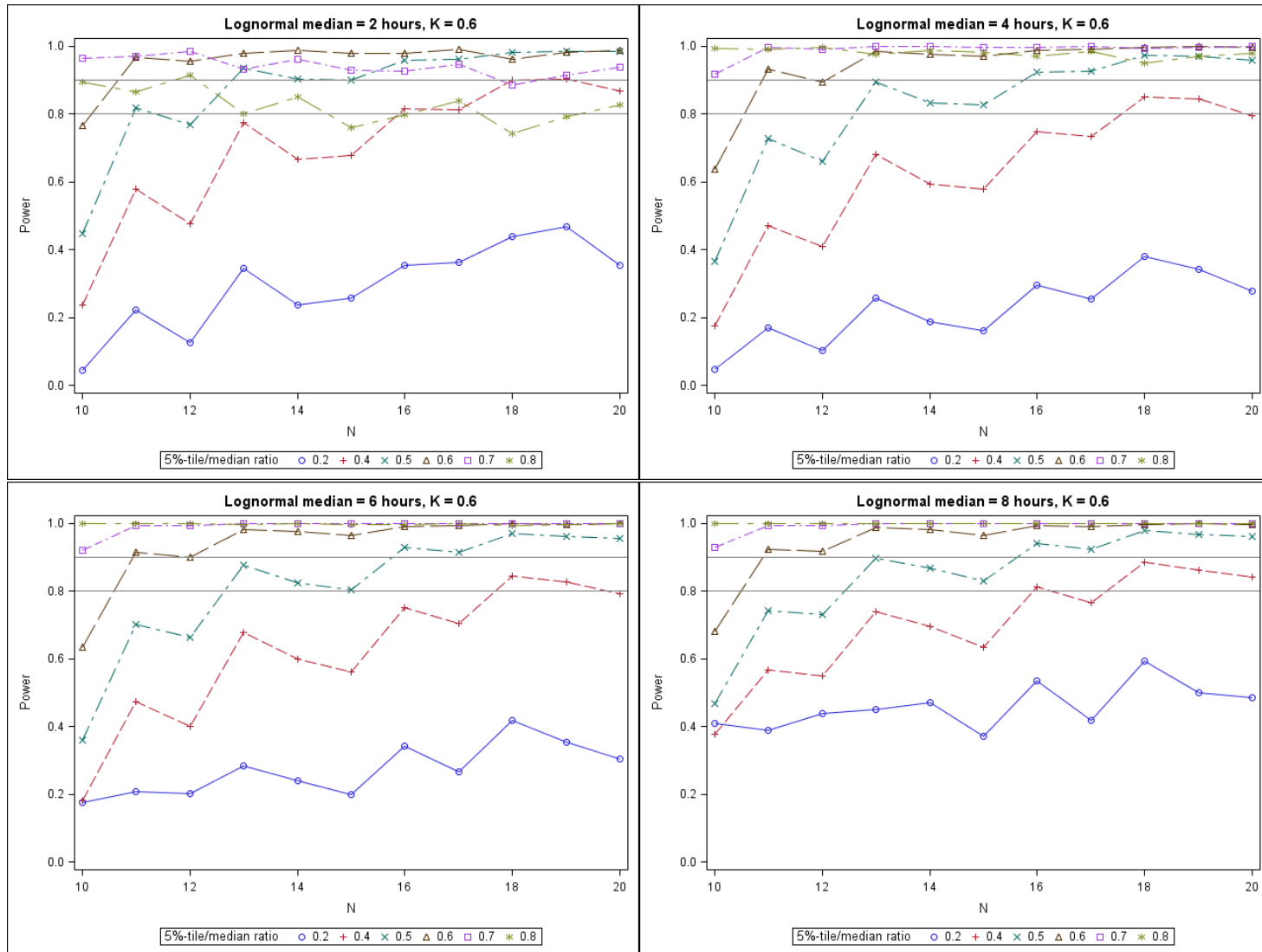


Figure 4-2: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.7$ (Lognormal distributions)

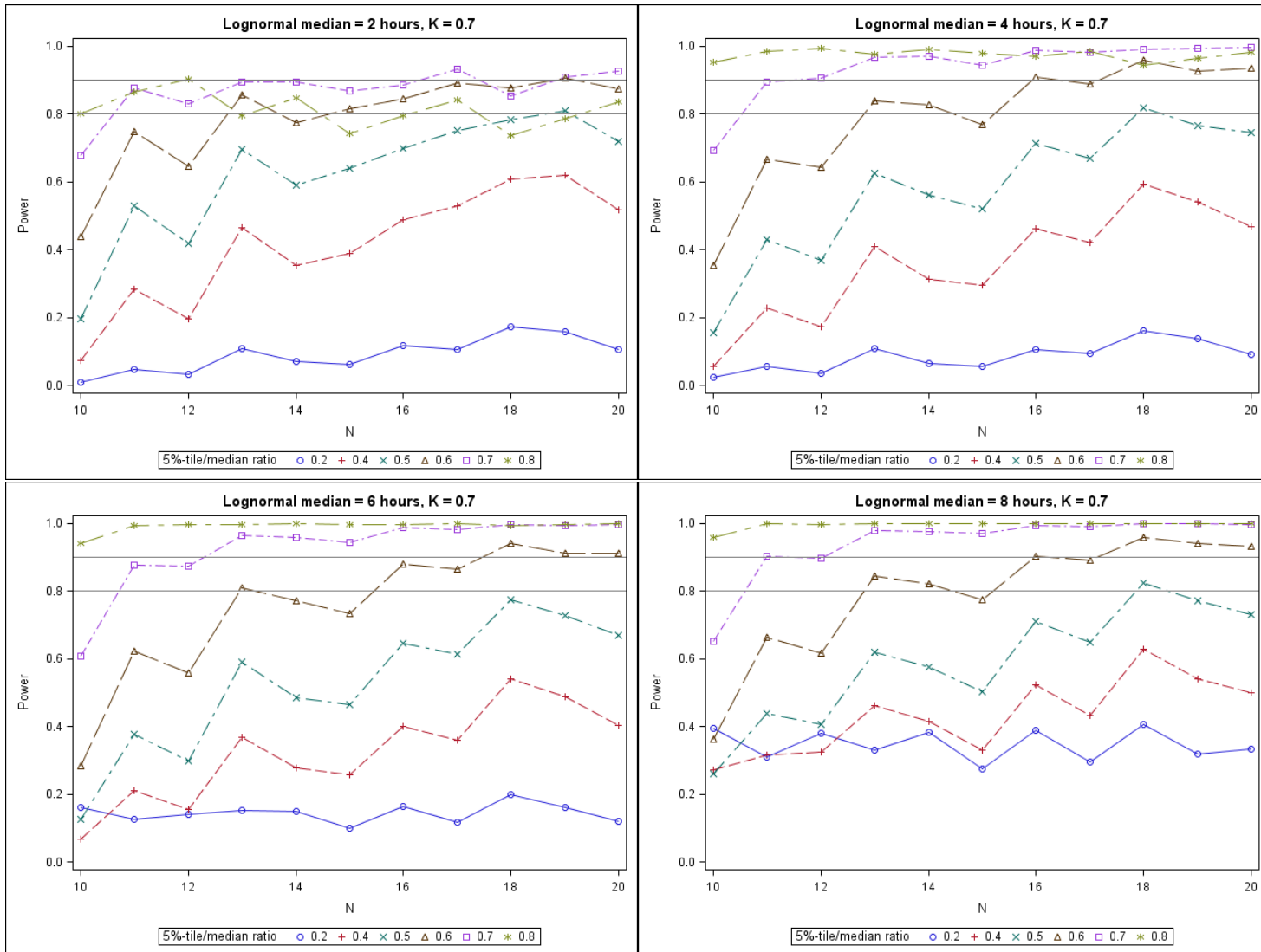


Figure 4-3: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.8$ (Lognormal distributions)

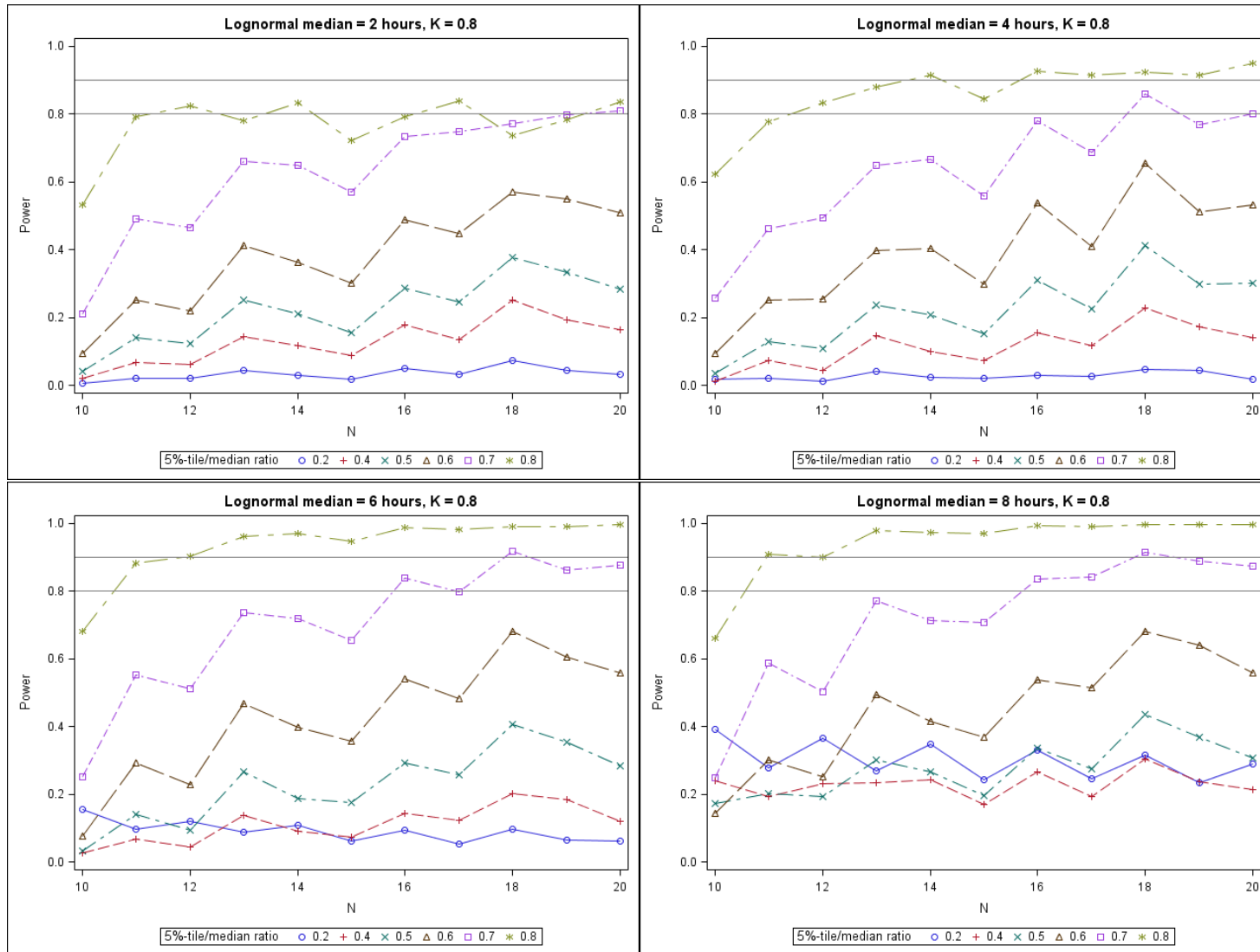


Figure 4-4: Power curves of study design when the lowest acceptable ratio $95\% \text{ LCL}_{\text{mCPT}}/\text{mCPT} = 0.6$ (Normal distributions)

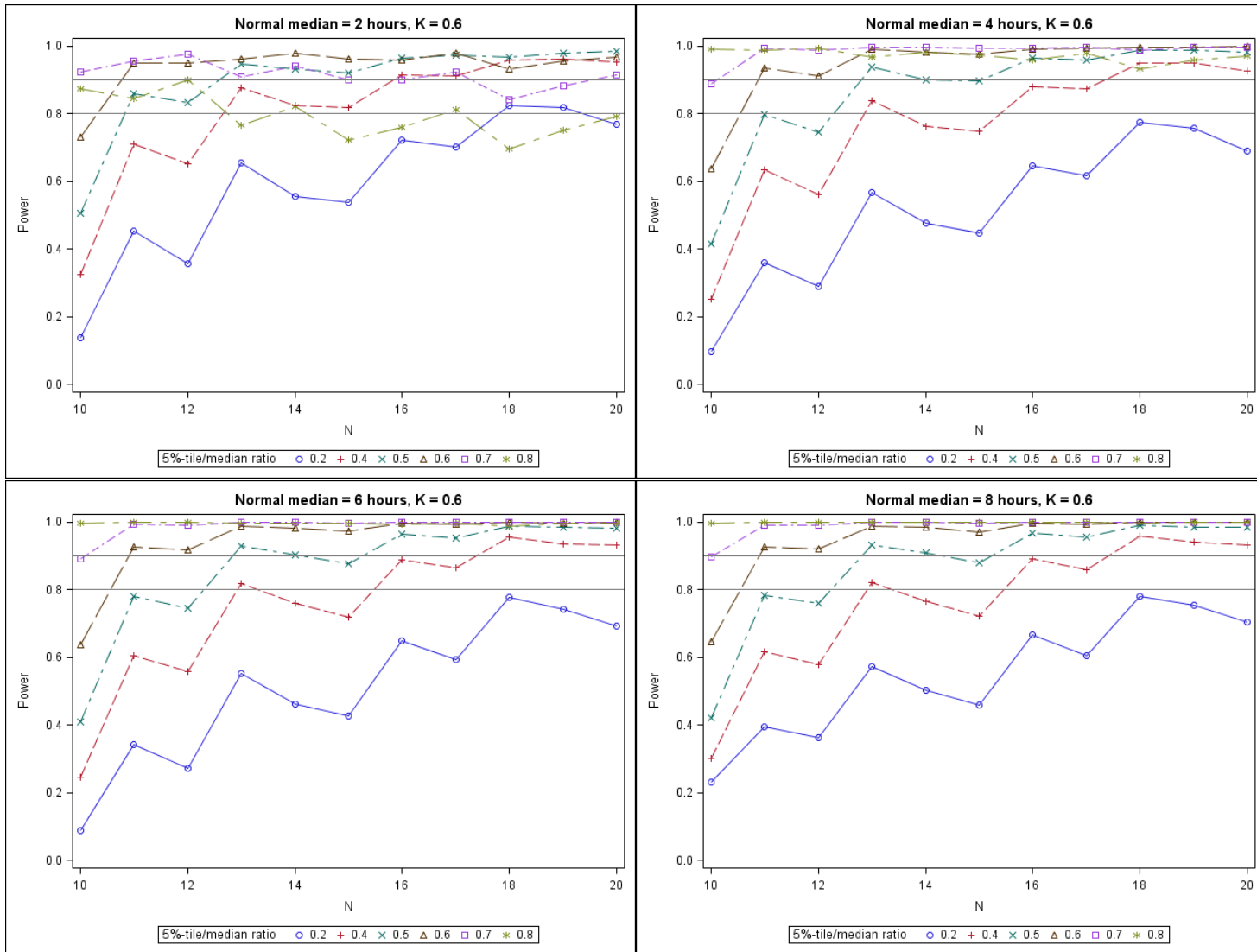


Figure 4-5: Power curves of study design when the lowest acceptable ratio $95\% \text{ LCL}_{\text{mCPT}}/\text{mCPT} = 0.7$ (Normal distributions)

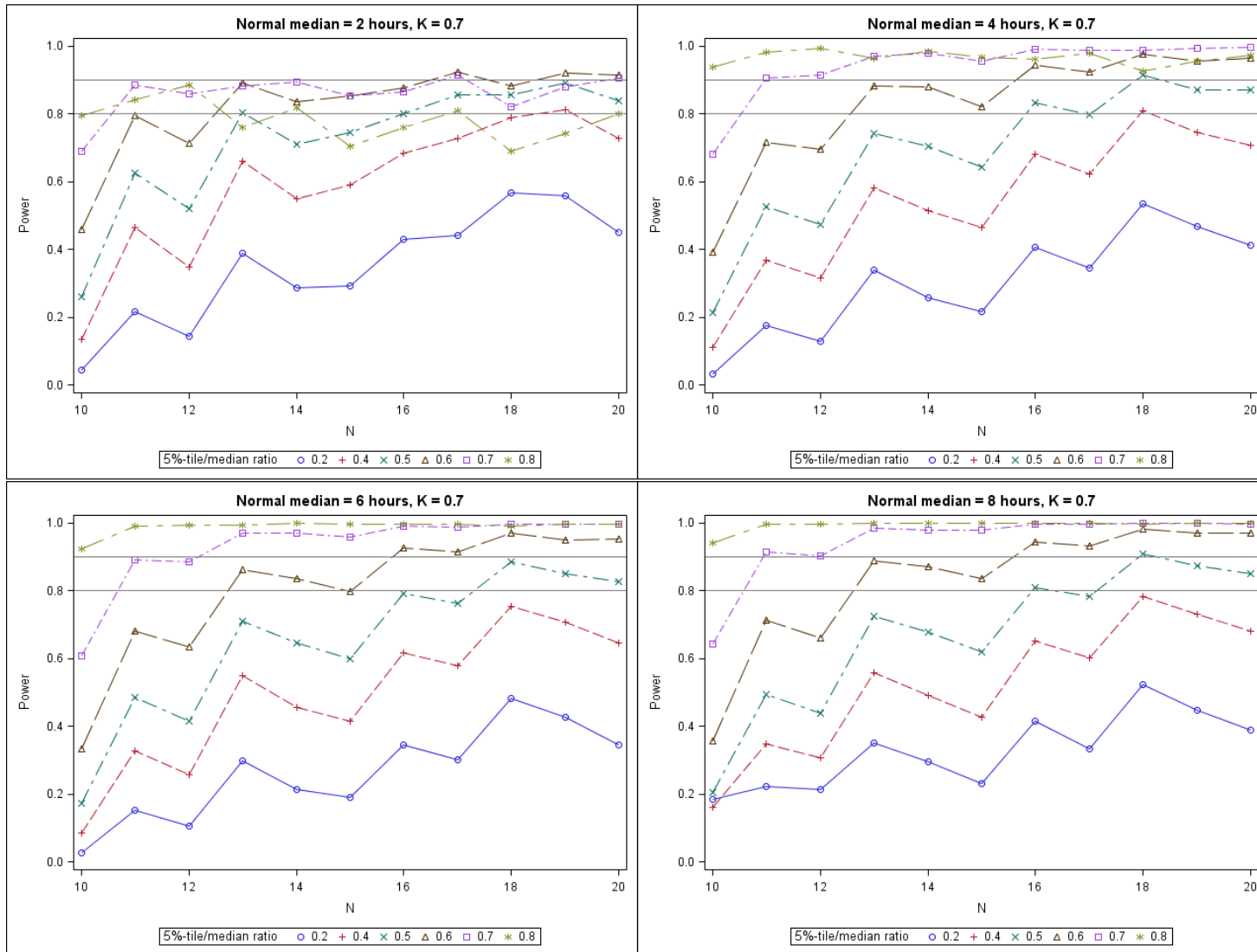


Figure 4-6: Power curves of study design when the lowest acceptable ratio $95\% \text{LCL}_{\text{mCPT}}/\text{mCPT} = 0.8$ (Normal distributions)

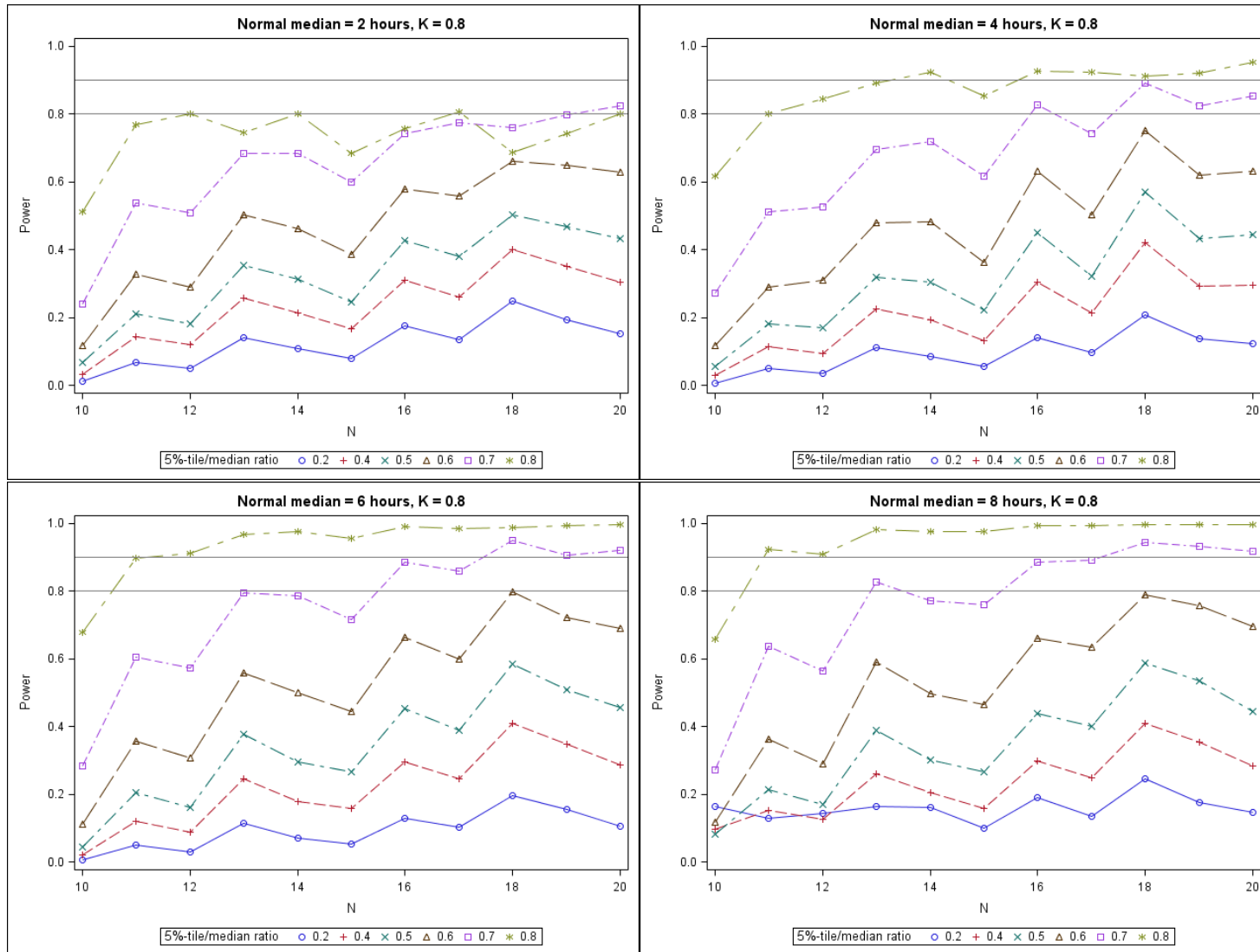
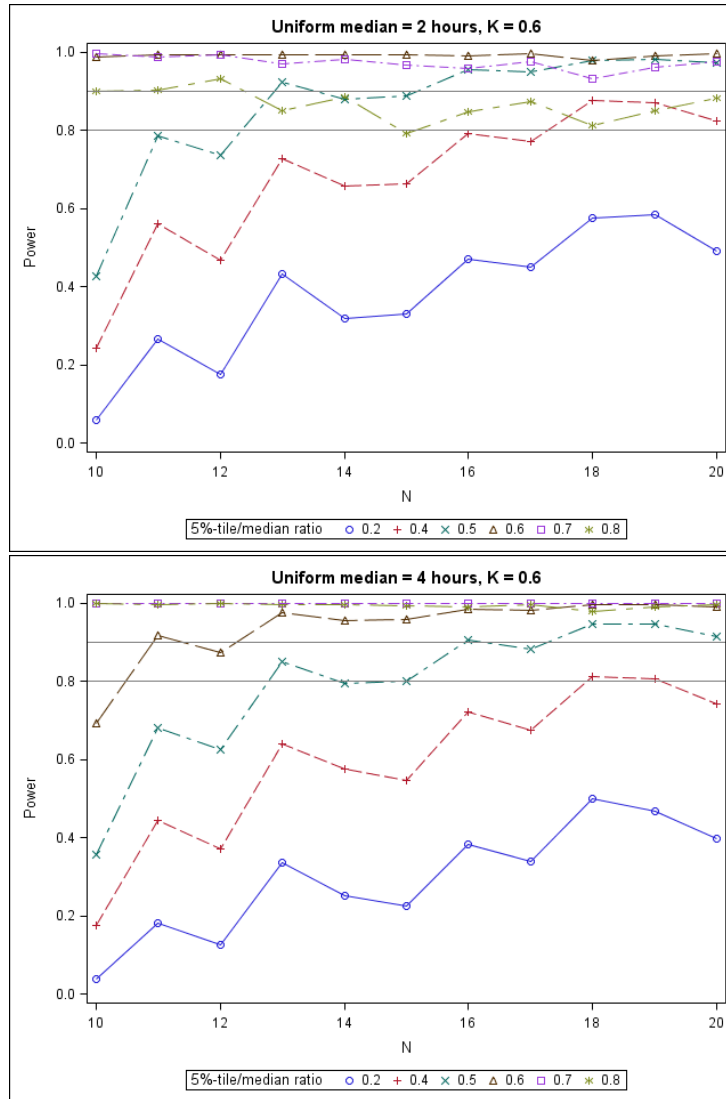


Figure 4-7: Power curves of study design when the lowest acceptable ratio $95\% \text{ LCL}_{\text{mCPT}}/\text{mCPT} = 0.6$ (Uniform distributions)



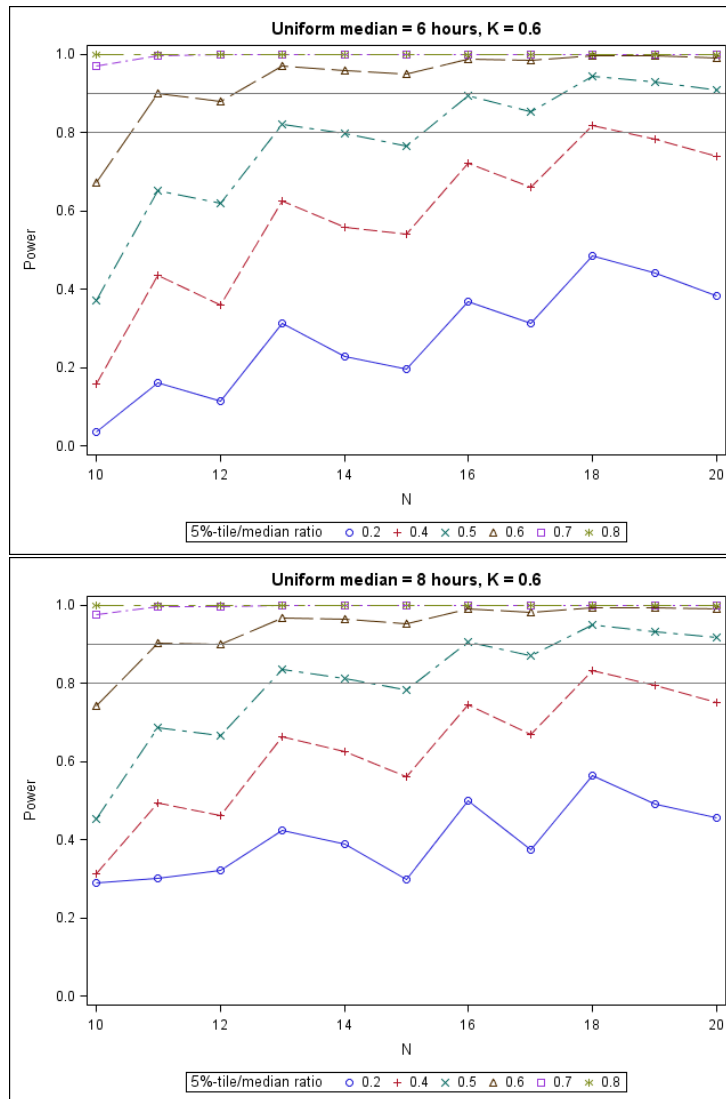
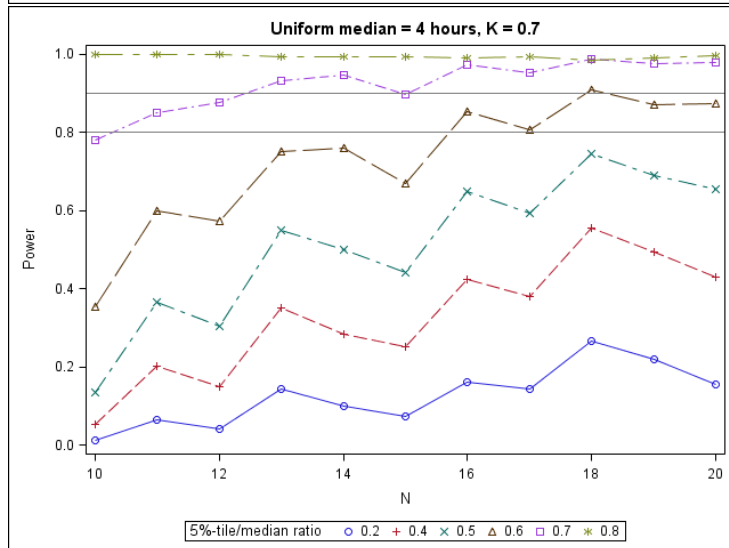
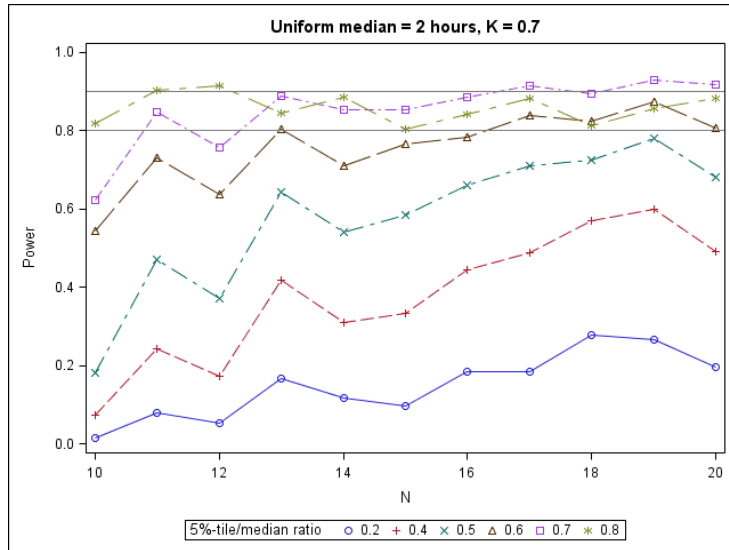


Figure 4-8: Power curves of study design when the lowest acceptable ratio 95% LCL_{mCPT}/mCPT = 0.7 (Uniform distributions)



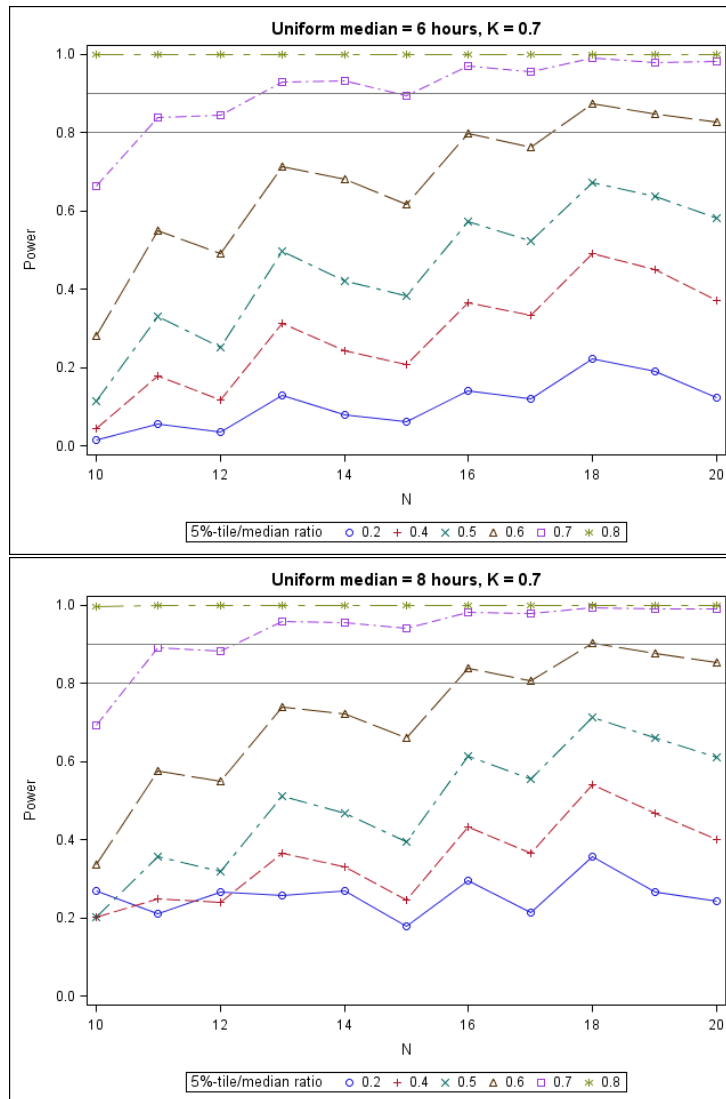


Figure 4-9: Power curves of study design when the lowest acceptable ratio 95% LCL_{mCPT}/mCPT = 0.8 (Uniform distributions)

