Appendix E

Graphical Displays of UCL95 for Various Robust ROS and Distribution

Type I Left Censored Datasets

Explanation of Legend Acronyms

Acronym	Explanation
Gamma ROS (BCA)	UCL based upon Gamma ROS method using the Bias Corrected Accelerated Percentile Bootstrap Method
Gamma ROS (Appx)	UCL based upon Gamma ROS method using Gamma Approximate-UCL Method
H-ROS (BCA)	UCL based upon Helsel's Robust Method using the Bias Corrected Accelerated Percentile Bootstrap Method.
H-ROS (%)	UCL based upon Helsel's Robust Method using The Percentile Bootstrap Method.
H-ROS (Jackknife)	UCL based upon Helsel's Robust Method using the Jackknife method
KM(t)	UCL based upon Kaplan-Meier Estimates using Student's t-Distribution Critical Value
KM (%)	UCL based upon Kaplan-Meier Estimates using the Percentile Bootstrap Method.
KM (BCA)	UCL based upon Kaplan-Meier Estimates using the Bias Corrected Accelerated Percentile Bootstrap Method.
KM (Chebyshev)	UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality
KM (Jackknife)	UCL based upon Kaplan-Meier Estimates using the Jackknife Method

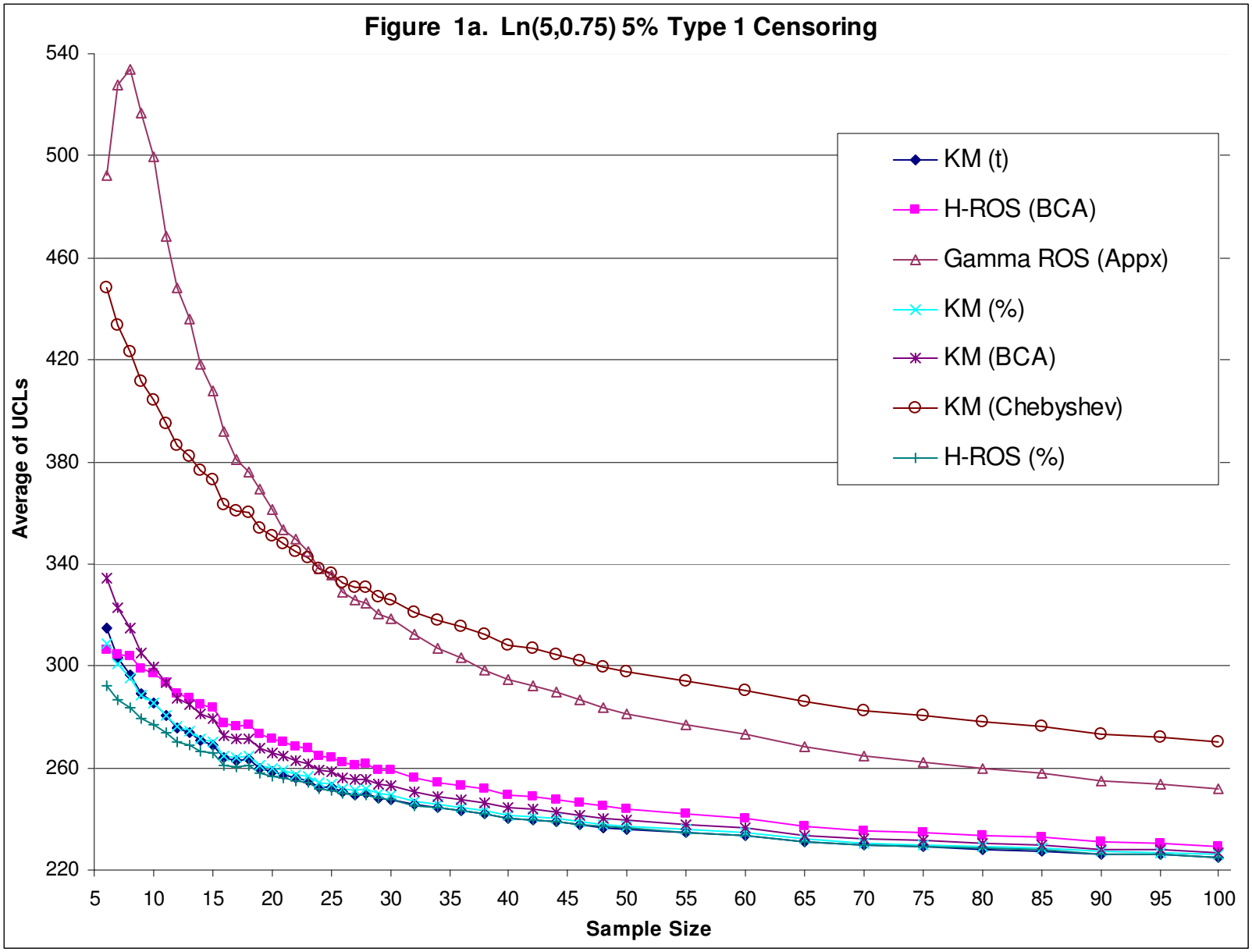
Figure 1a. Ln(5,0.75) 5% Type 1 Censoring
Average of UCLs
540
500
460
420
380
340
300
260
220
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

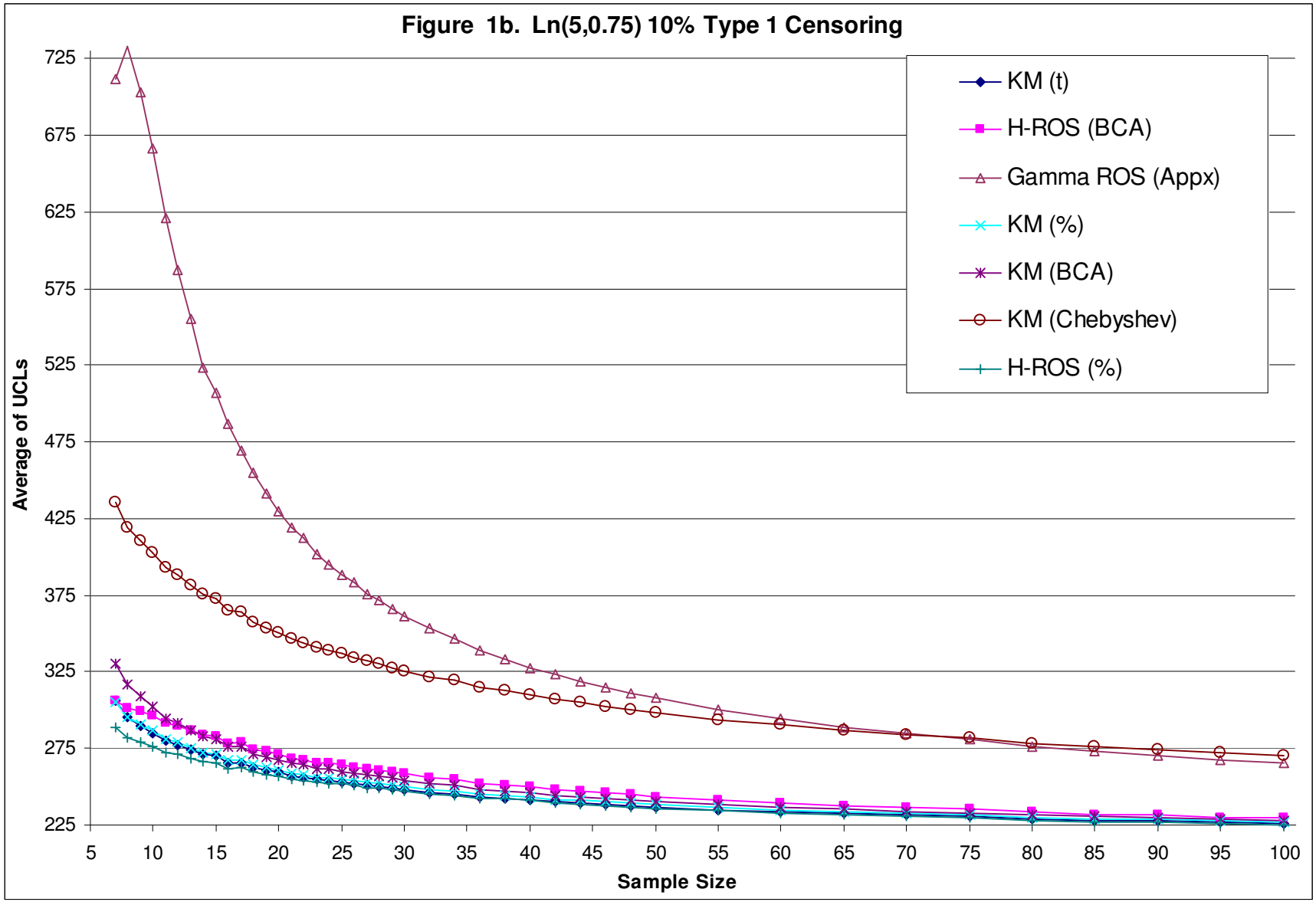
Figure 1b. Ln(5,0.75) 10% Type 1 Censoring
Average of UCLs
725
675
625
575
525
475
425
375
325
275
225
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

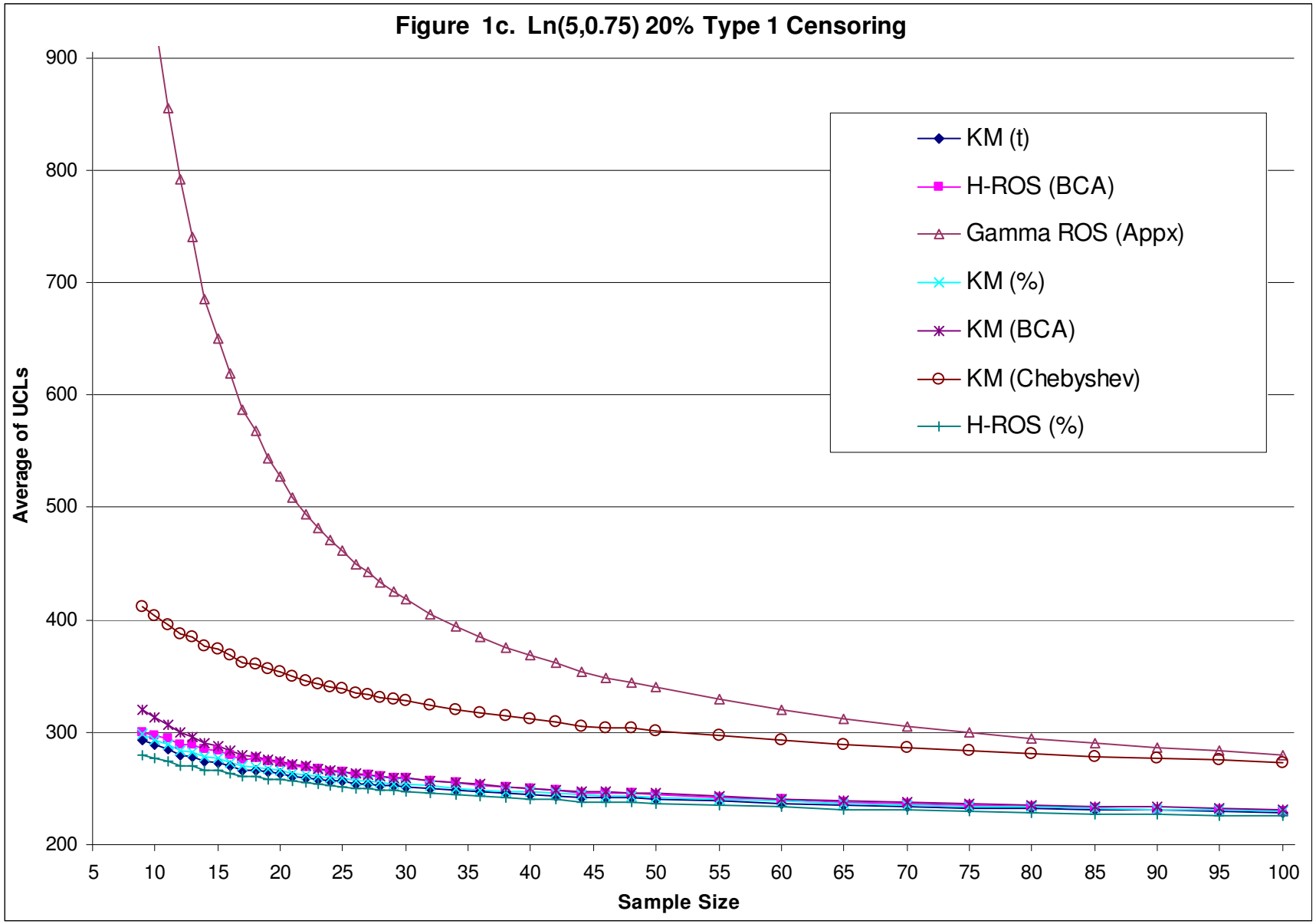
Figure 1c. Ln(5,0.75) 20% Type 1 Censoring
Average of UCLs
900
800
700
600
500
400
300
200
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

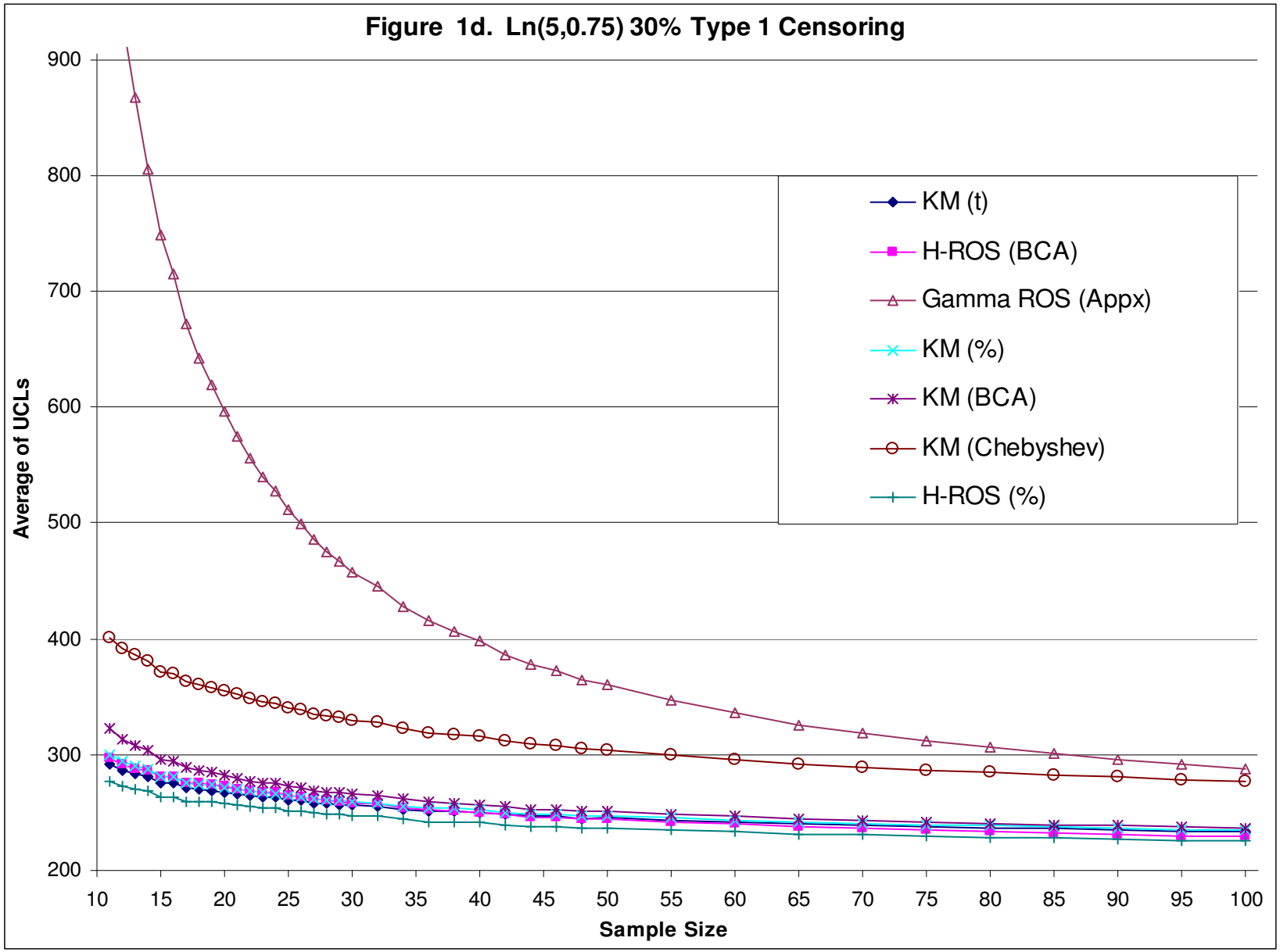
Figure 1d. Ln(5,0.75) 30% Type 1 Censoring
Average of UCLs
900
800
700
600
500
400
300
200
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

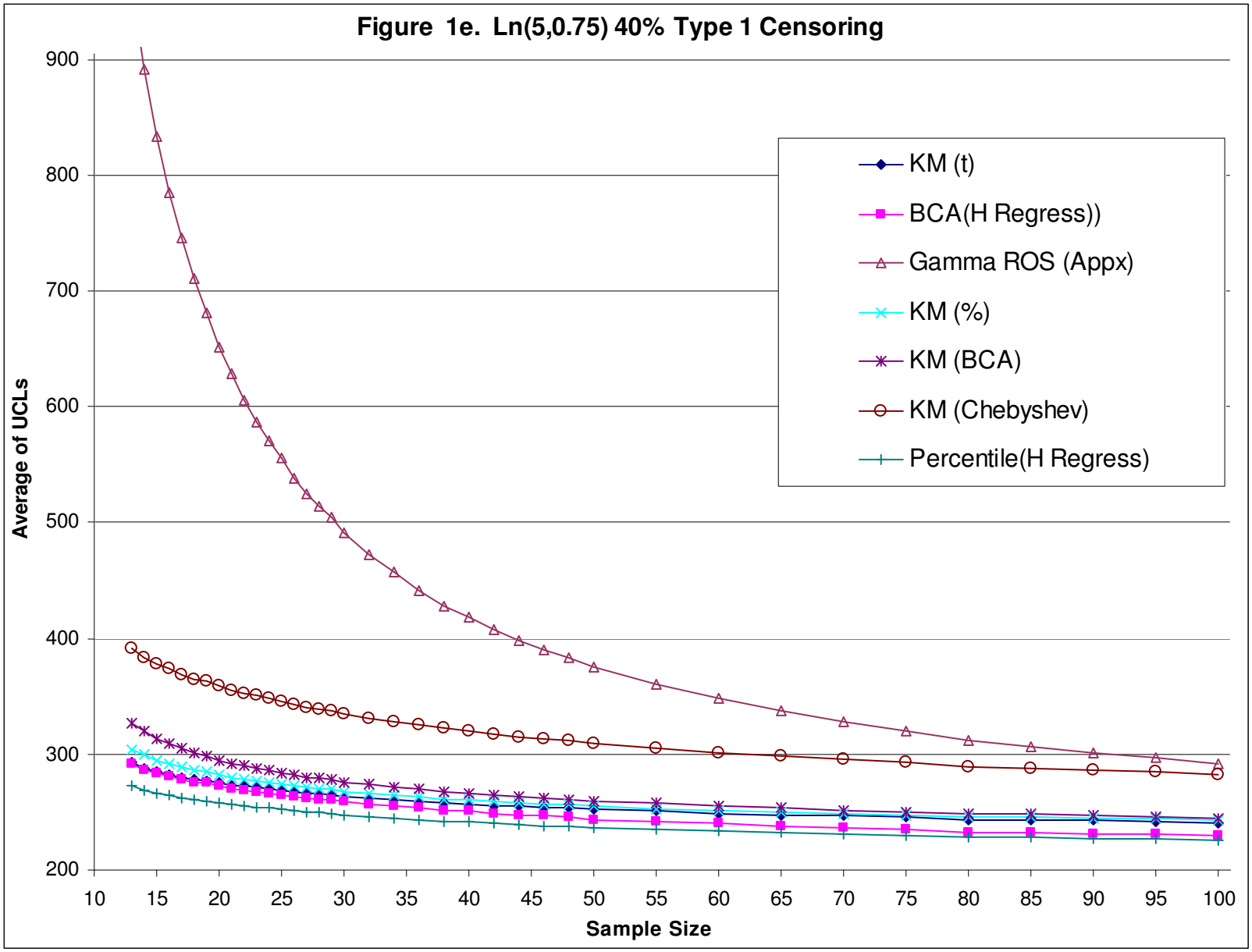
Figure 1e. Ln(5,0.75) 40% Type 1 Censoring
Average of UCLs
900
800
700
600
500
400
300
200
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
BCA(H Regress))
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
Percentile(H Regress)

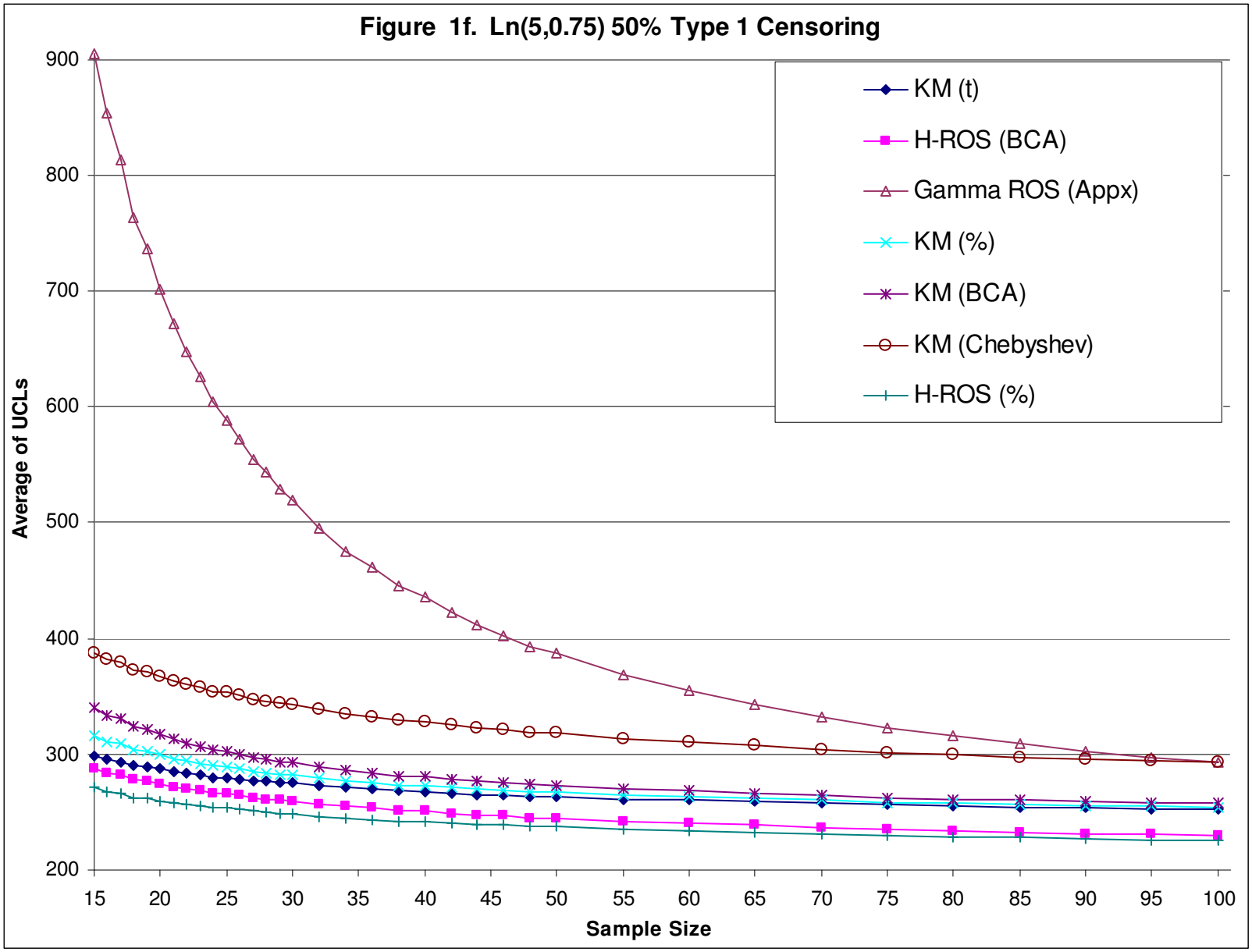
Figure 1f. Ln(5,0.75) 50% Type 1 Censoring
Average of UCLs
900
800
700
600
500
400
300
200
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

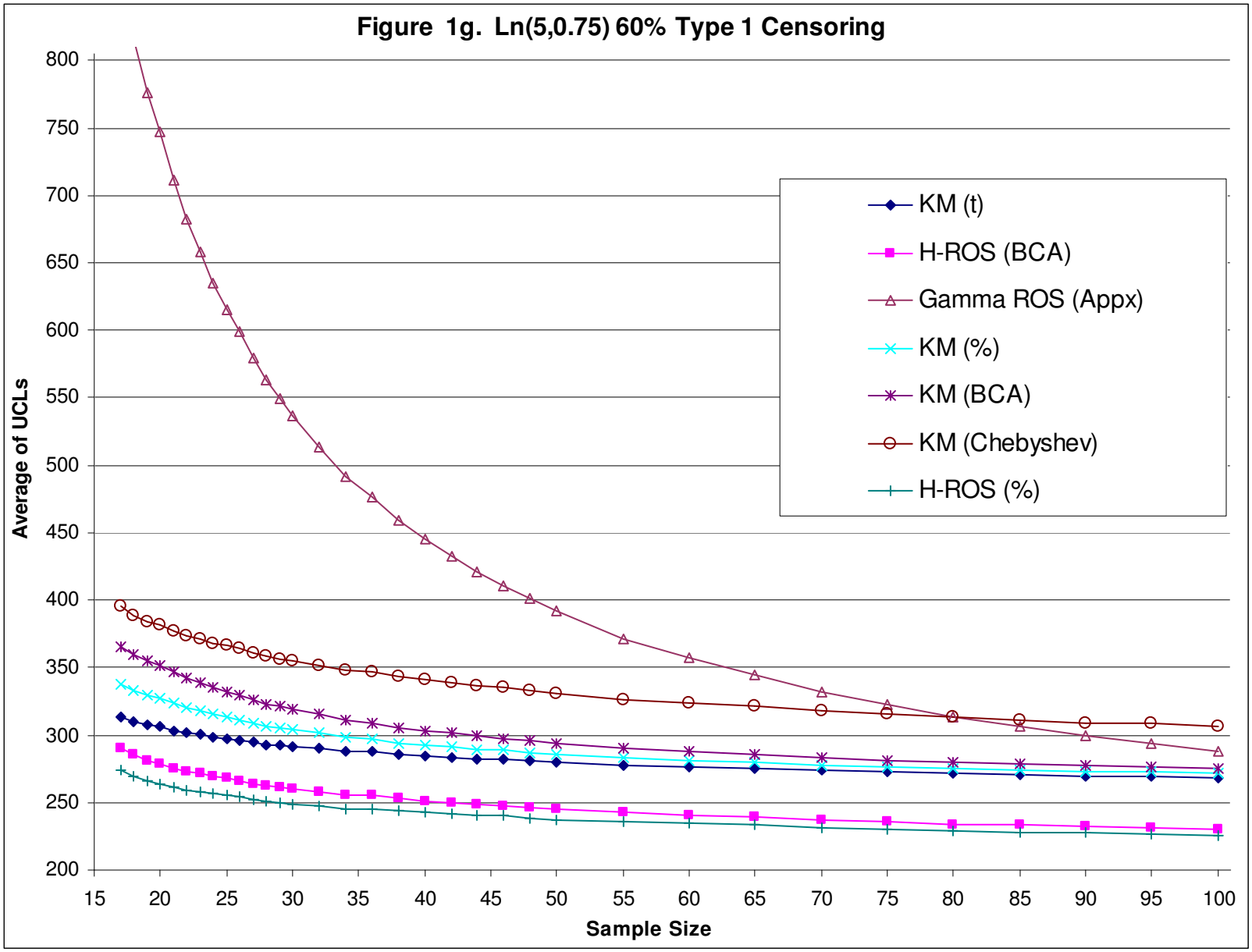
Figure 1g. Ln(5,0.75) 60% Type 1 Censoring
Average of UCLs
800
750
700
650
600
550
500
450
400
350
300
250
200
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

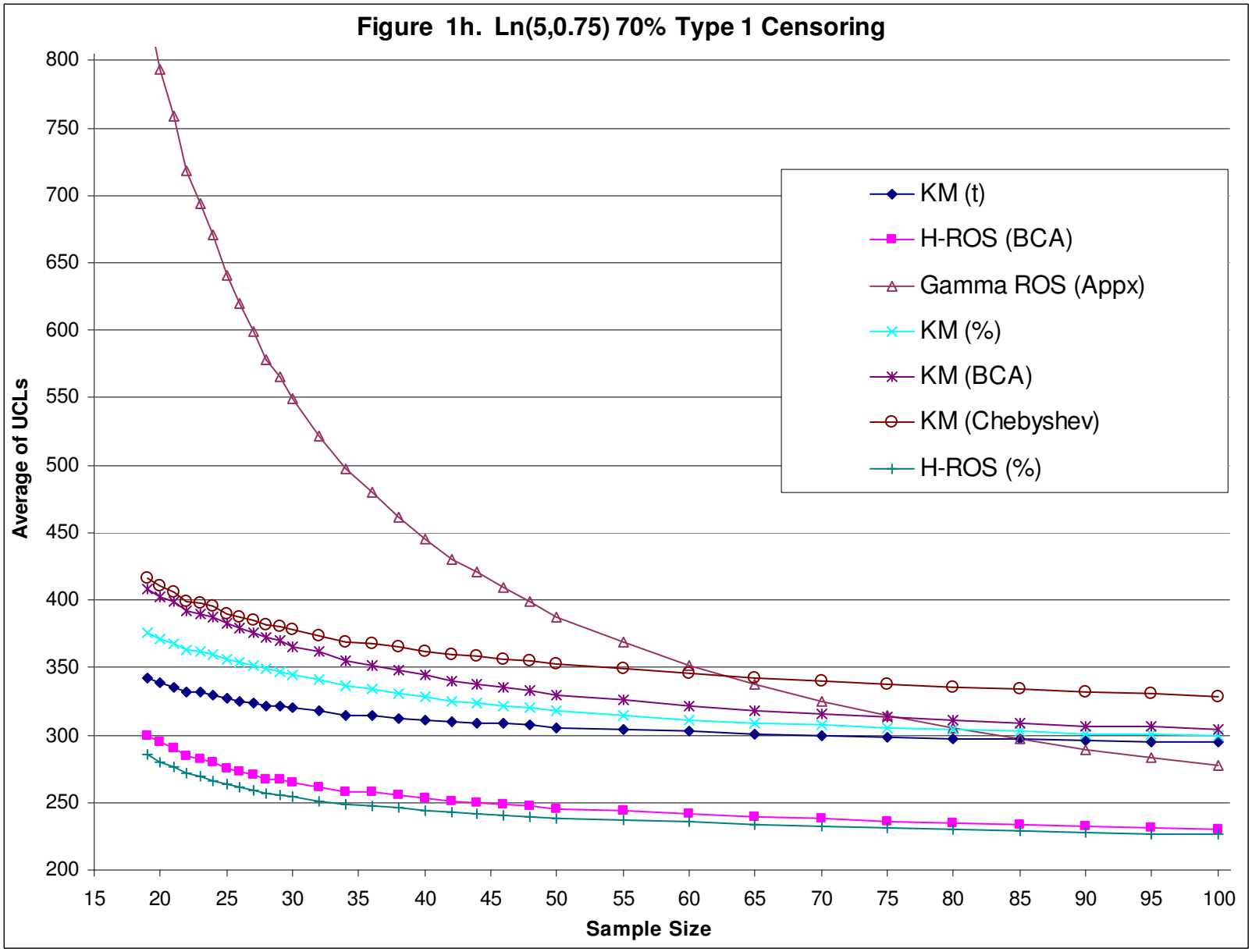
Figure 1h. Ln(5,0.75) 70% Type 1 Censoring
Average of UCLs
800
750
700
650
600
550
500
450
400
350
300
250
200
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

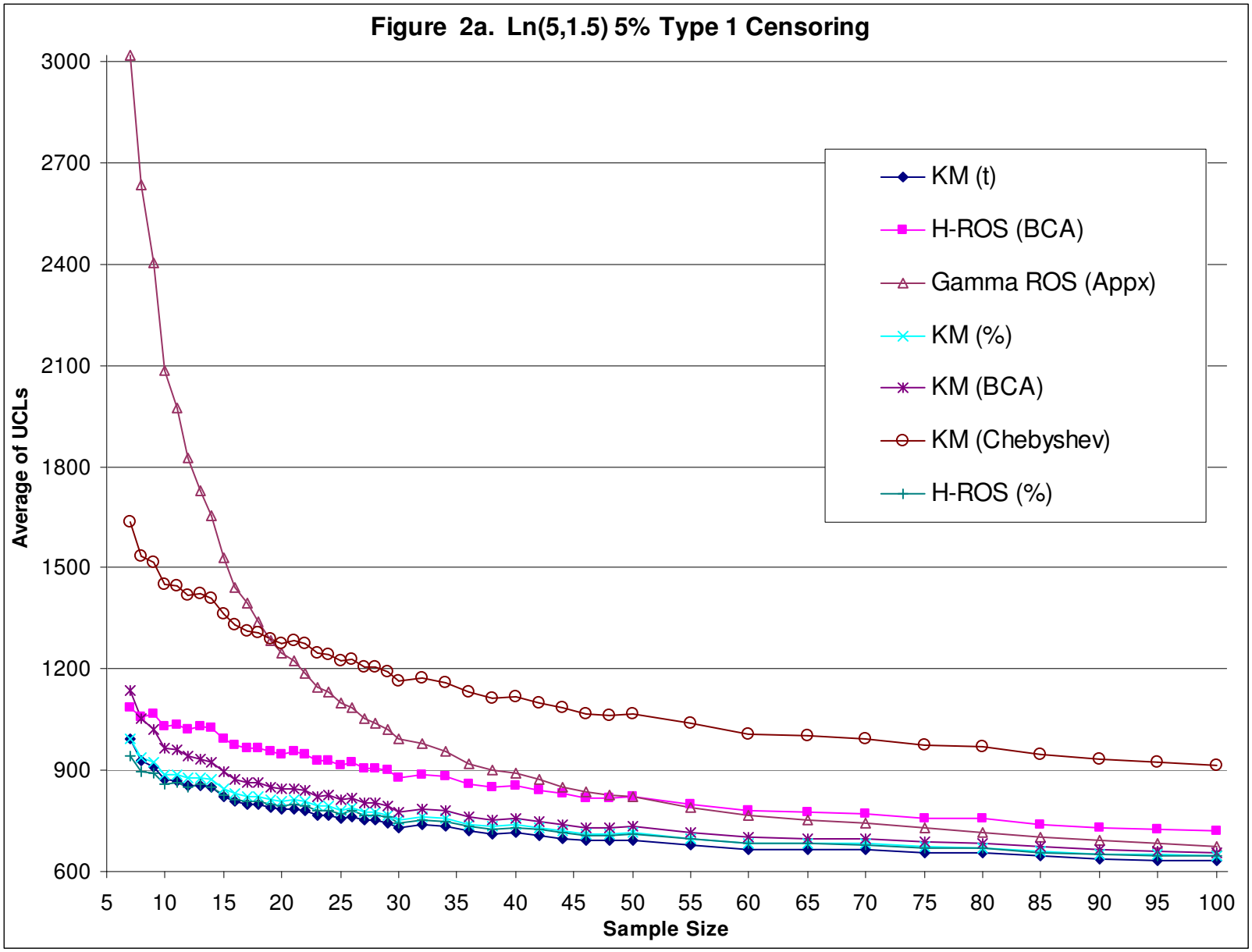
Figure 2a. Ln(5,1.5) 5% Type 1 Censoring
Average of UCLs
3000
2700
2400
2100
1800
1500
1200
900
600
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

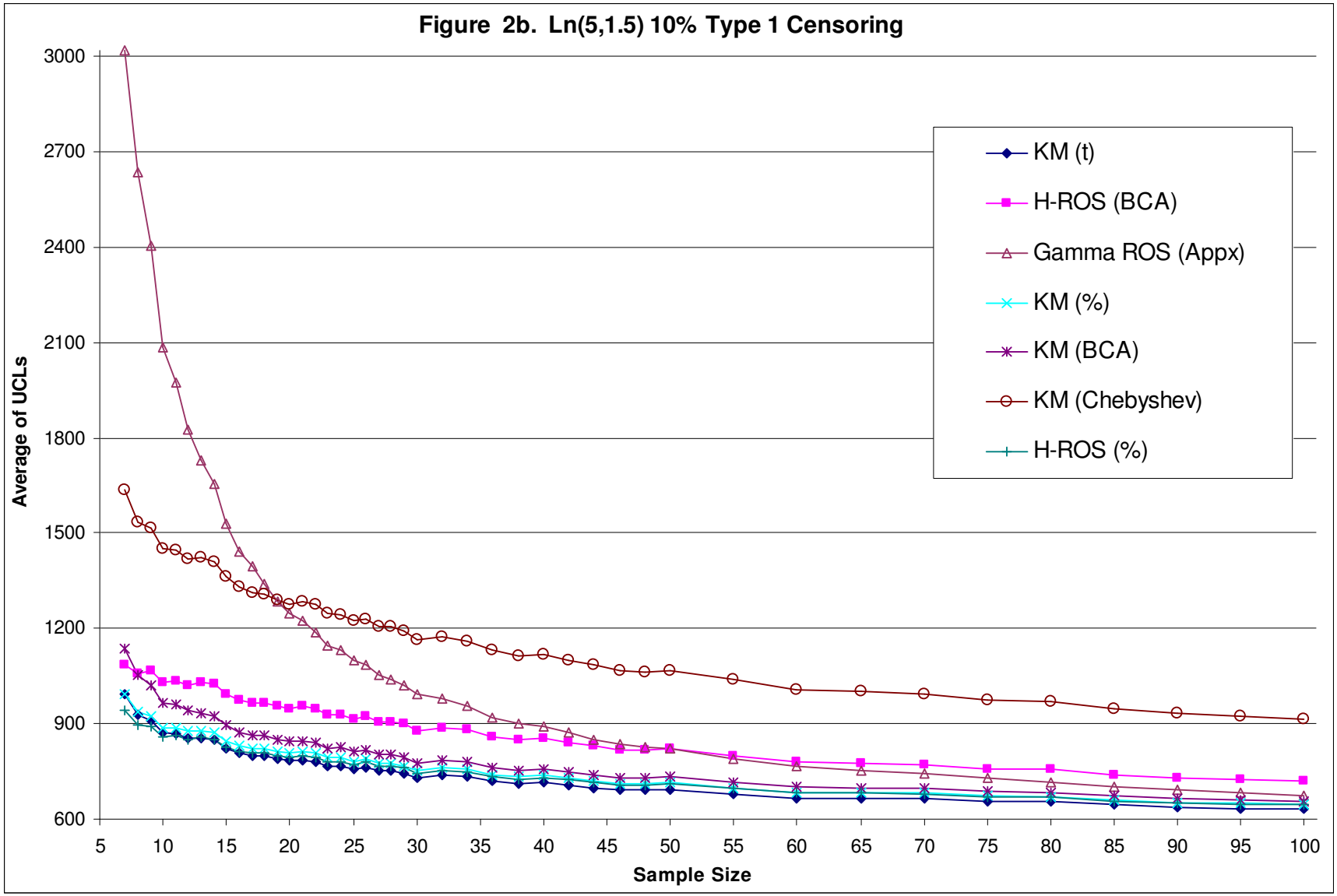
Figure 2b. Ln(5,1.5) 10% Type 1 Censoring
Average of UCLs
3000
2700
2400
2100
1800
1500
1200
900
600
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

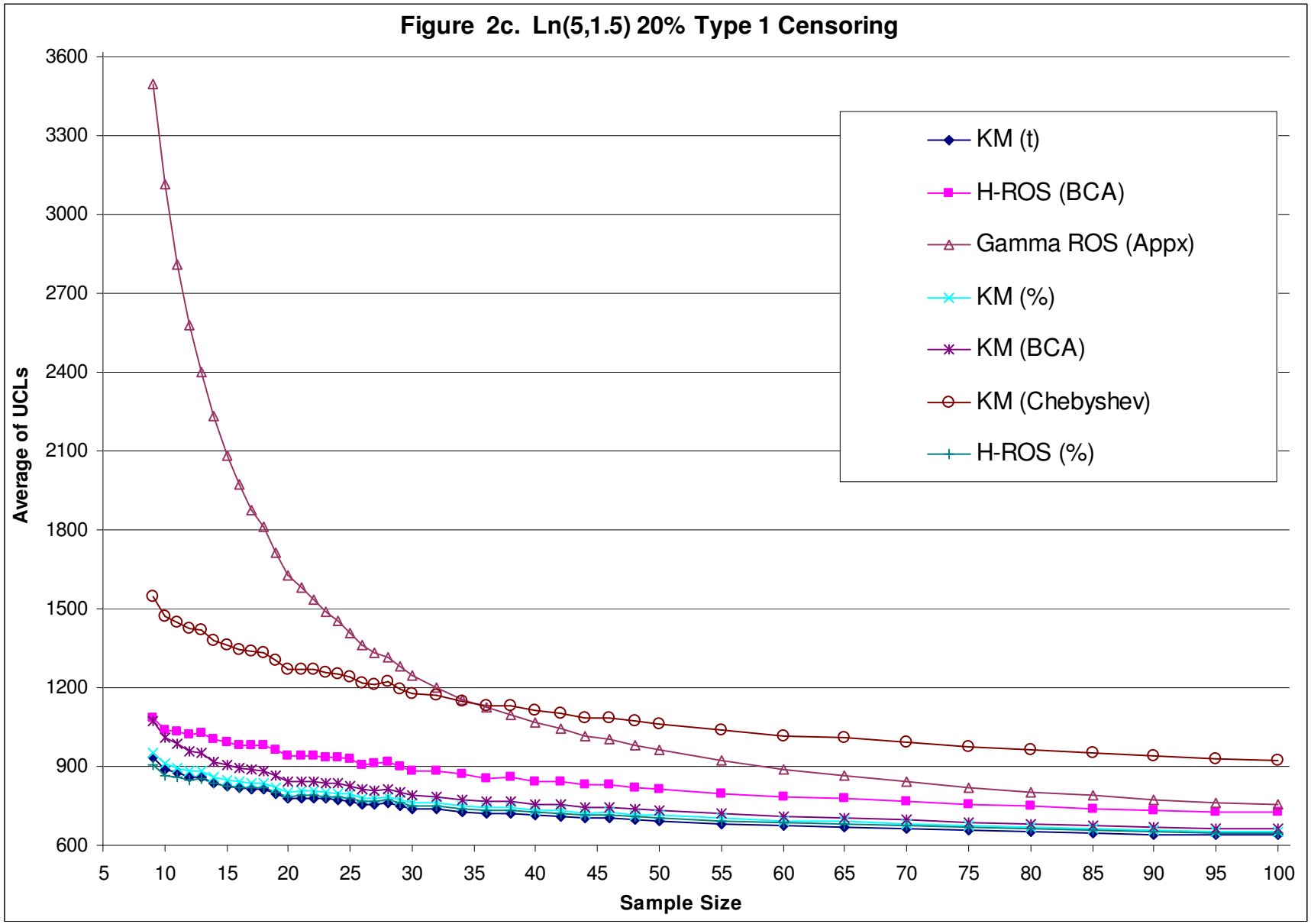
Figure 2c. Ln(5,1.5) 20% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

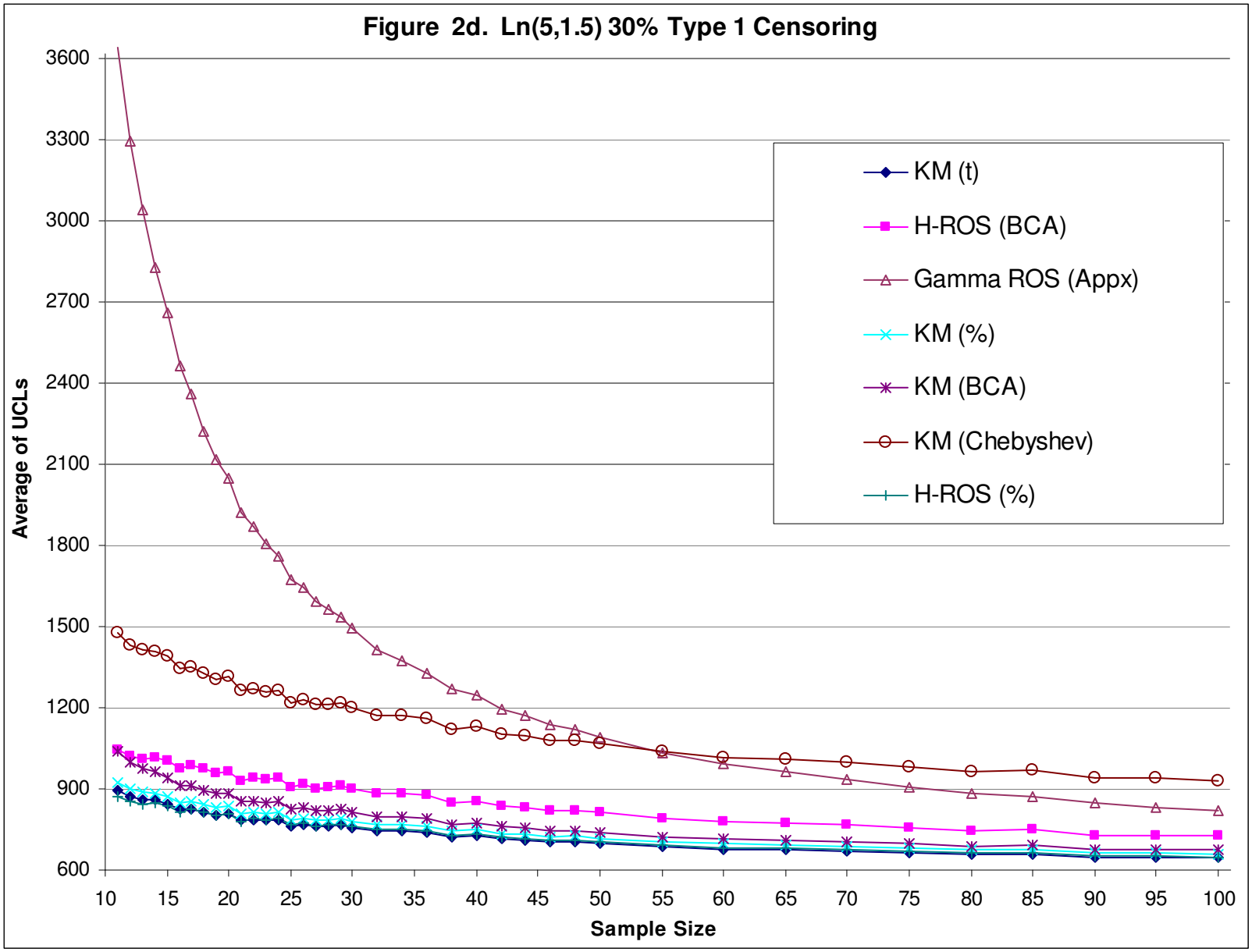
Figure 2d. Ln(5,1.5) 30% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

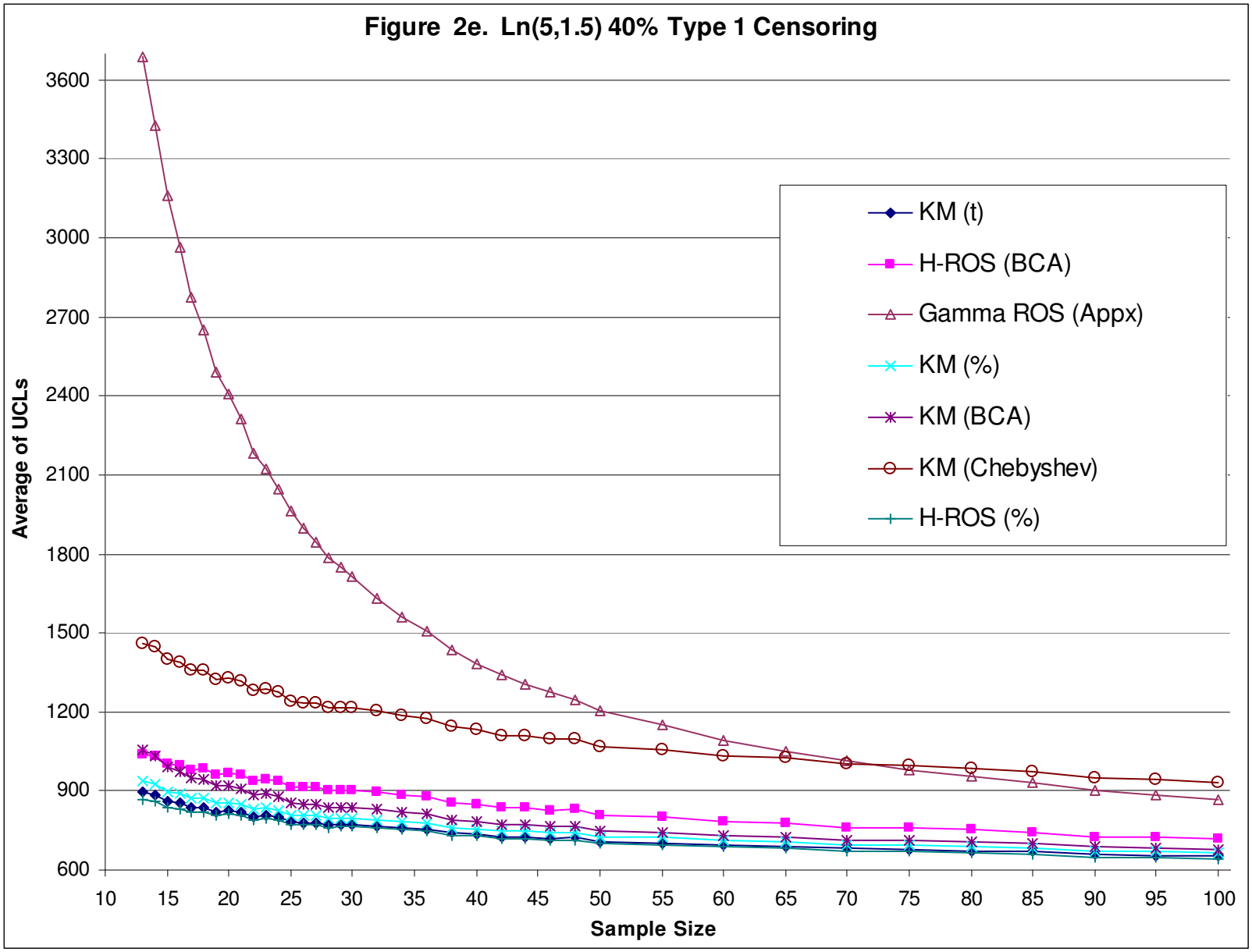
Figure 2e. Ln(5,1.5) 40% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

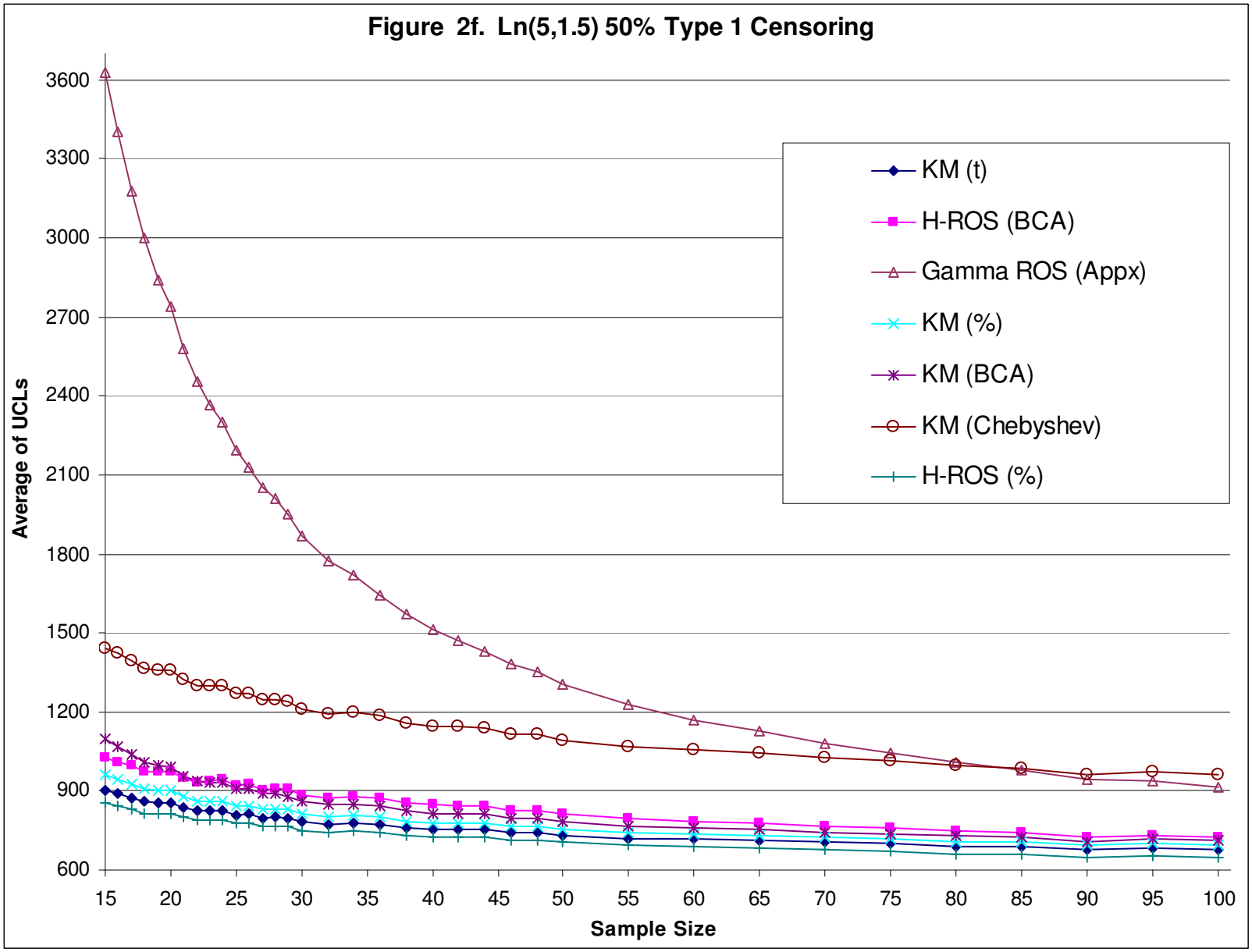
Figure 2f. Ln(5,1.5) 50% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

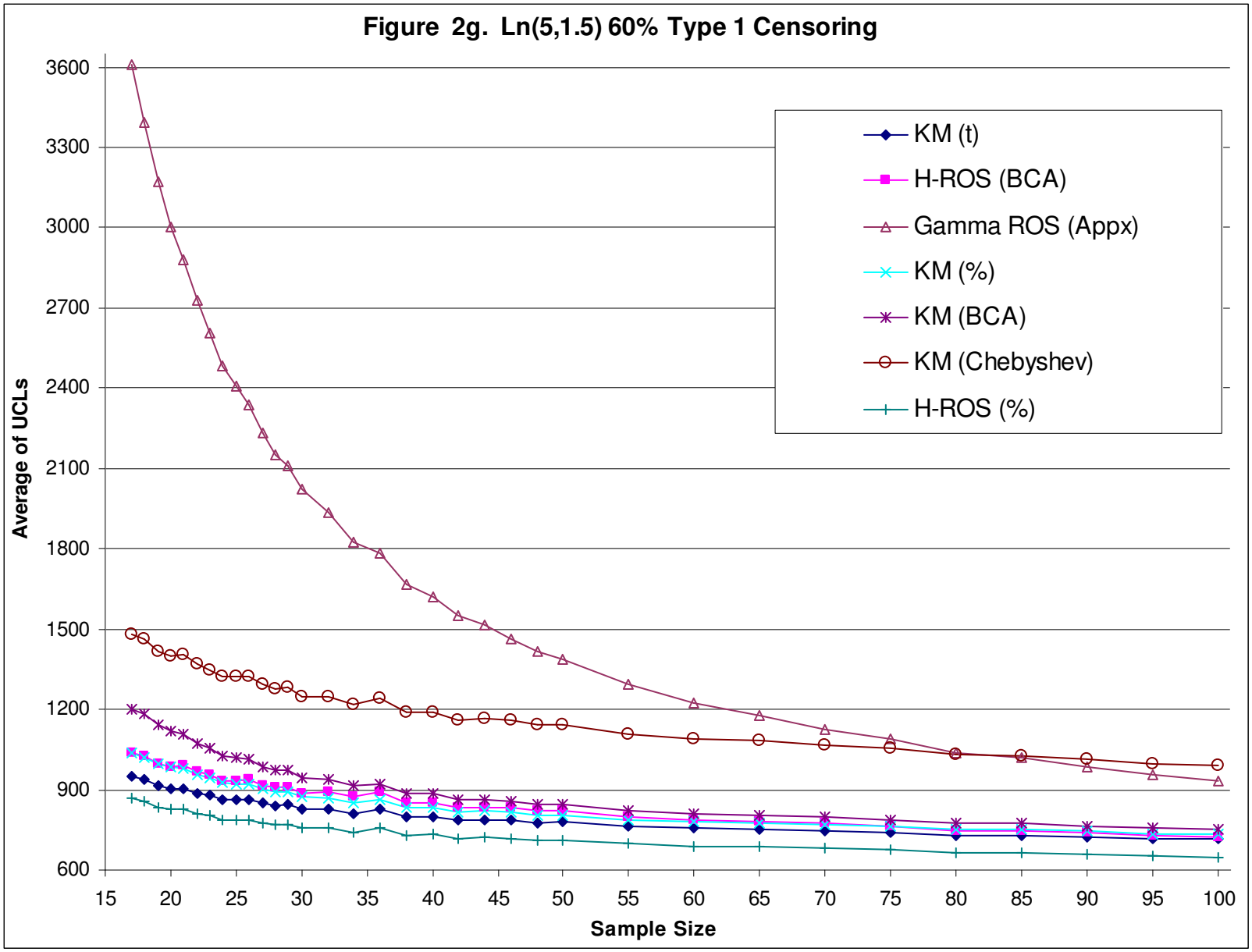
Figure 2g. Ln(5,1.5) 60% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

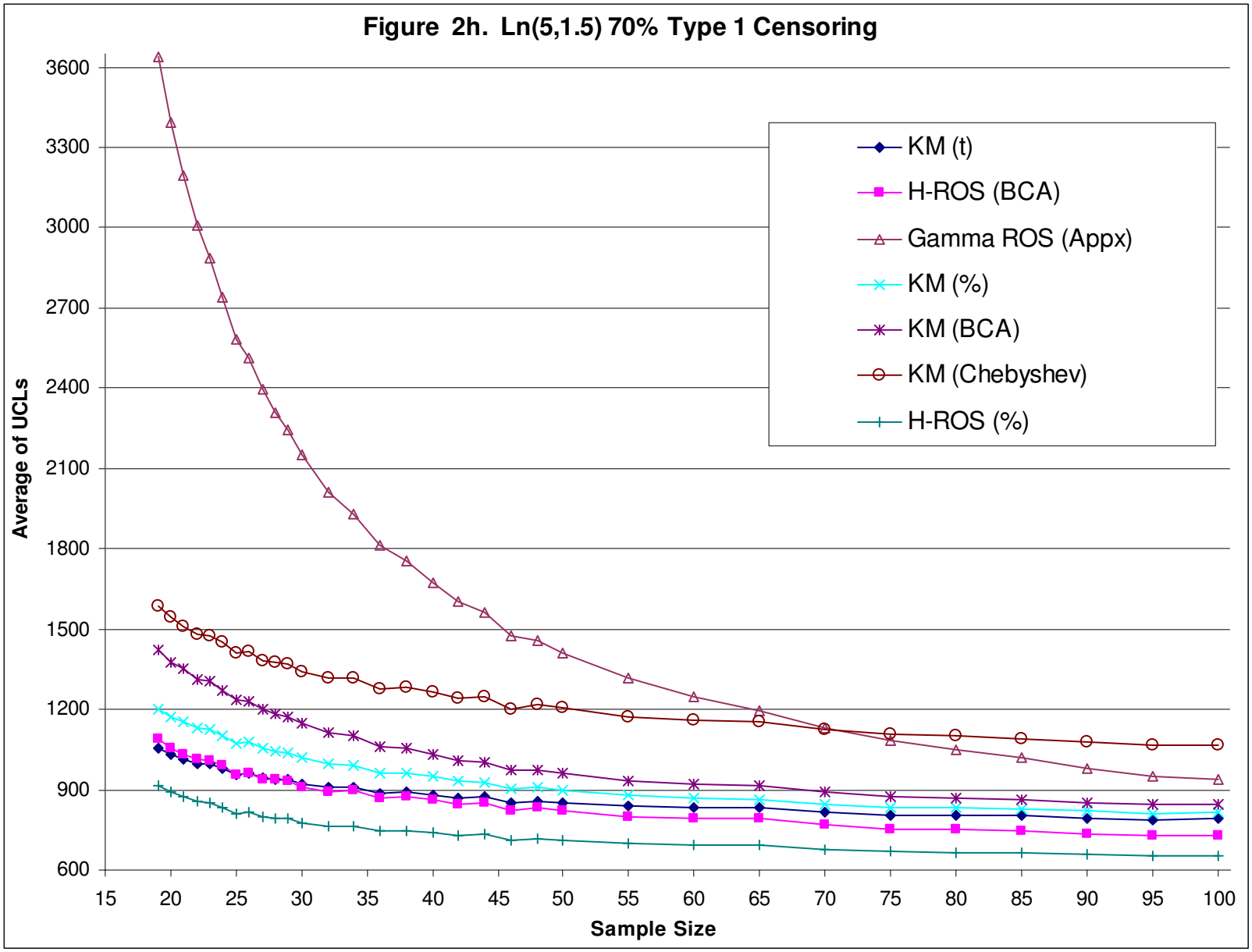
Figure 2h. Ln(5,1.5) 70% Type 1 Censoring
Average of UCLs
3600
3300
3000
2700
2400
2100
1800
1500
1200
900
600
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

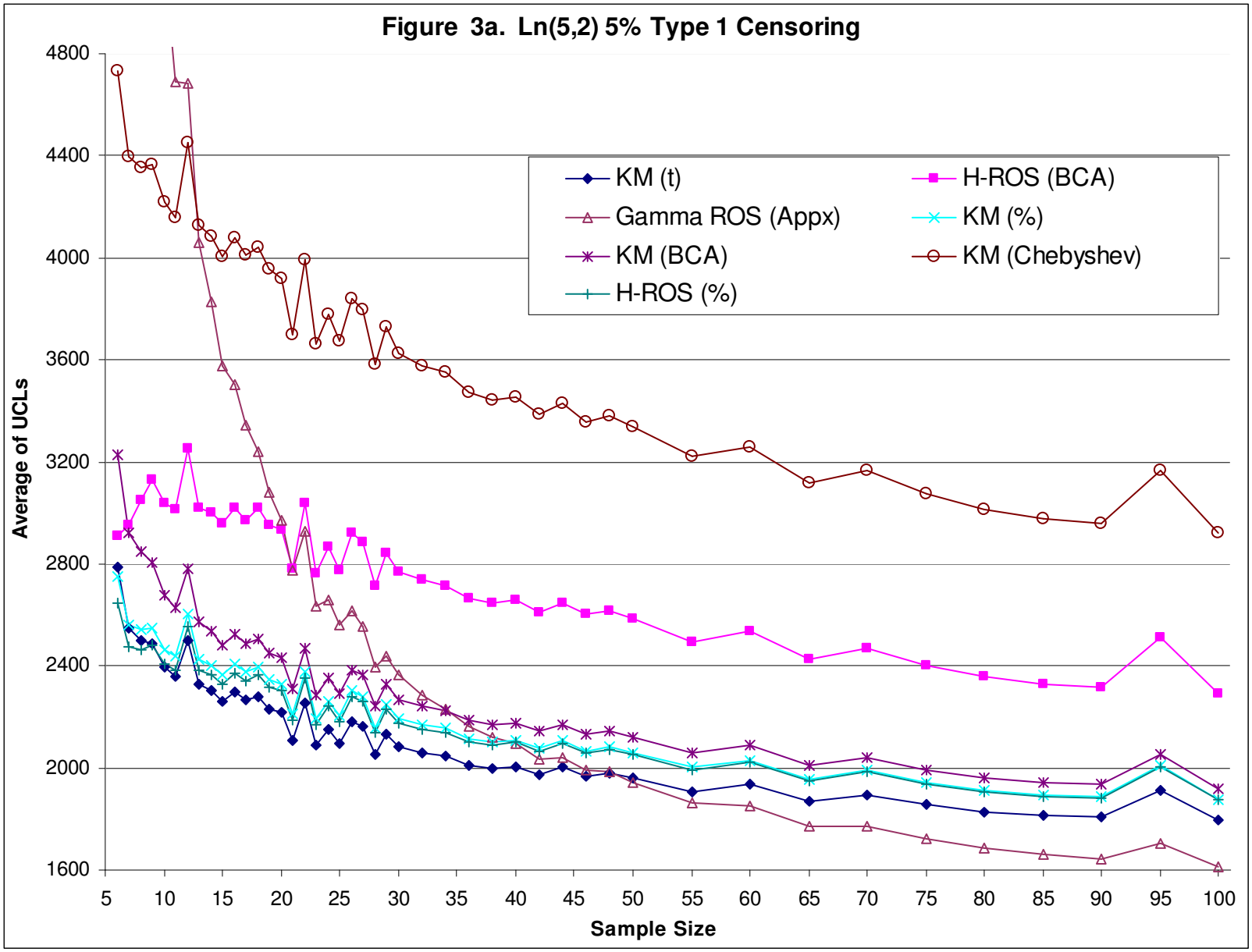
Figure 3a. Ln(5,2) 5% Type 1 Censoring
Average of UCLs
Sample Size
4800
4400
4000
3600
3200
2800
2400
2000
1600
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

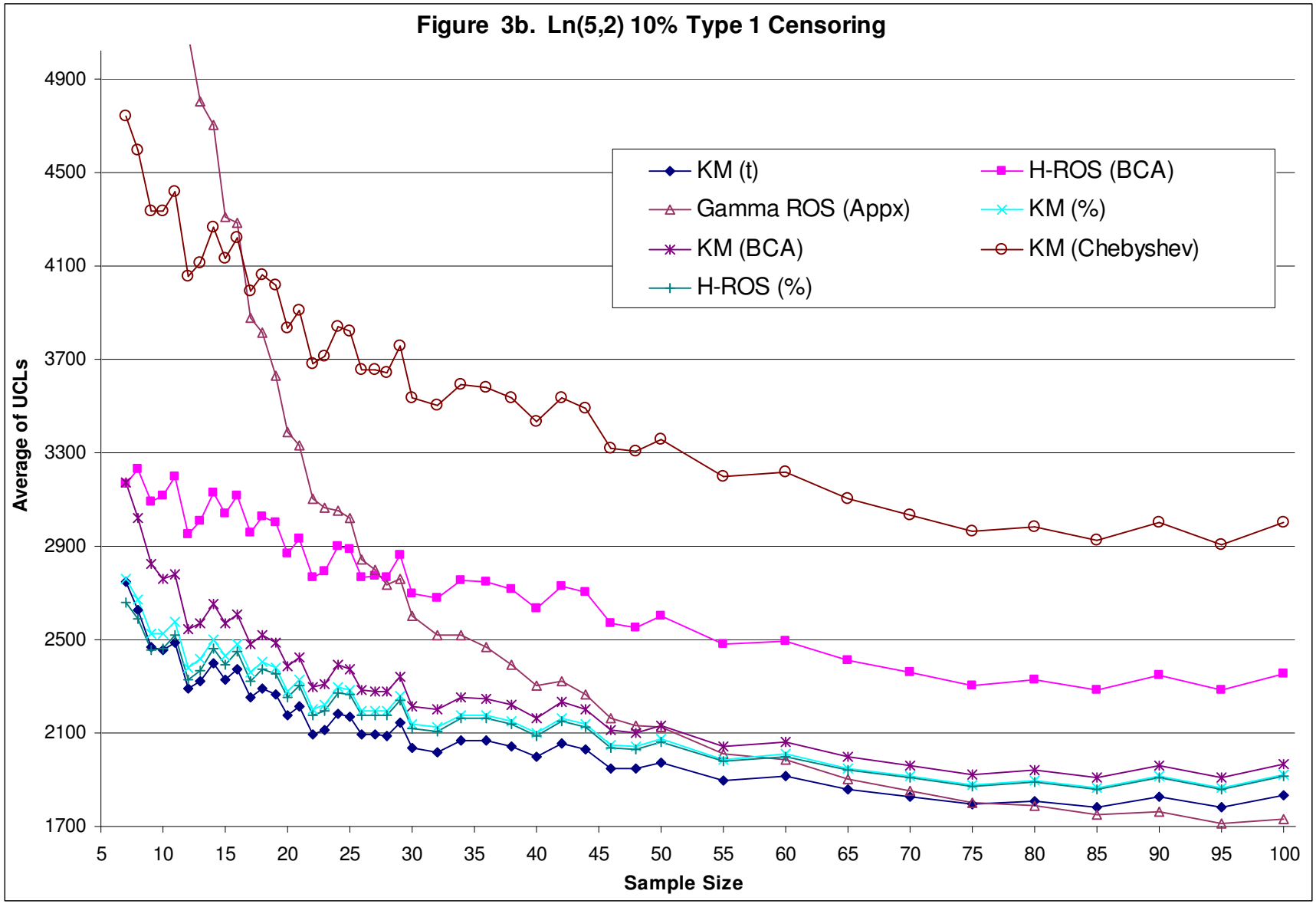
Figure 3b. Ln(5,2) 10% Type 1 Censoring
Average of UCLs
4900
4500
4100
3700
3300
2900
2500
2100
1700
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

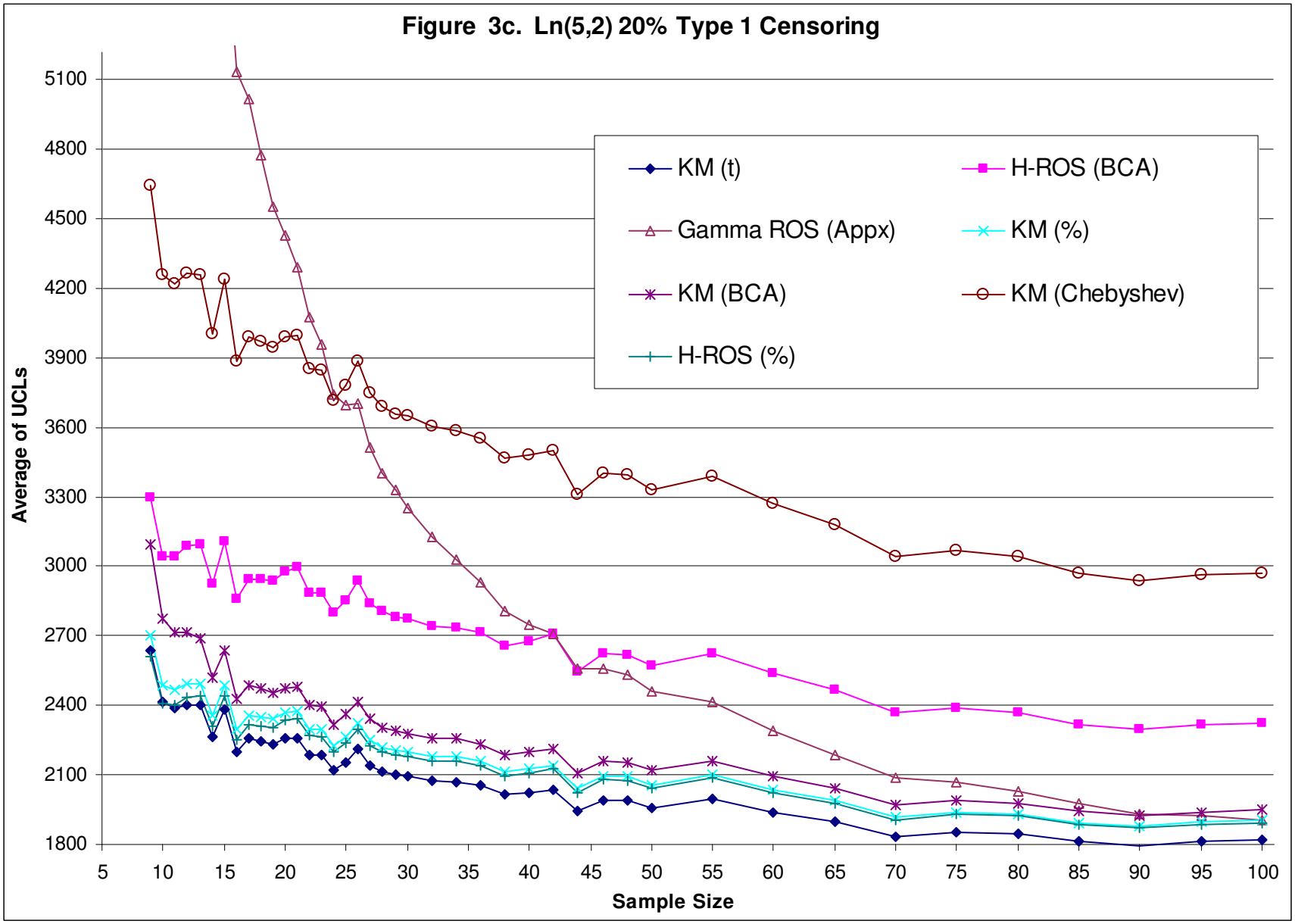
Figure 3c. Ln(5,2) 20% Type 1 Censoring
Average of UCLs
5100
4800
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

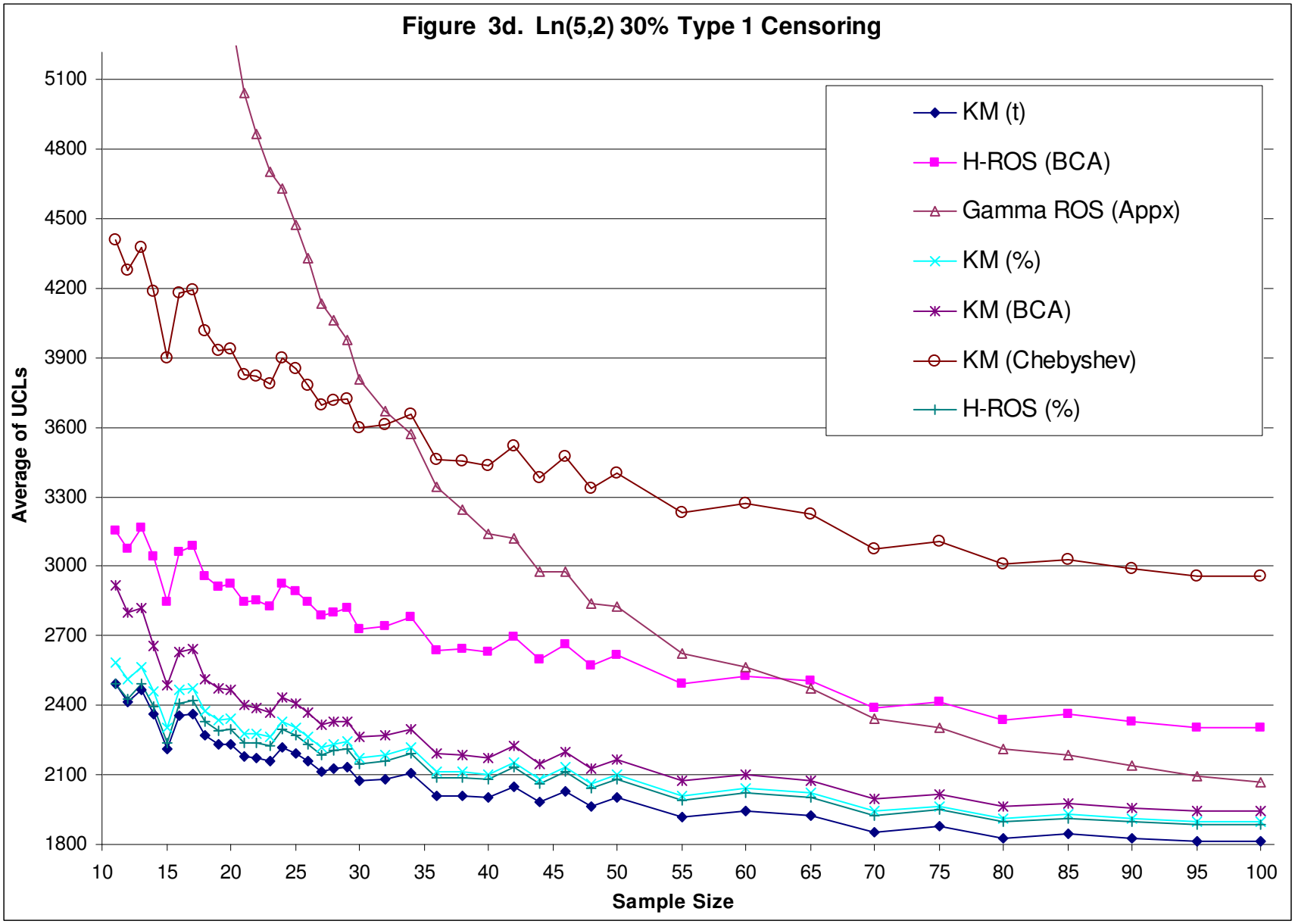
Figure 3d. Ln(5,2) 30% Type 1 Censoring
Average of UCLs
5100
4800
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

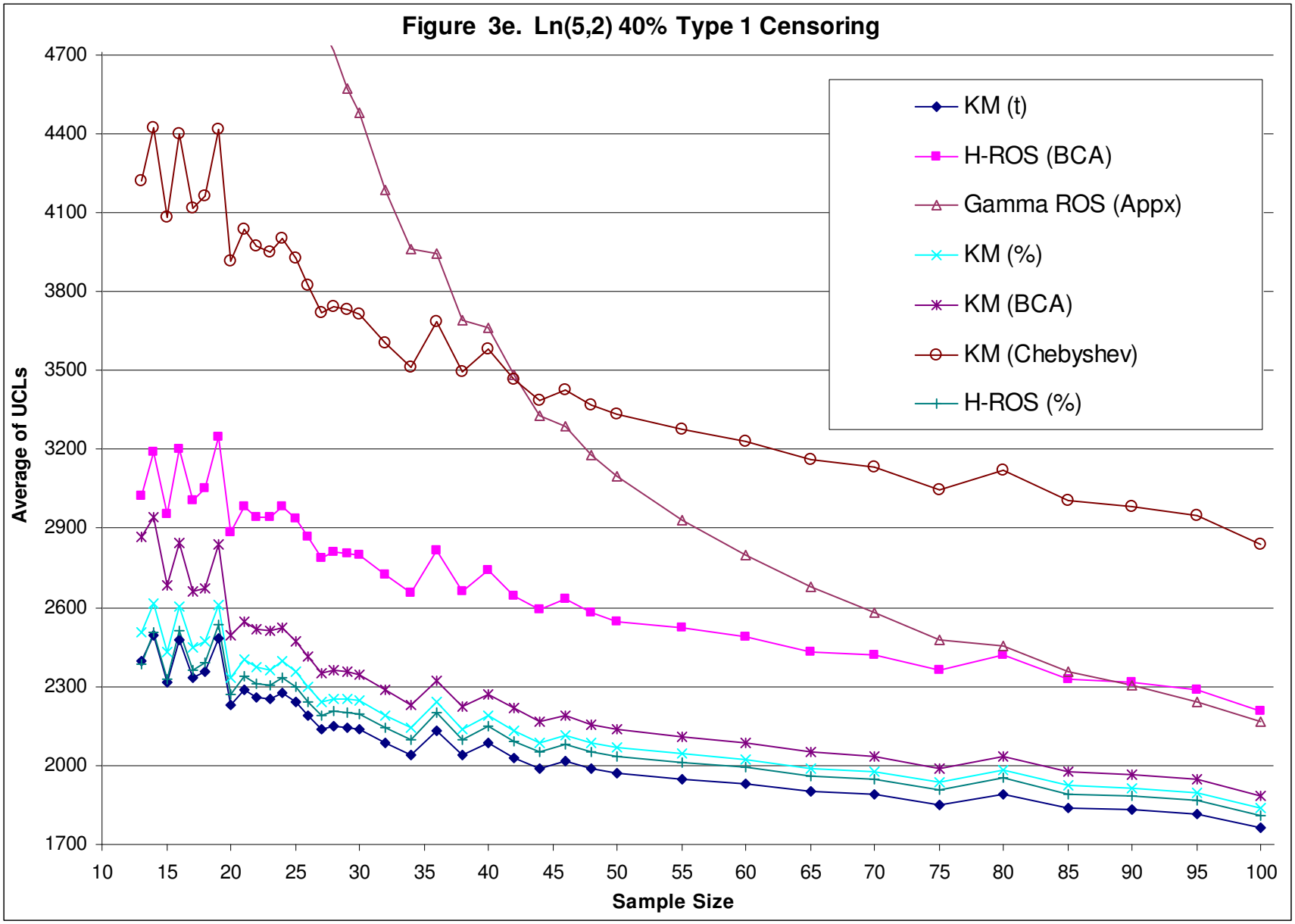
Figure 3e. Ln(5,2) 40% Type 1 Censoring
Average of UCLs
Sample Size
4700
4400
4100
3800
3500
3200
2900
2600
2300
2000
1700
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

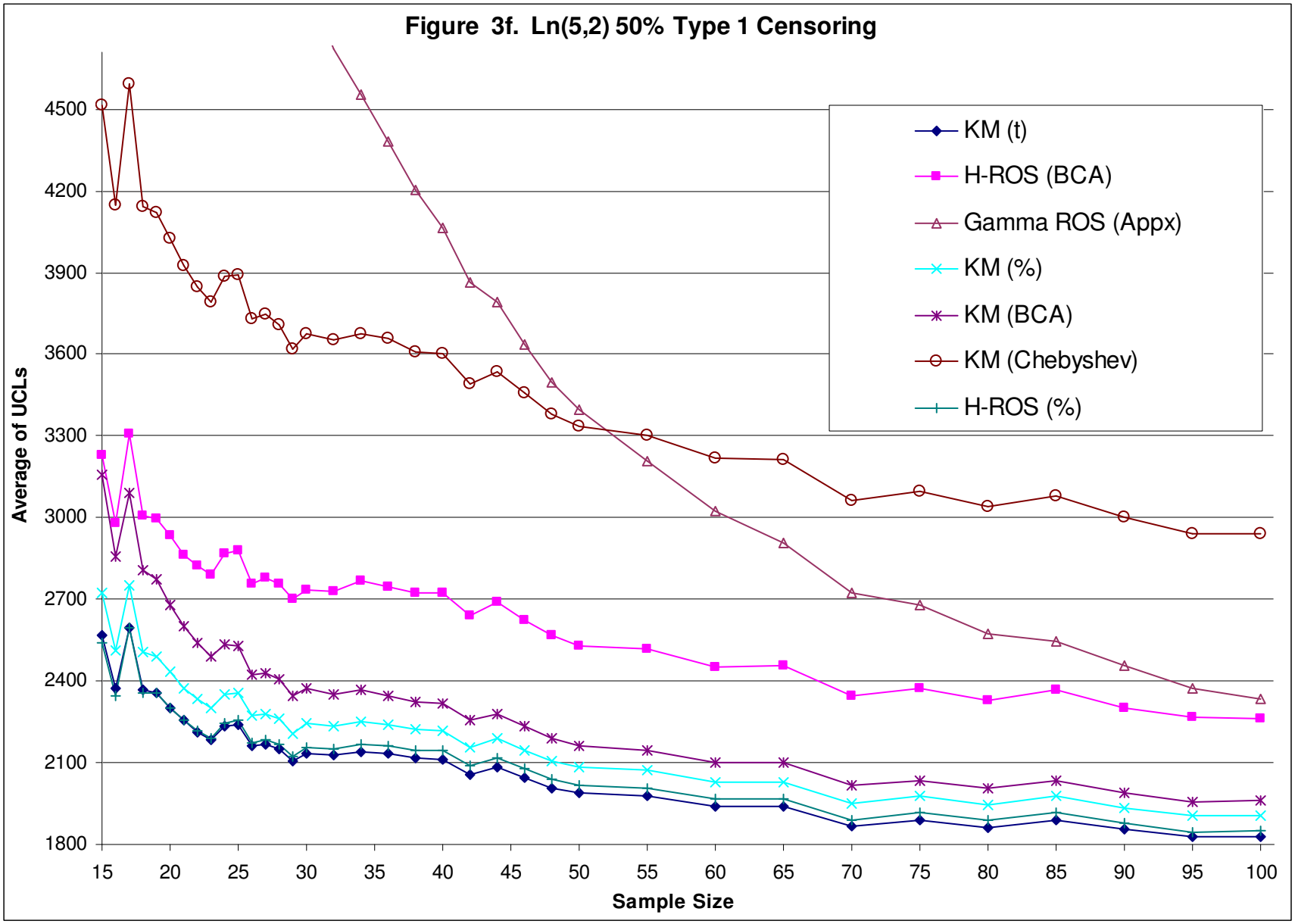
Figure 3f. Ln(5,2) 50% Type 1 Censoring
Average of UCLs
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

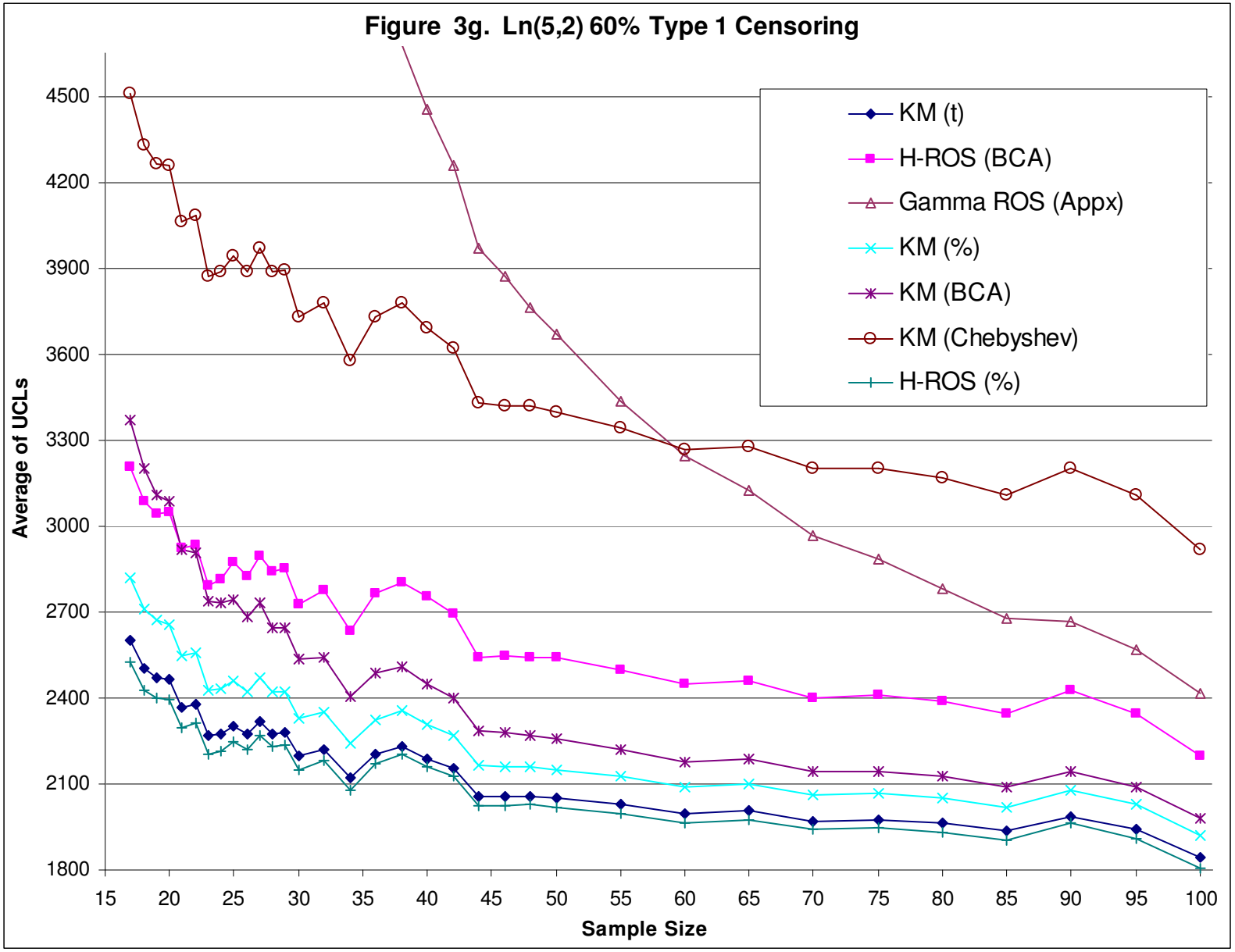
Figure 3g. Ln(5,2) 60% Type 1 Censoring
Average of UCLs
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

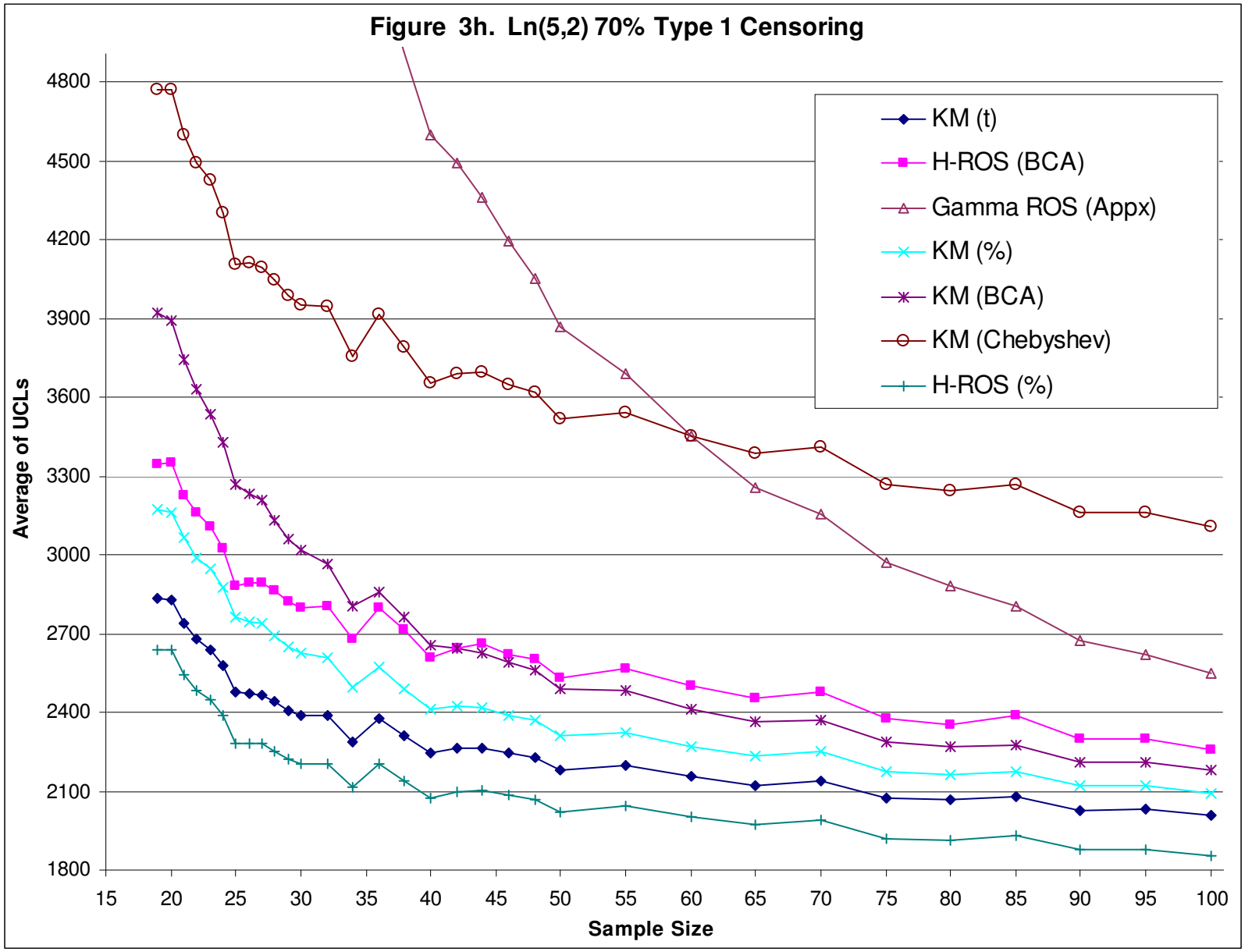
Figure 3h. Ln(5,2) 70% Type 1 Censoring
Average of UCLs
4800
4500
4200
3900
3600
3300
3000
2700
2400
2100
1800
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
H-ROS (BCA)
Gamma ROS (Appx)
KM (%)
KM (BCA)
KM (Chebyshev)
H-ROS (%)

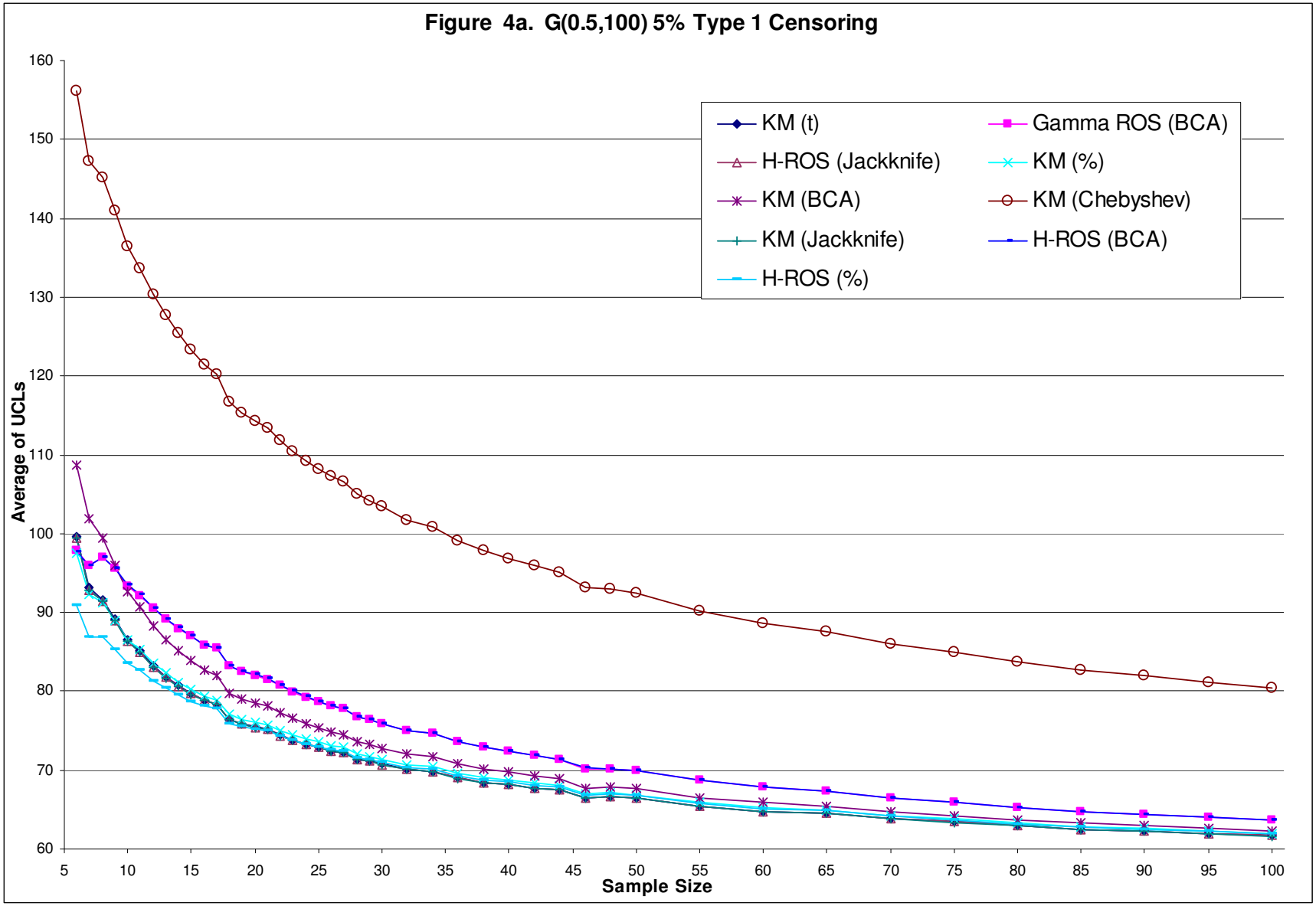
Figure 4a. G(0.5,100) 5% Type 1 Censoring
Average of UCLs
Sample Size
160
150
140
130
120
110
100
90
80
70
60
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

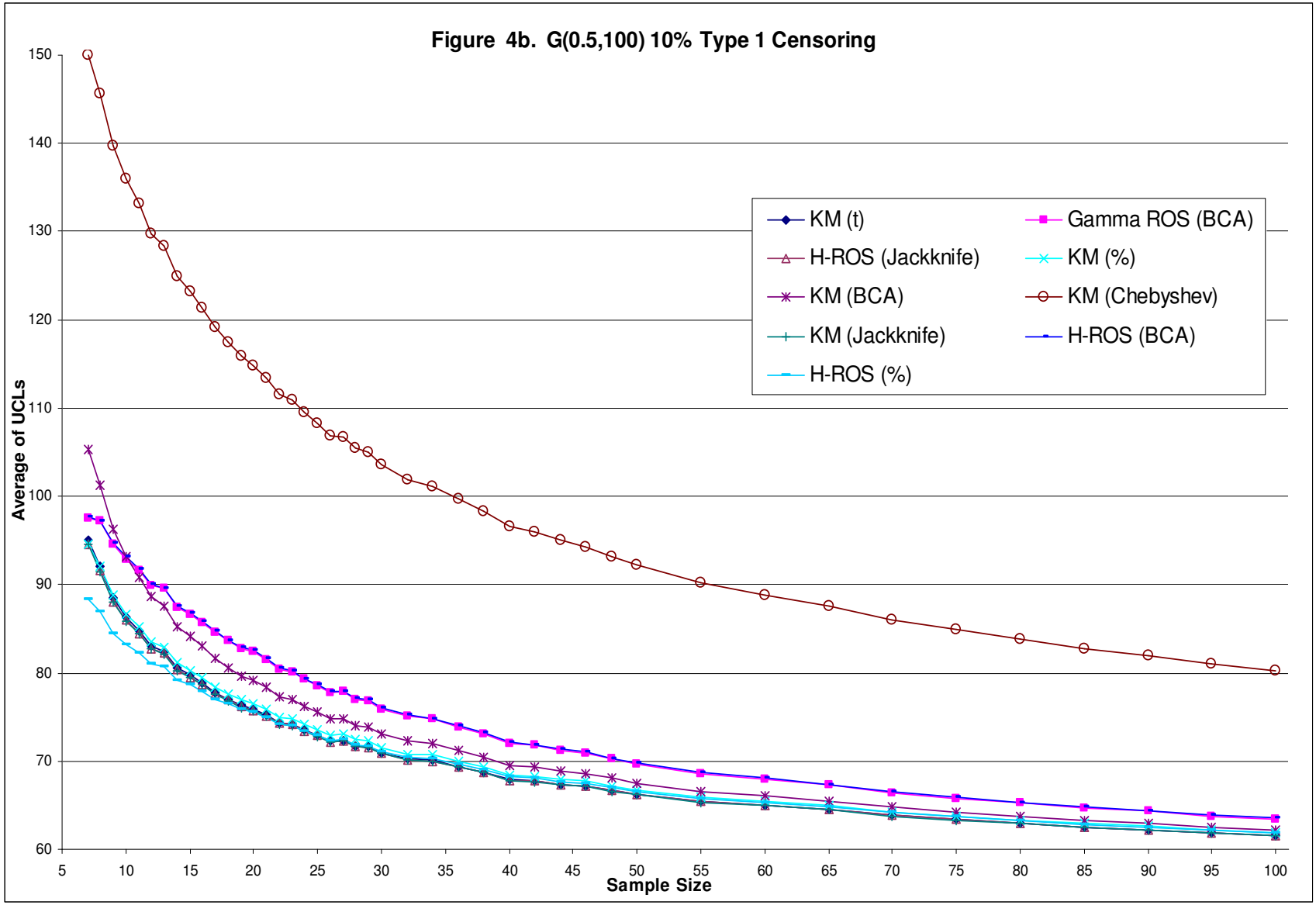
Figure 4b. G(0.5,100) 10% Type 1 Censoring
Average of UCLs
Sample Size
150
140
130
120
110
100
90
80
70
60
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

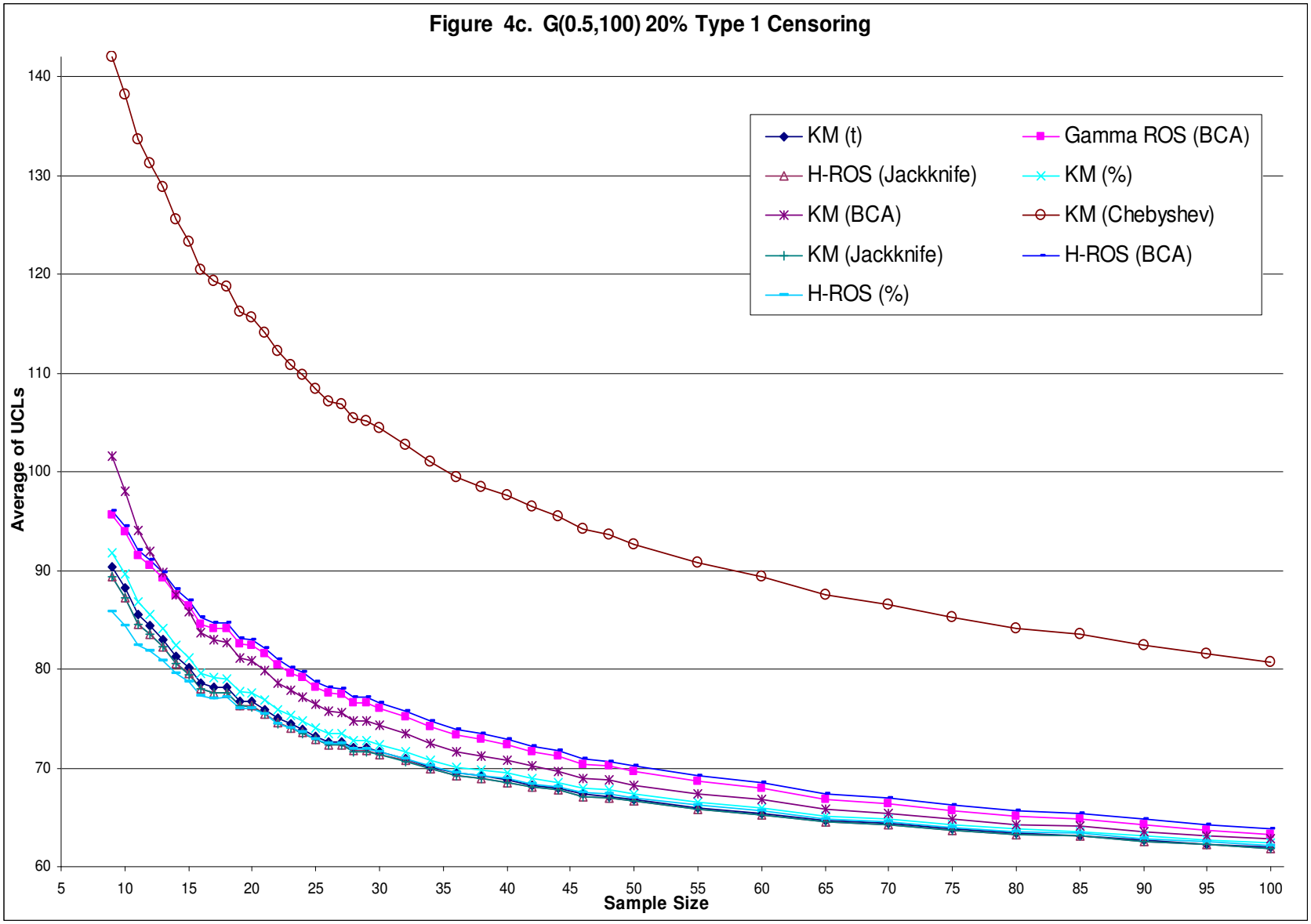
Figure 4c. G(0.5,100) 20% Type 1 Censoring
Average of UCLs
Sample Size
140
130
120
110
100
90
80
70
60
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

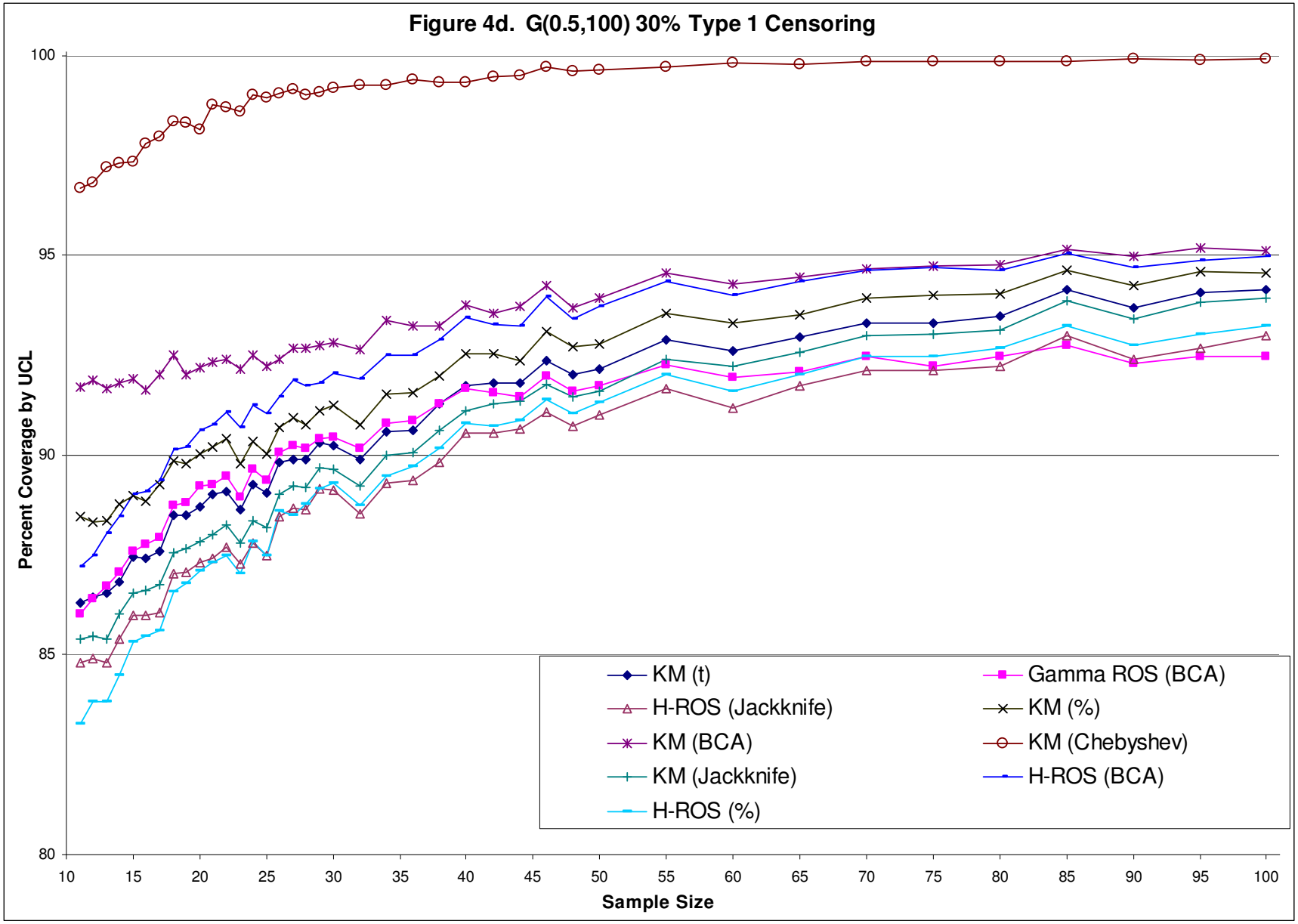
Figure 4d. G(0.5,100) 30% Type 1 Censoring
Percent Coverage by UCL
Sample Size
100
95
90
85
80
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

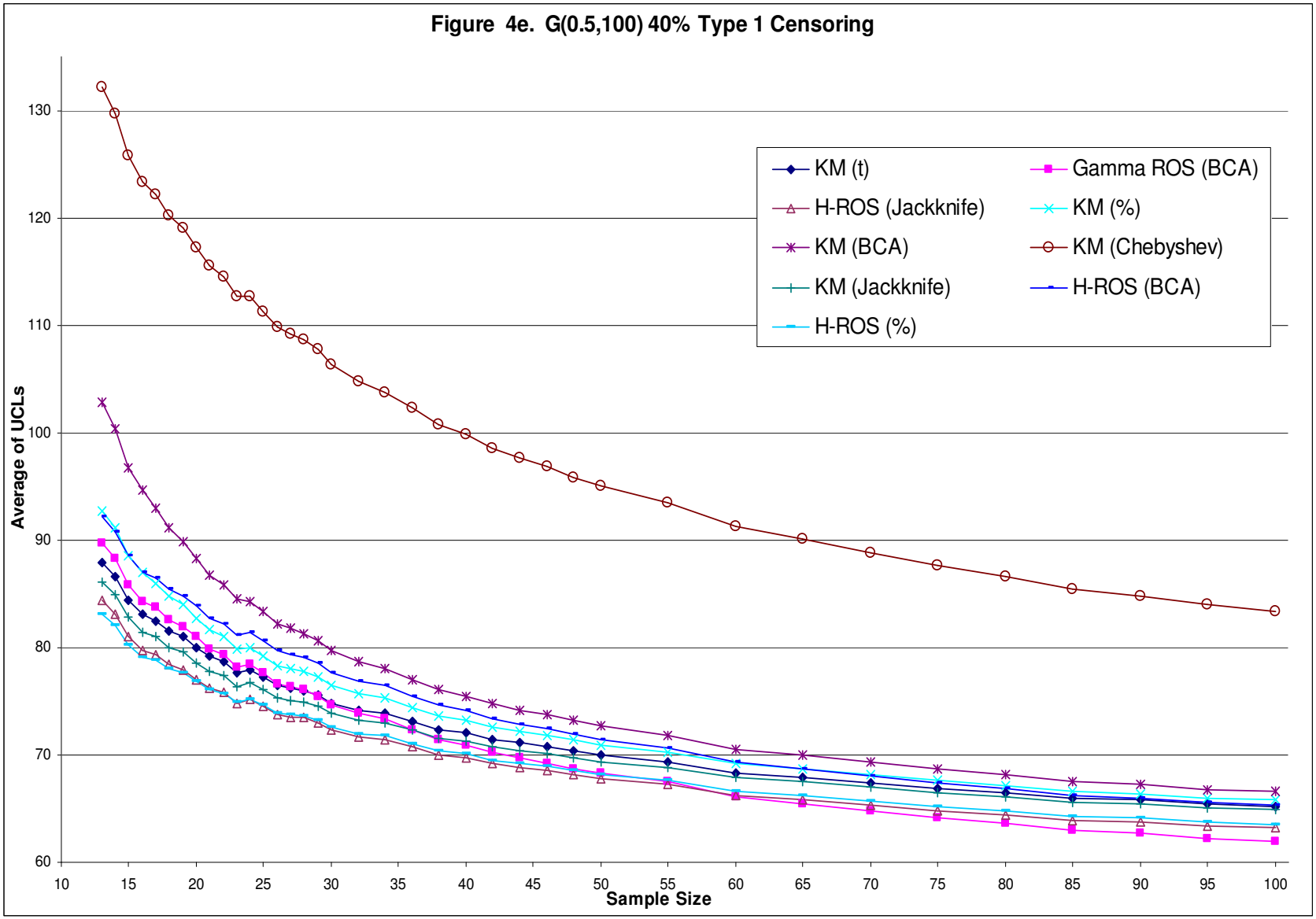
Figure 4e. G(0.5,100) 40% Type 1 Censoring
Average of UCLs
Sample Size
130
120
110
100
90
80
70
60
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

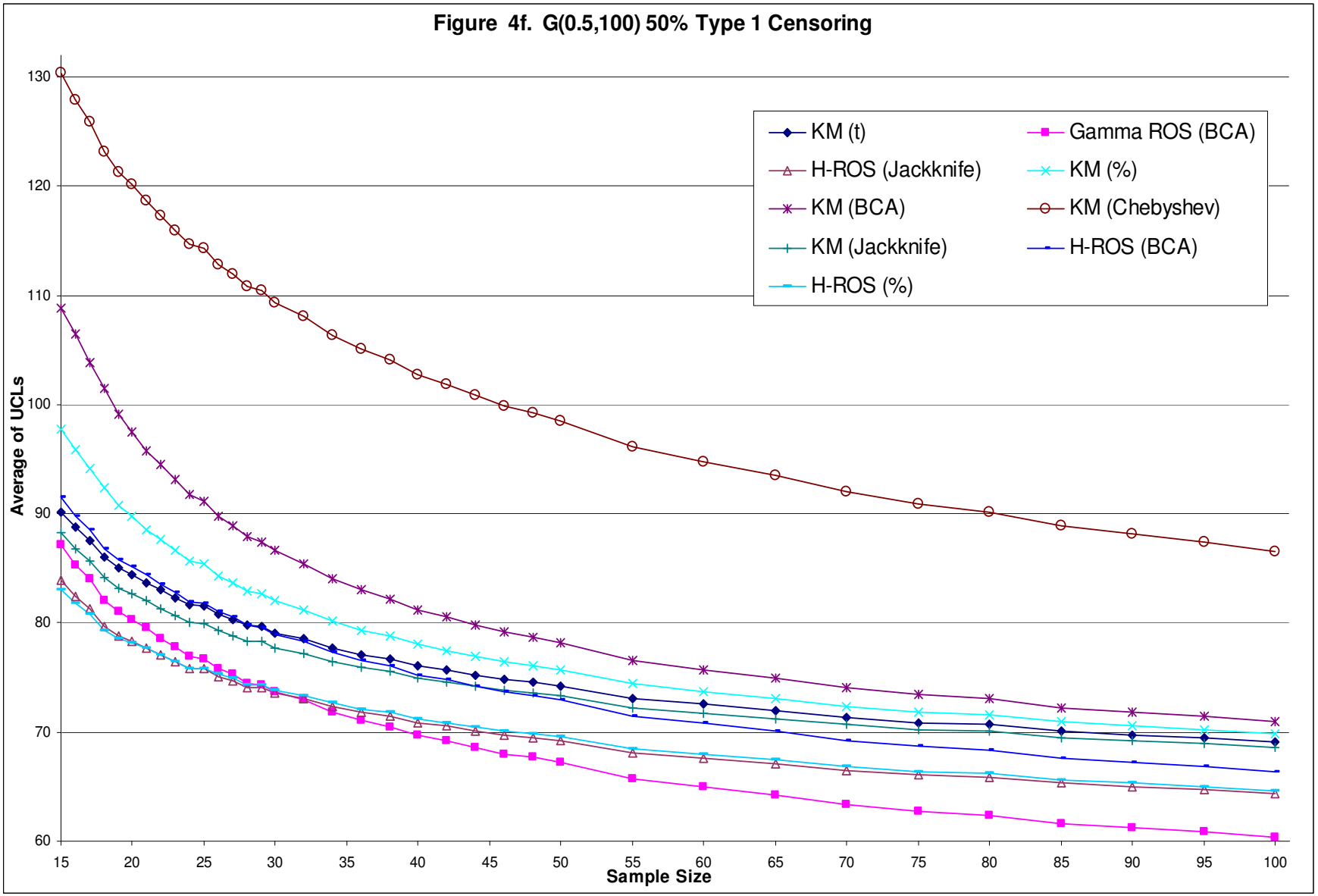
Figure 4f. G(0.5,100) 50% Type 1 Censoring
Average of UCLs
Sample Size
130
120
110
100
90
80
70
60
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

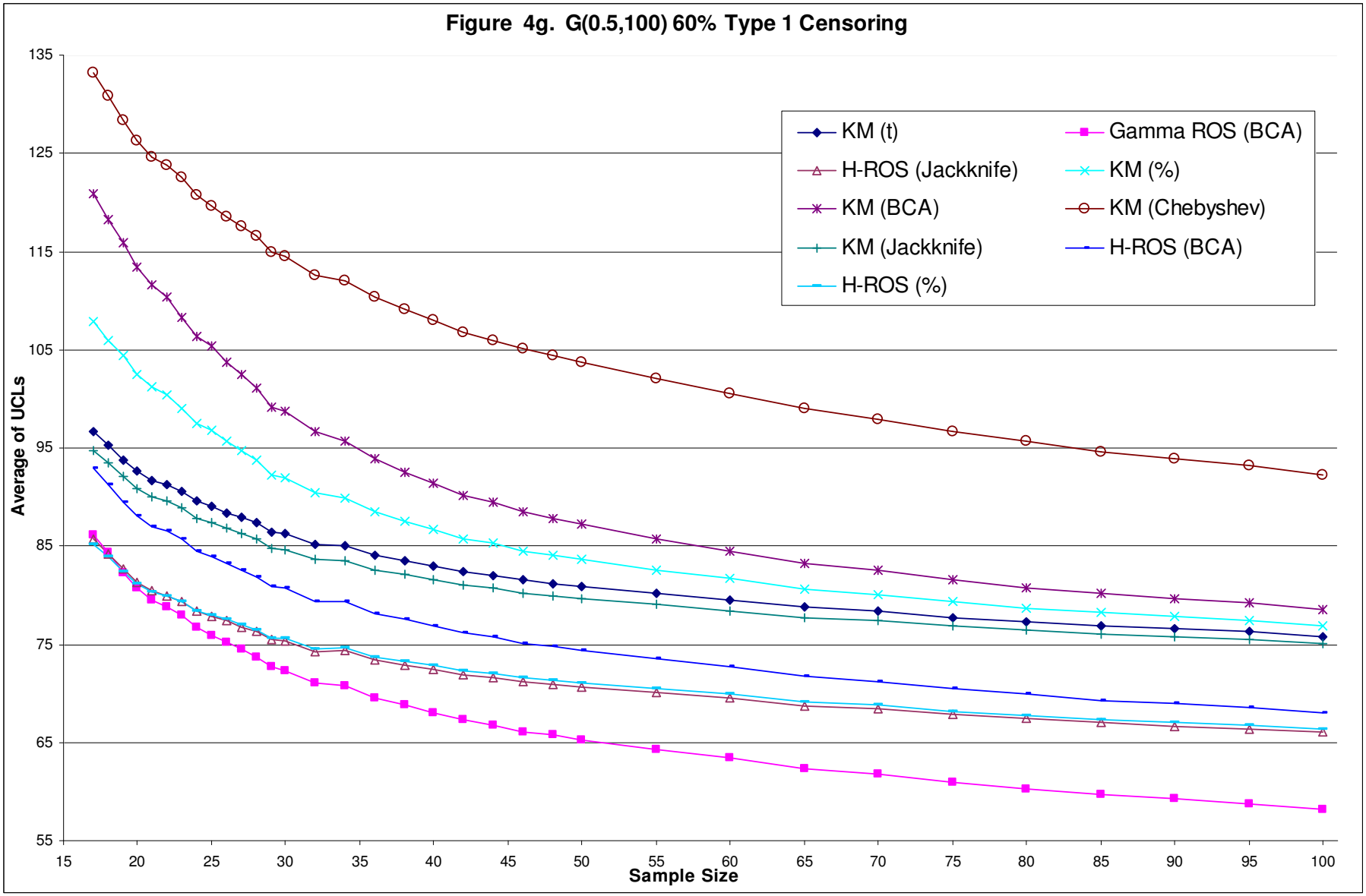
Figure 4g. G(0.5,100) 60% Type 1 Censoring
Average of UCLs
Sample Size
135
125
115
105
95
85
75
65
55
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

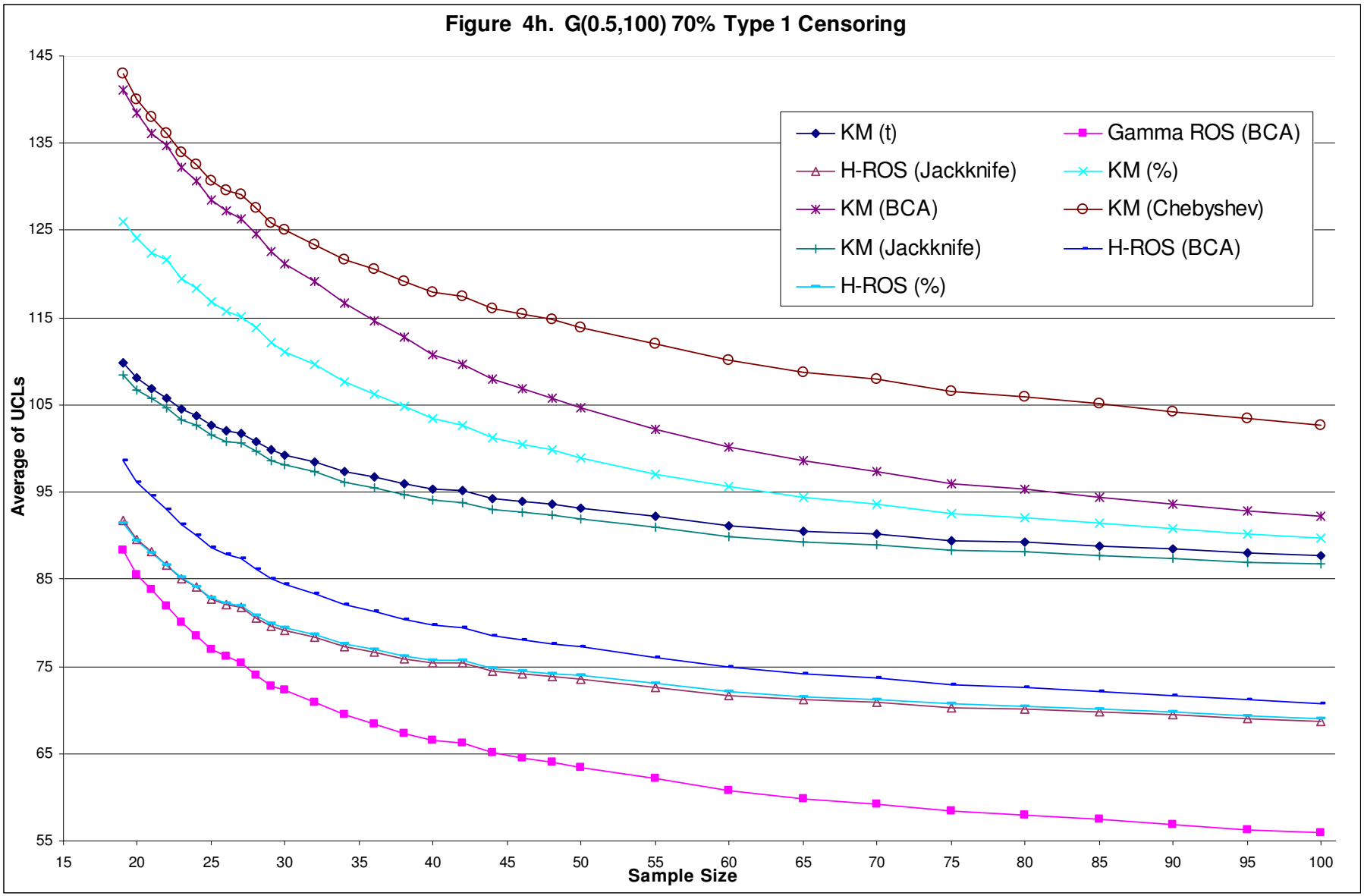
Figure 4h. G(0.5,100) 70% Type 1 Censoring
Average of UCLs
Sample Size
145
135
125
115
105
95
85
75
65
55
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

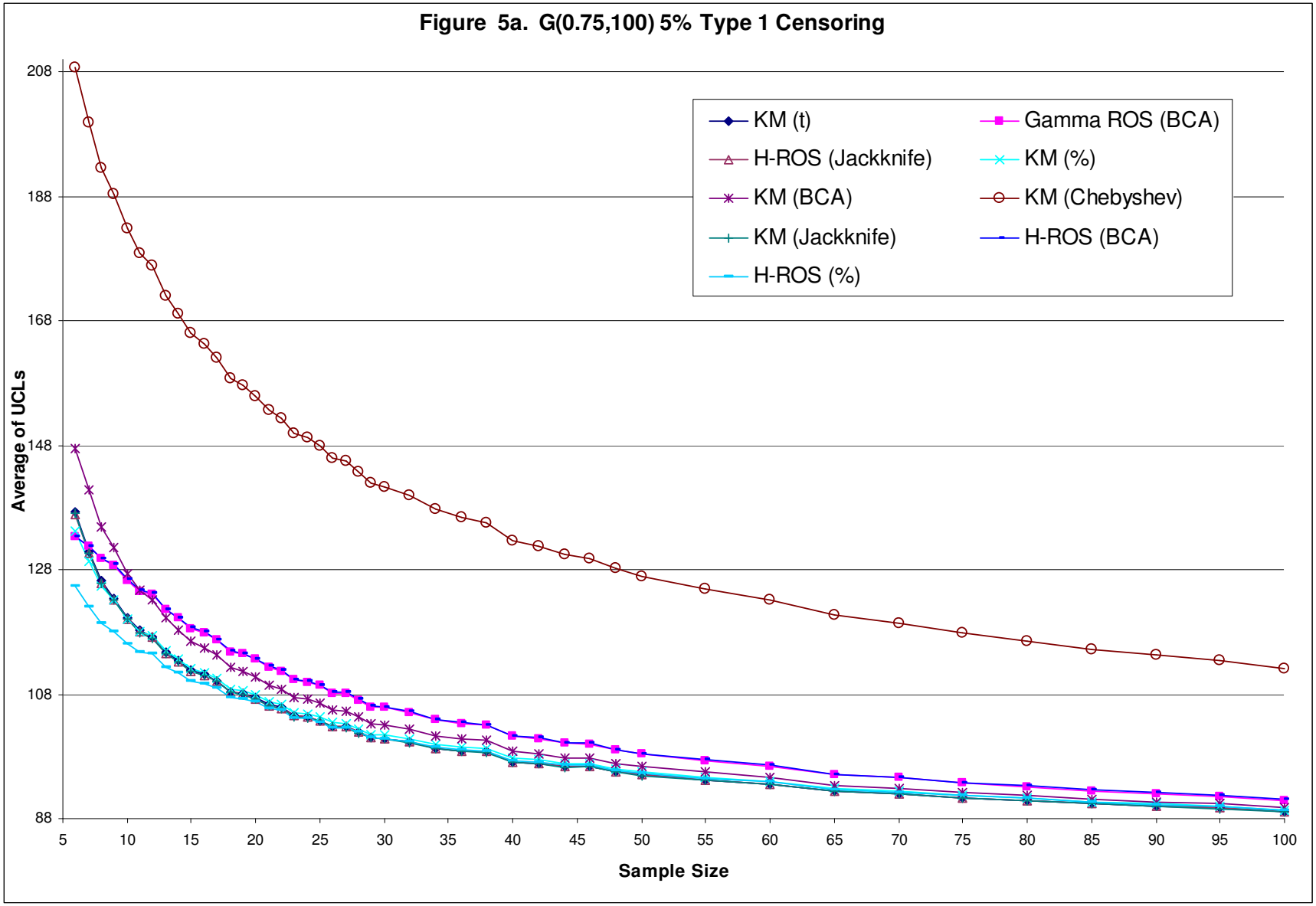
Figure 5a. G(0.75,100) 5% Type 1 Censoring
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)
Average of UCLs
208
188
168
148
128
108
88
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size

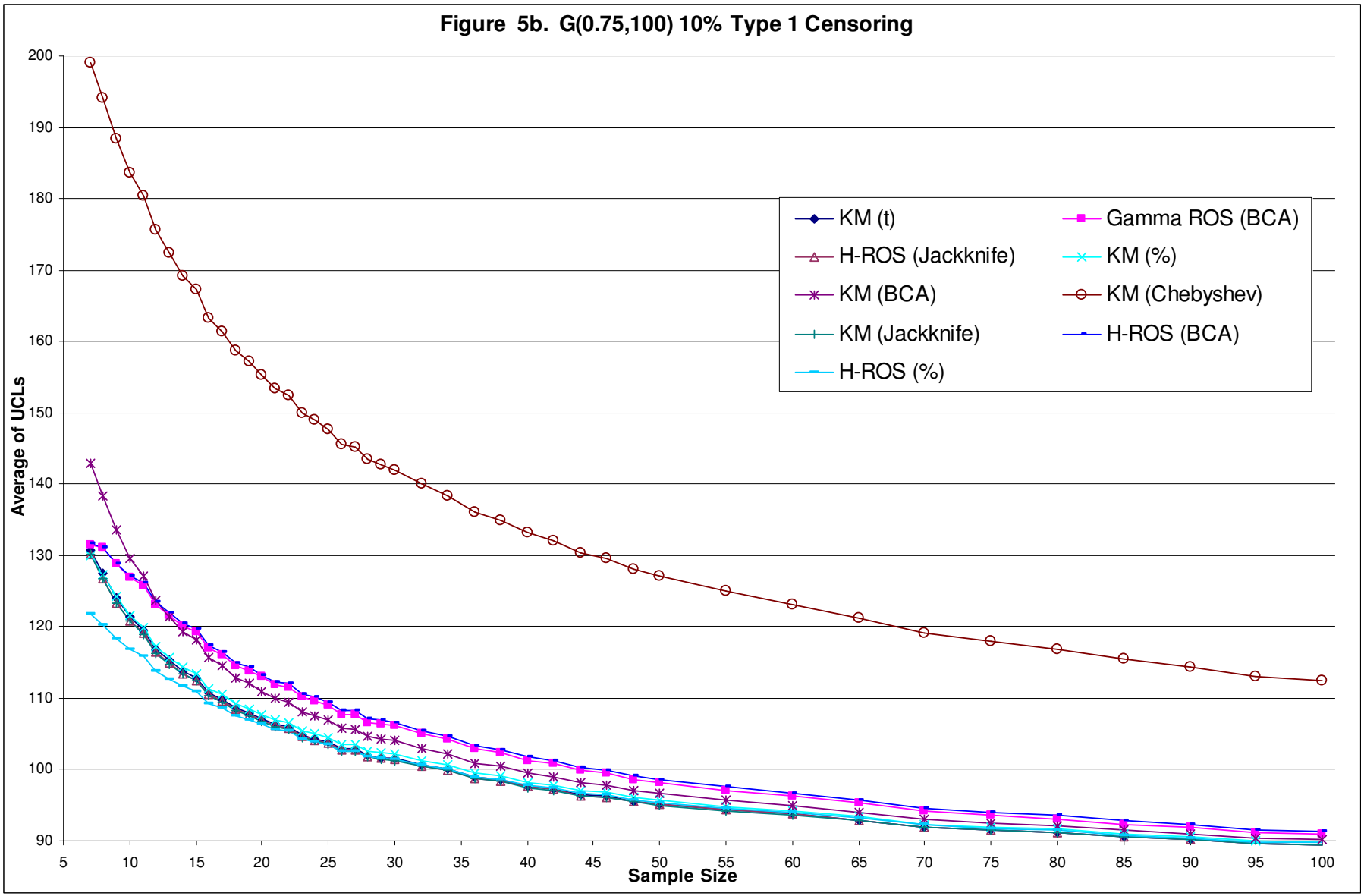
Figure 5b. G(0.75,100) 10% Type 1 Censoring
Average of UCLs
Sample Size
200
190
180
170
160
150
140
130
120
110
100
90
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

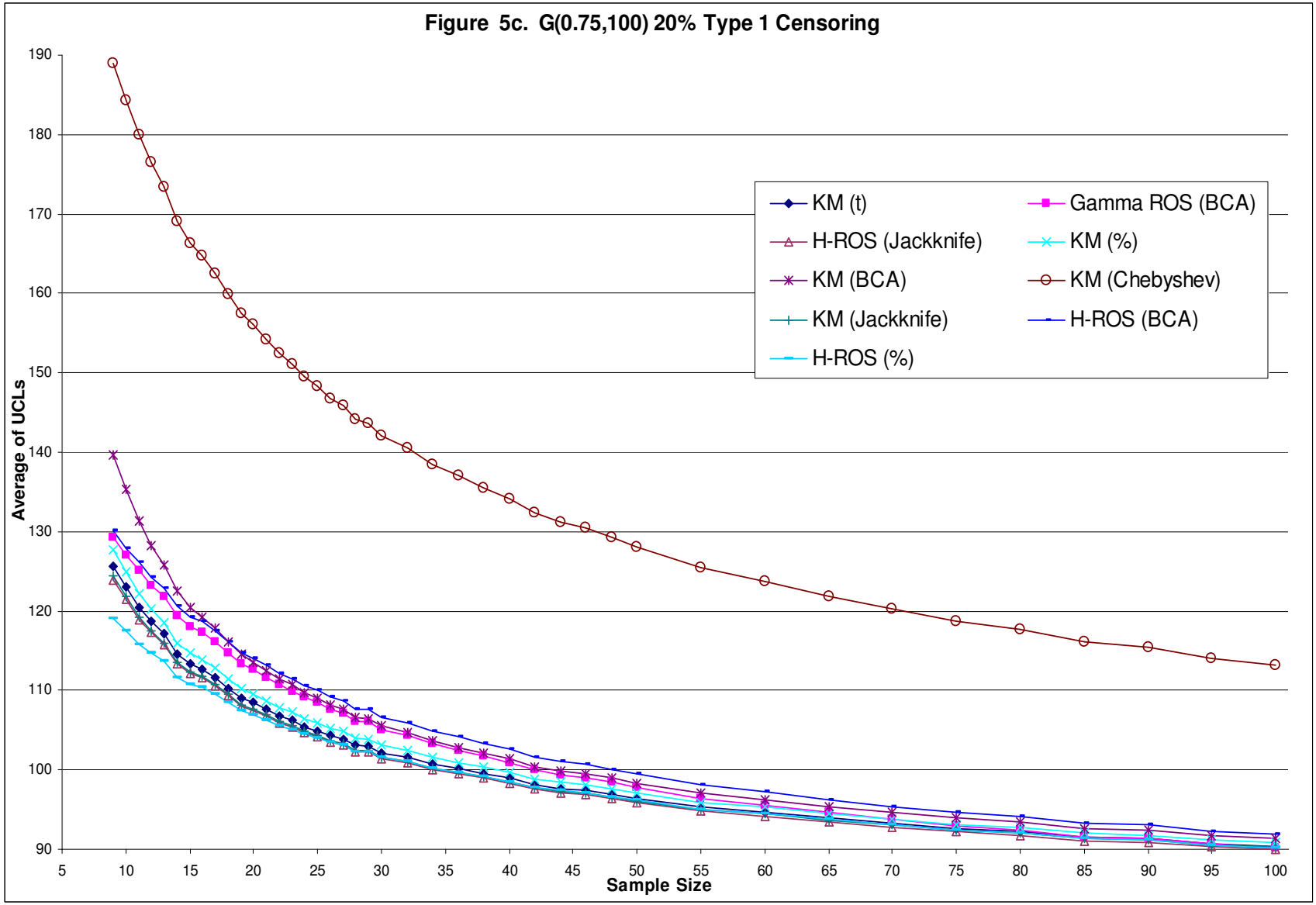
Figure 5c. G(0.75,100) 20% Type 1 Censoring
Average of UCLs
Sample Size
190
180
170
160
150
140
130
120
110
100
90
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

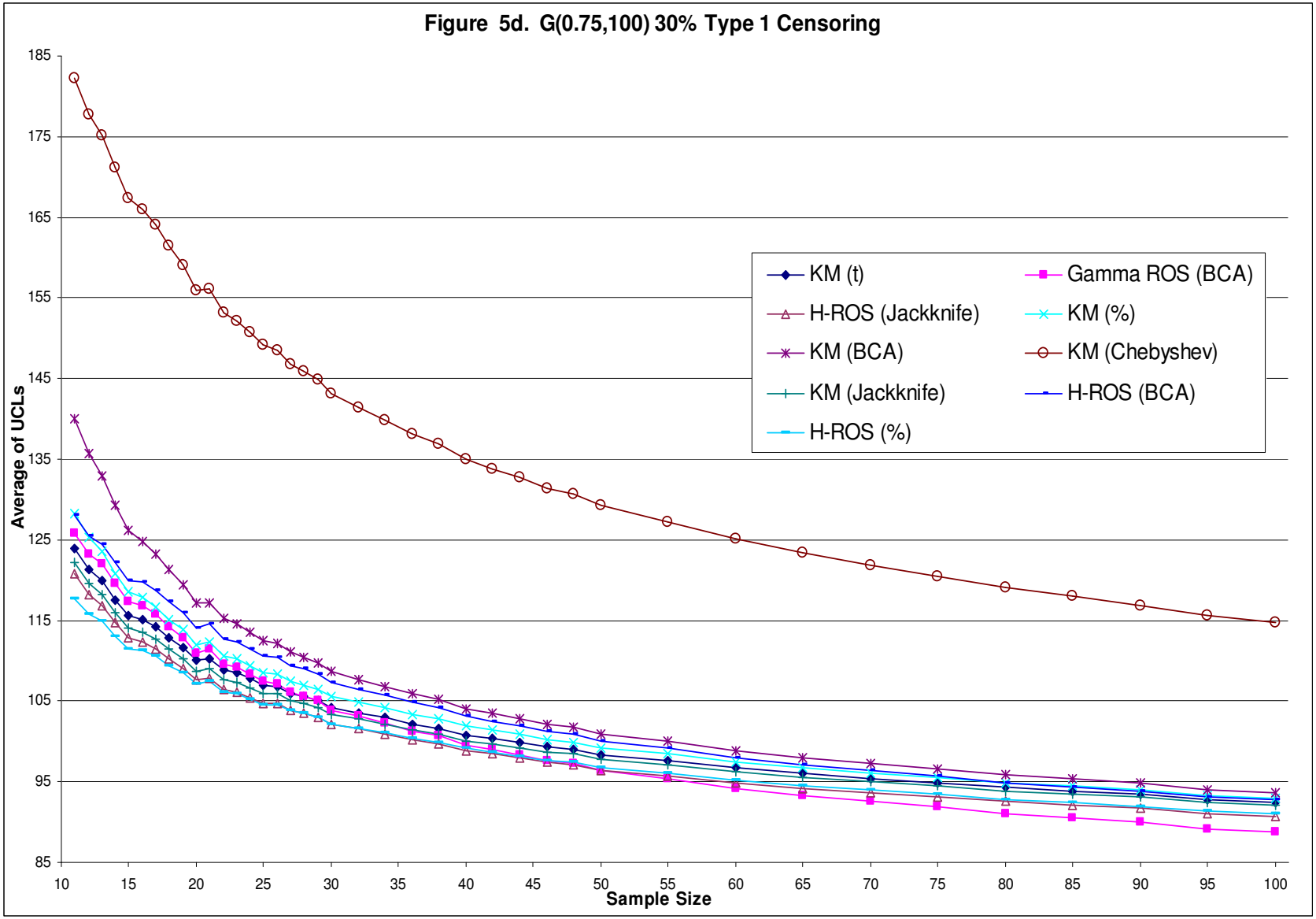
Figure 5d. G(0.75,100) 30% Type 1 Censoring
Average of UCLs
Sample Size
185
175
165
155
145
135
125
115
105
95
85
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

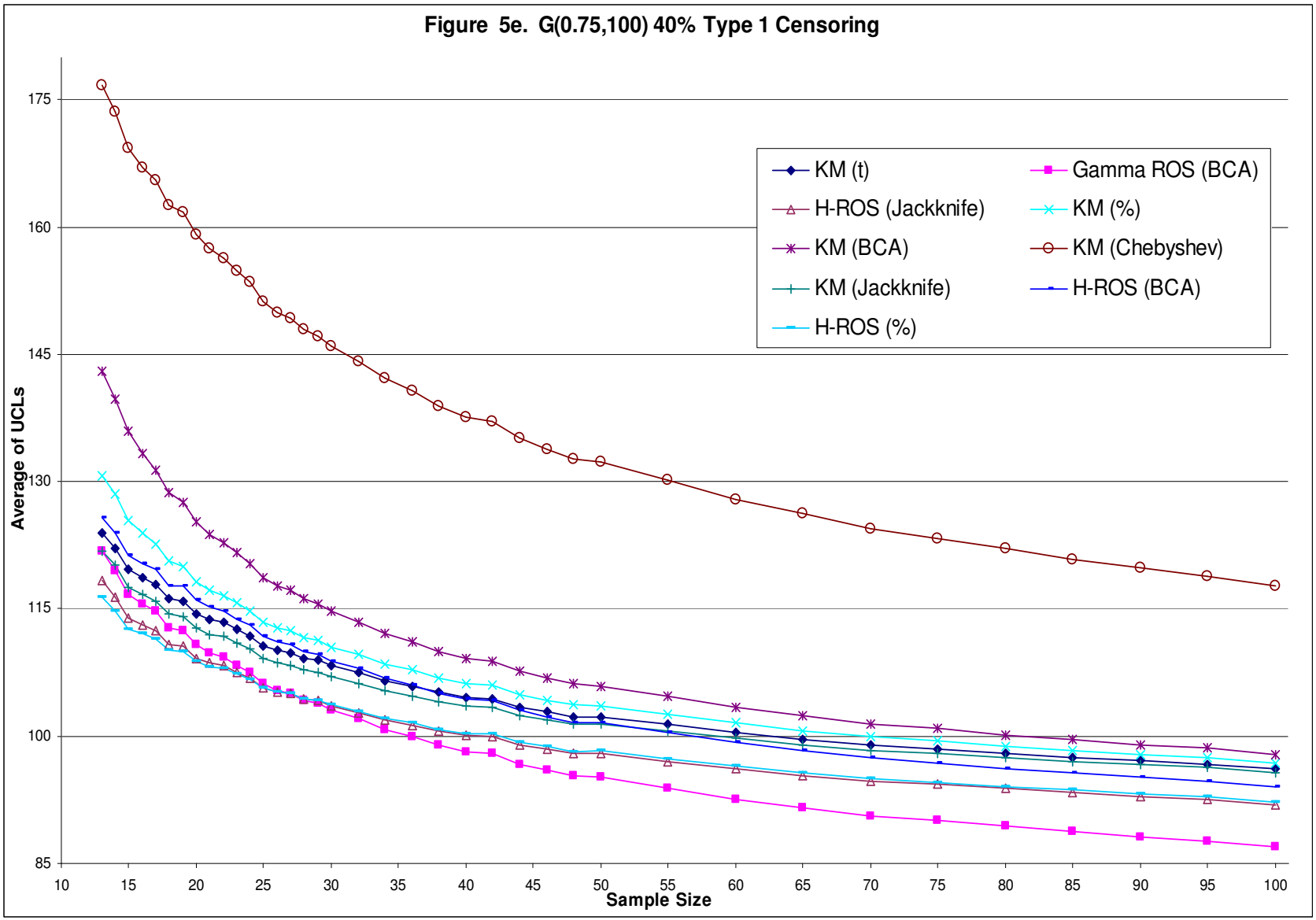
Figure 5e. G(0.75,100) 40% Type 1 Censoring
Average of UCLs
Sample Size
175
160
145
130
115
100
85
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

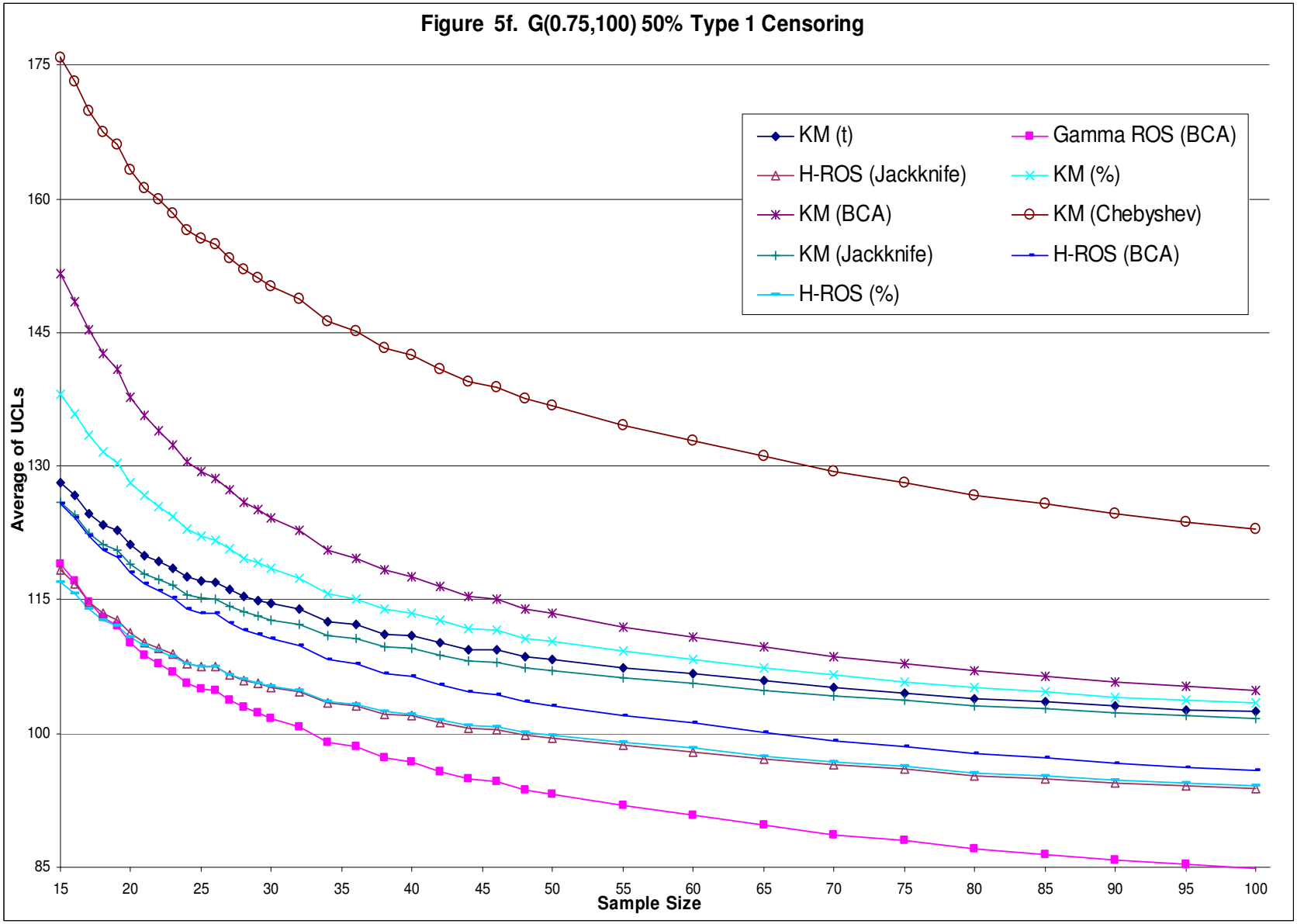
Figure 5f. G(0.75,100) 50% Type 1 Censoring
Average of UCLs
Sample Size
175
160
145
130
115
100
85
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

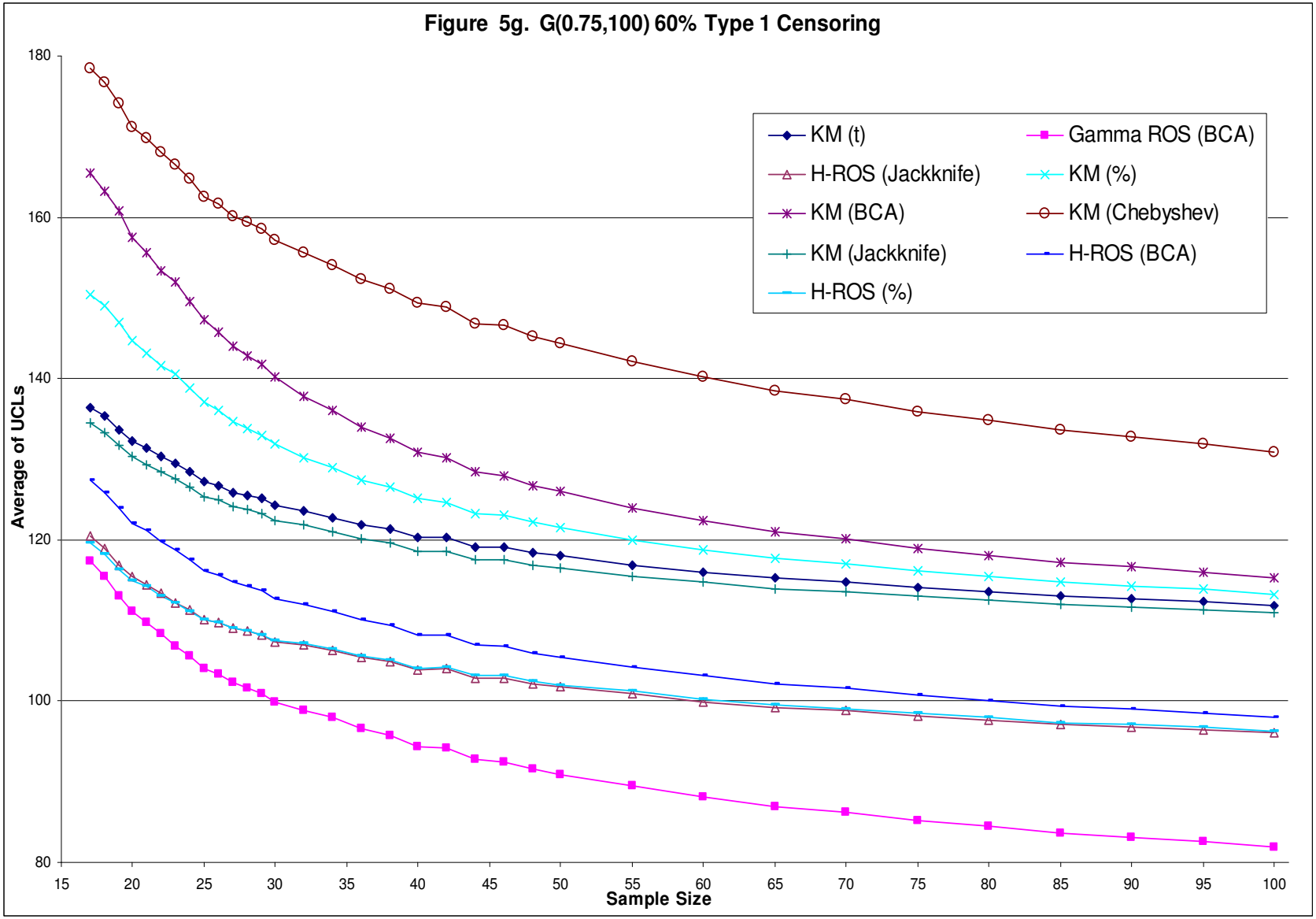
Figure 5g. G(0.75,100) 60% Type 1 Censoring
Average of UCLs
Sample Size
180
160
140
120
100
80
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

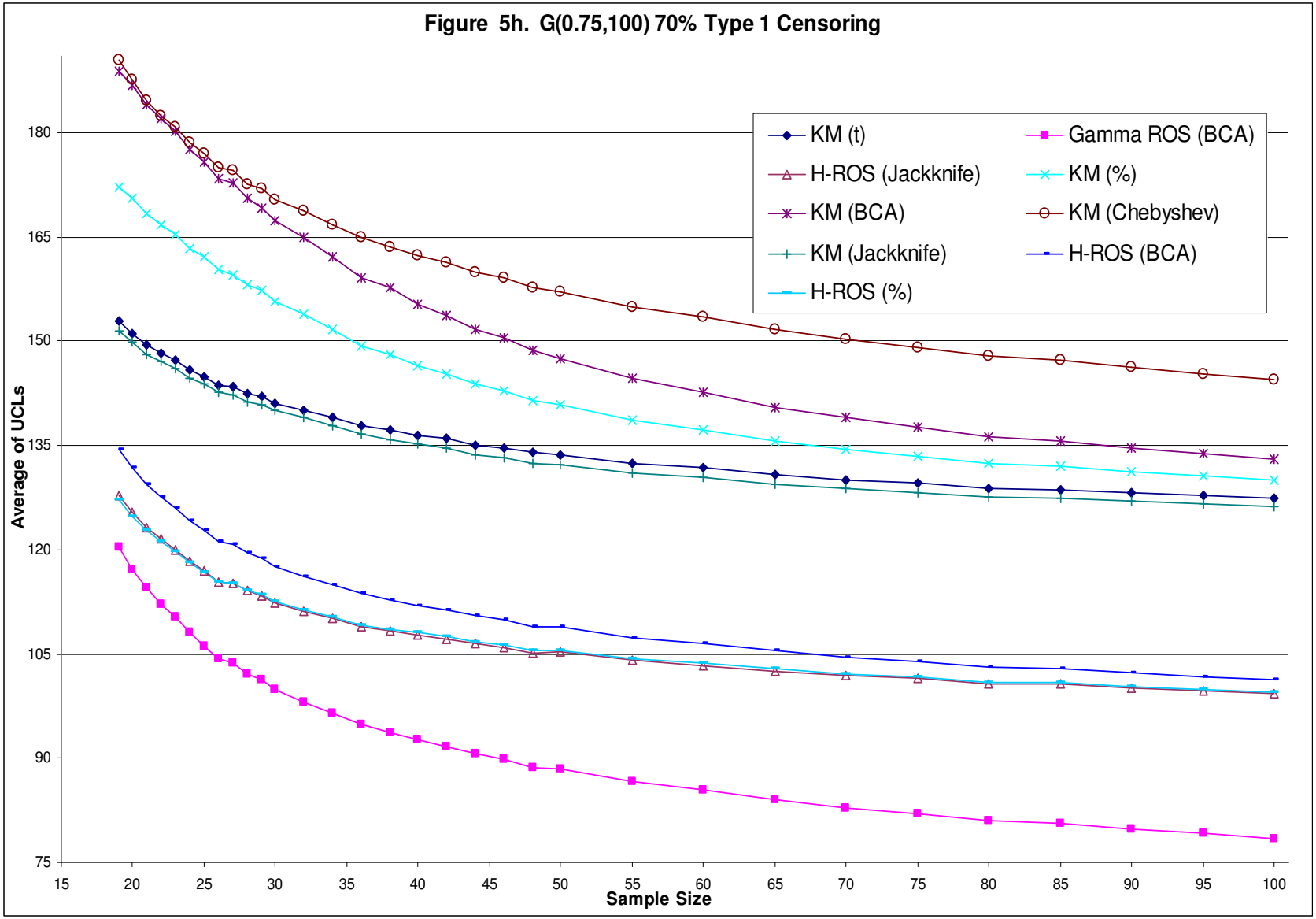
Figure 5h. G(0.75,100) 70% Type 1 Censoring
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)
Average of UCLs
Sample Size
180
165
150
135
120
105
90
75
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

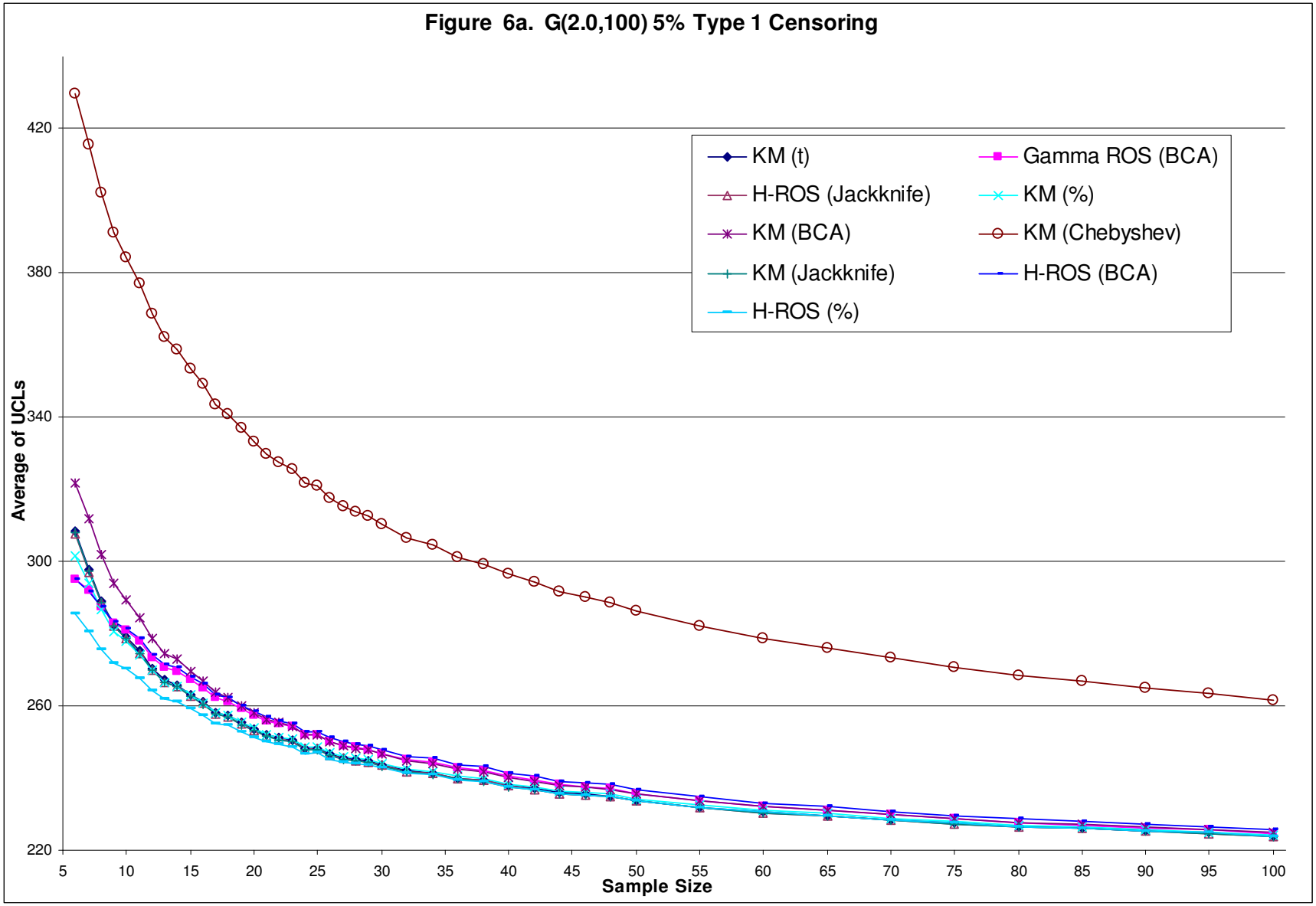
Figure 6a. G(2.0,100) 5% Type 1 Censoring
Average of UCLs
Sample Size
420
380
340
300
260
220
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

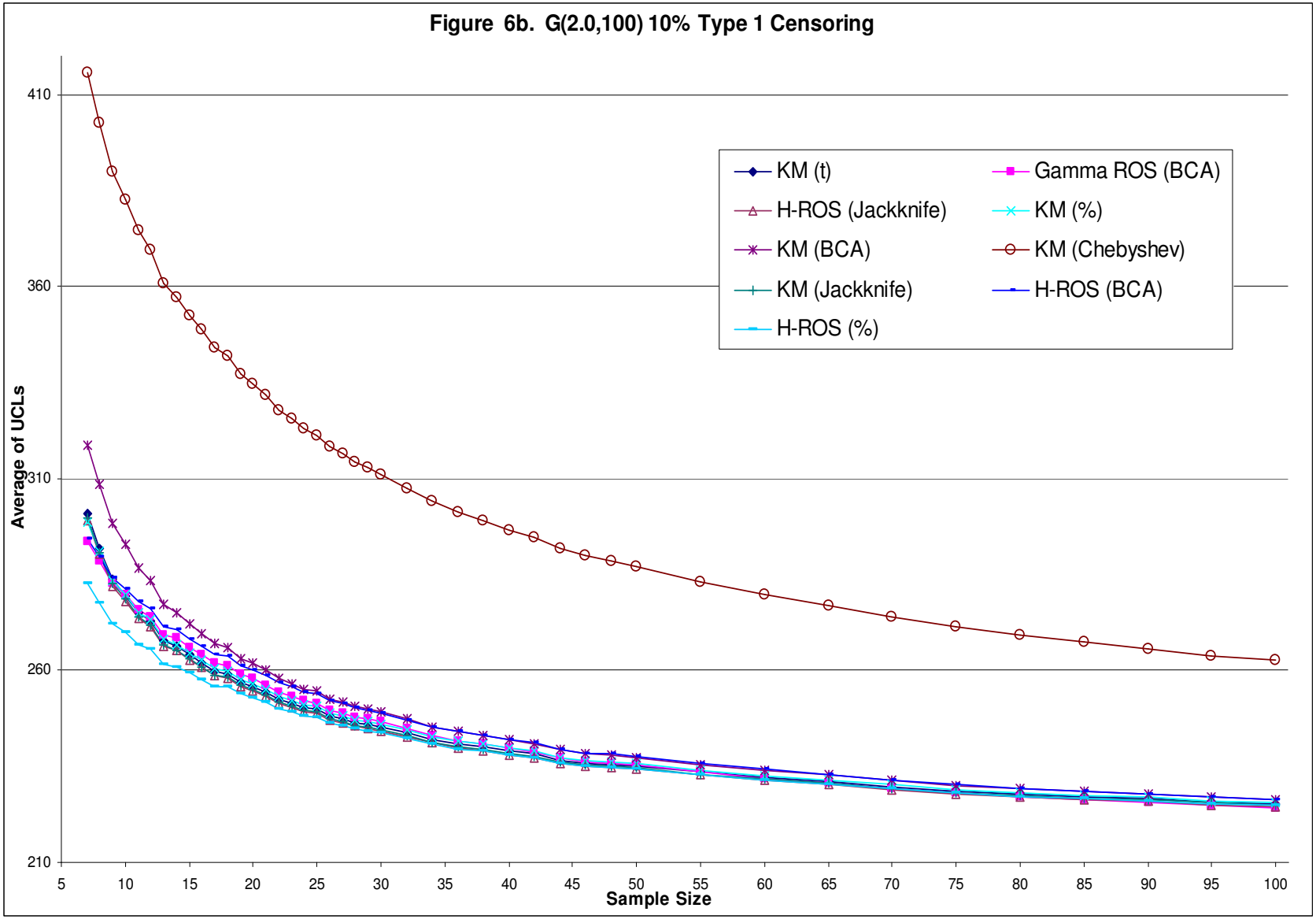
Figure 6b. G(2.0,100) 10% Type 1 Censoring
Average of UCLs
410
360
310
260
210
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Sample Size
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

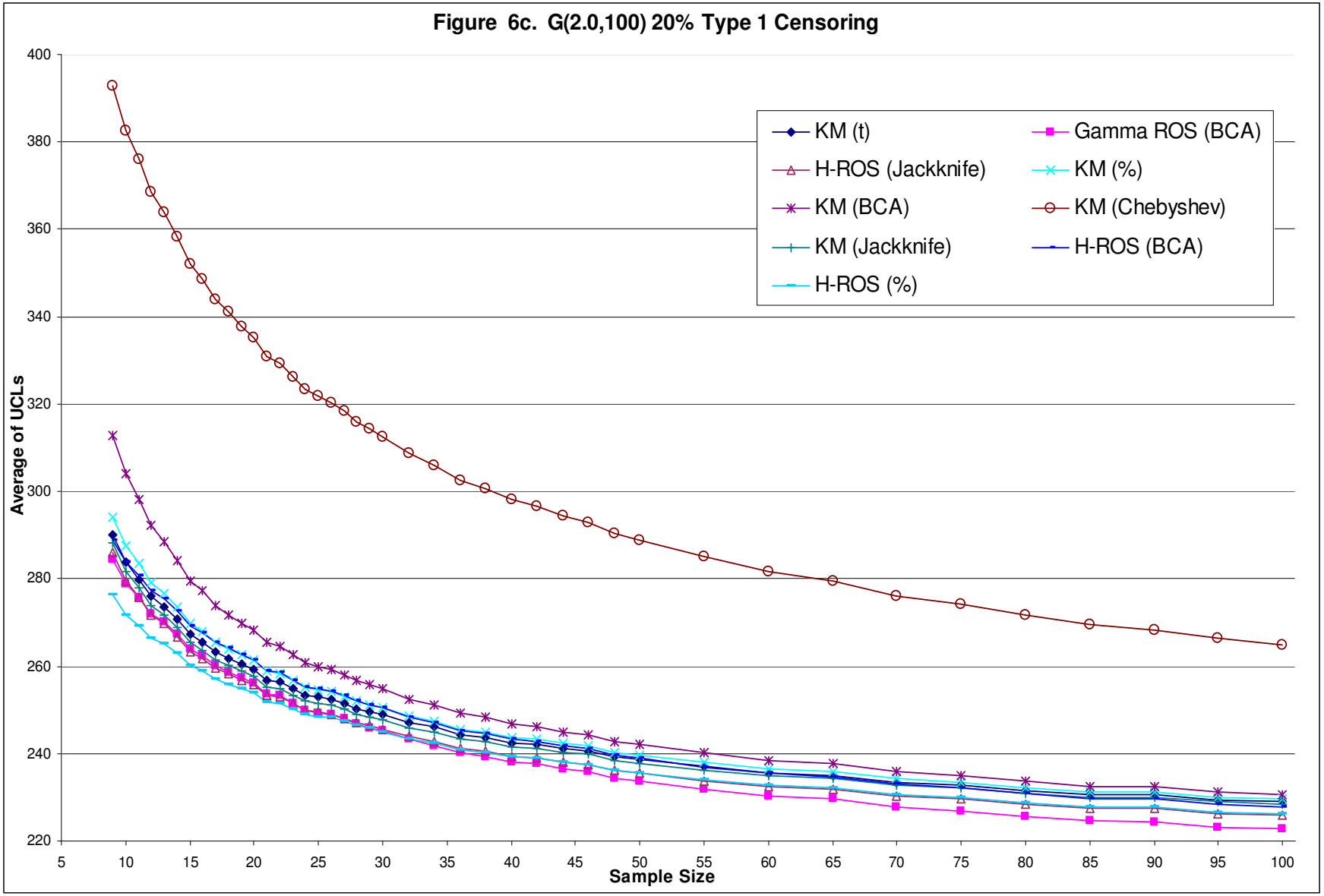
Figure 6c. G(2.0,100) 20% Type 1 Censoring
Average of UCLs
Sample Size
400
380
360
340
320
300
280
260
240
220
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

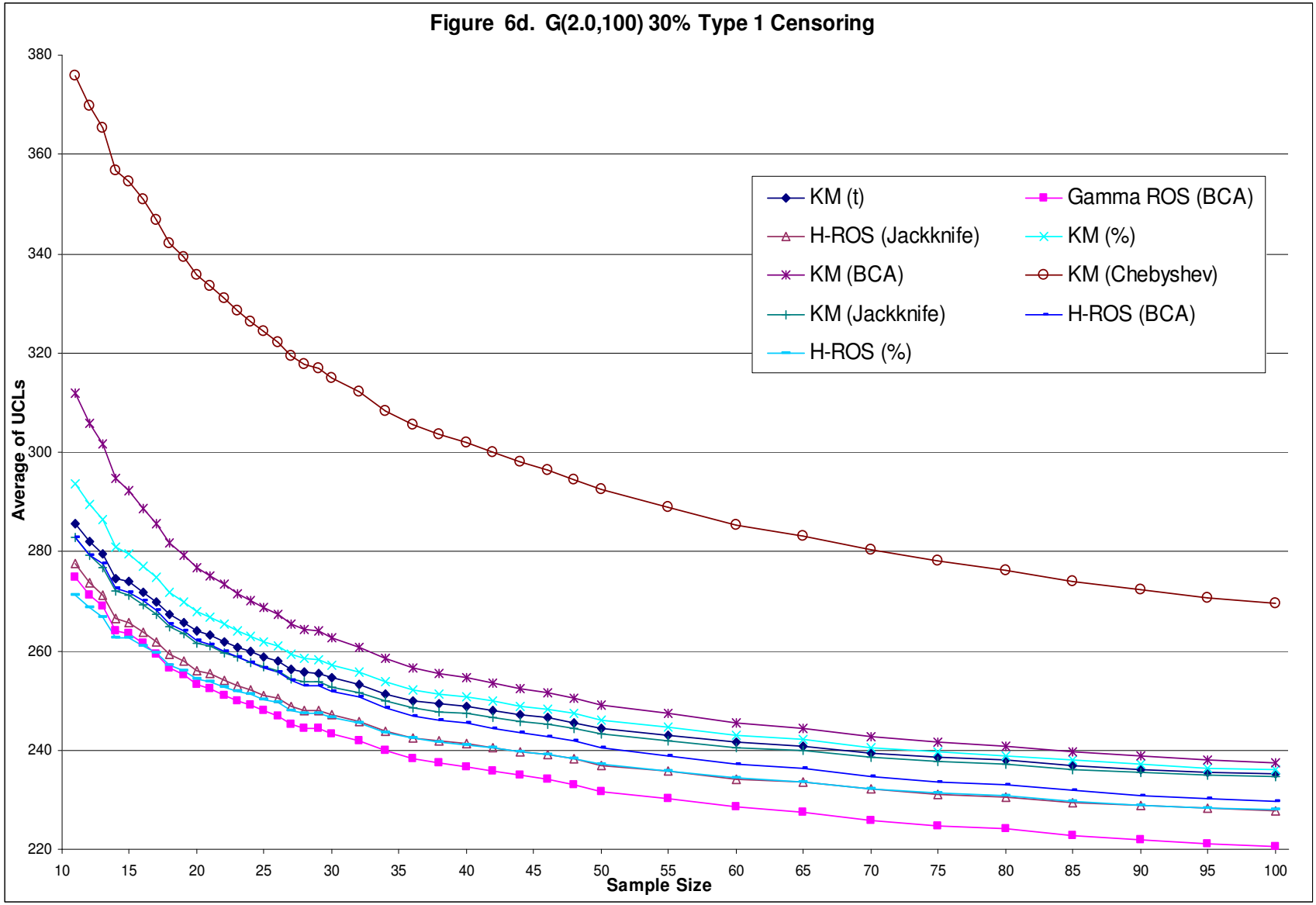
Figure 6d. G(2.0,100) 30% Type 1 Censoring
Average of UCLs
Sample Size
380
360
340
320
300
280
260
240
220
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

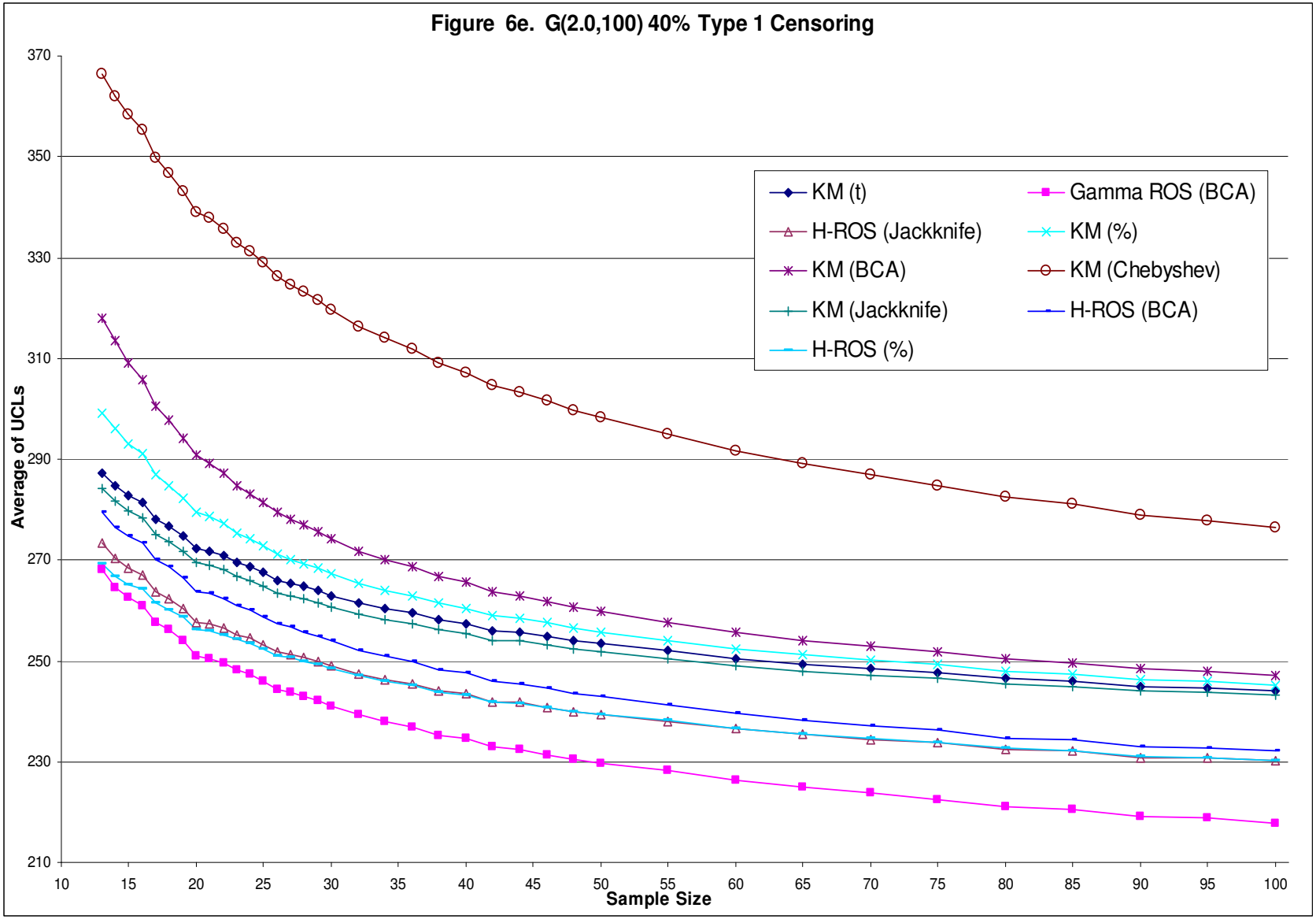
Figure 6e. G(2.0,100) 40% Type 1 Censoring
Average of UCLs
Sample Size
370
350
330
310
290
270
250
230
210
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

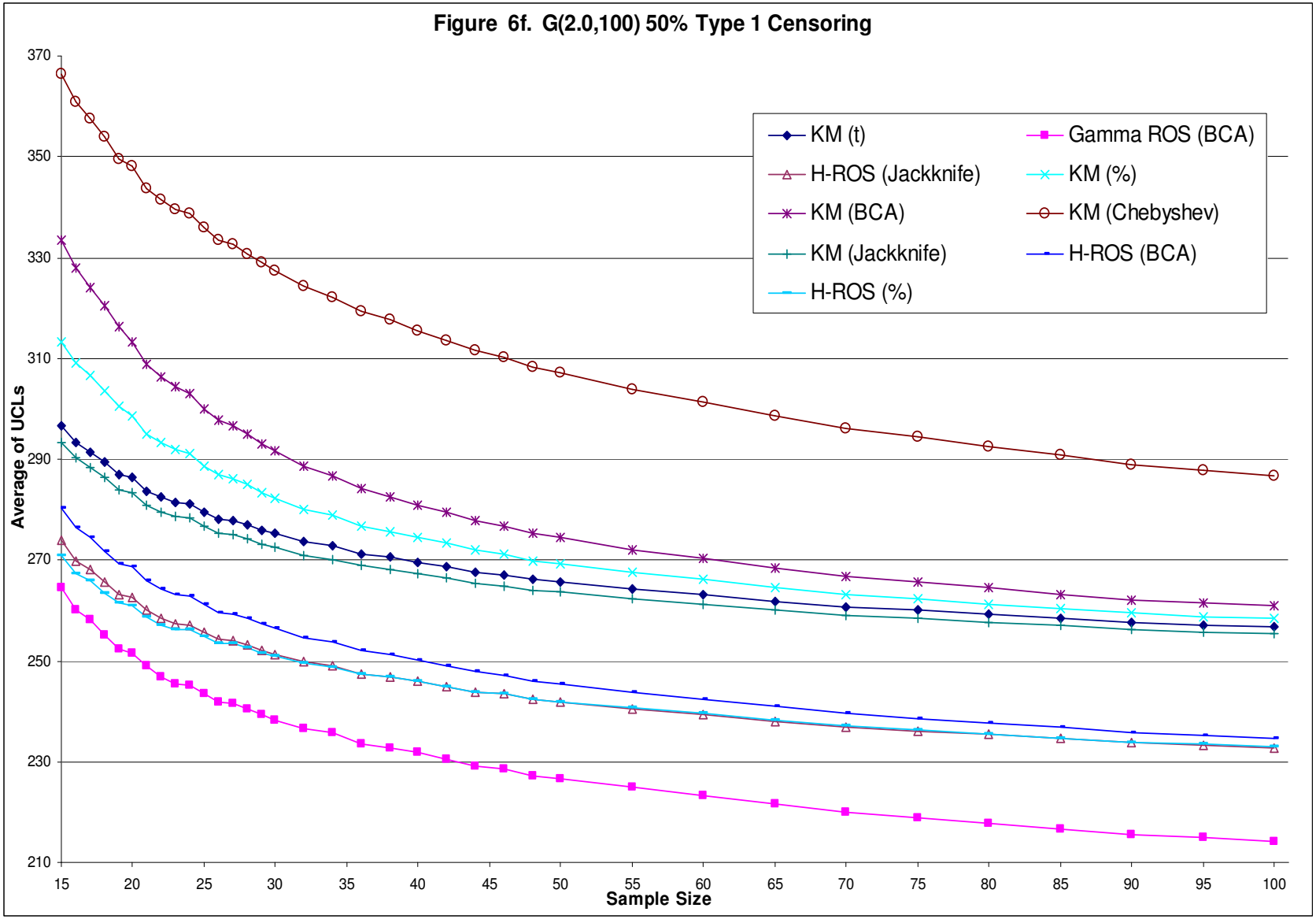
Figure 6f. G(2.0,100) 50% Type 1 Censoring
Average of UCLs
Sample Size
370
350
330
310
290
270
250
230
210
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

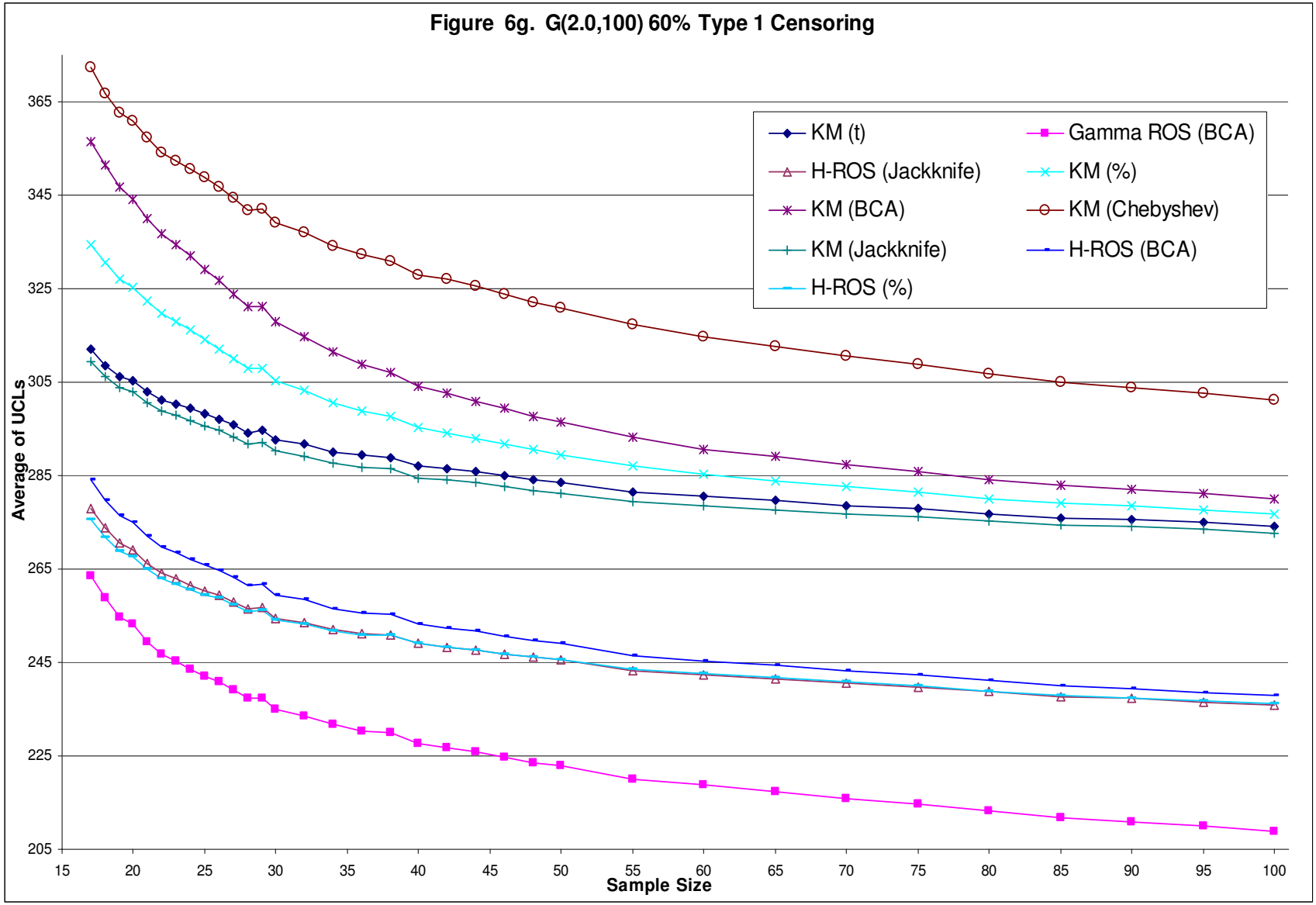
Figure 6g. G(2.0,100) 60% Type 1 Censoring
Average of UCLs
Sample Size
365
345
325
305
285
265
245
225
205
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)

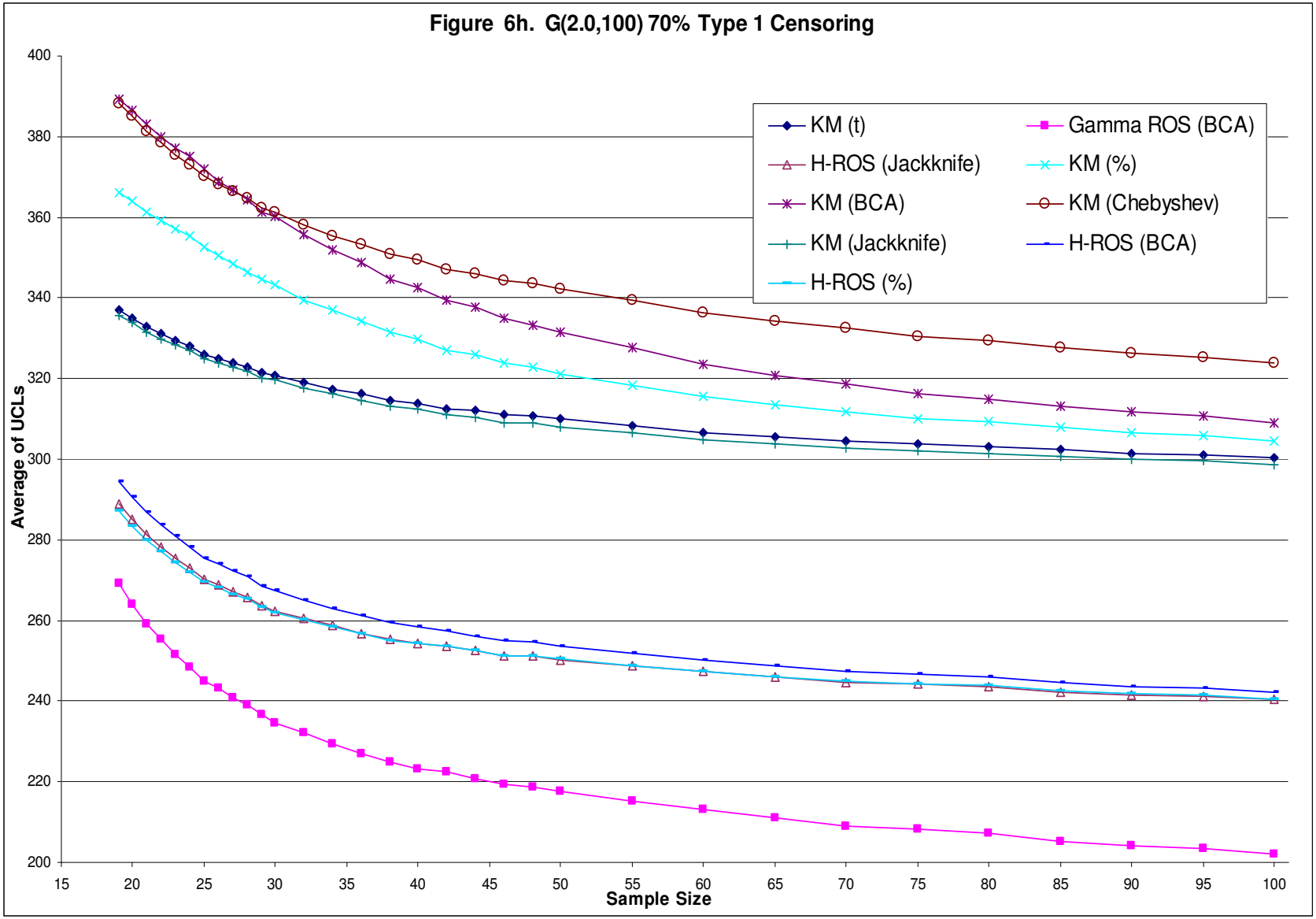
Figure 6h. G(2.0,100) 70% Type 1 Censoring
Average of UCLs
Sample Size
400
380
360
340
320
300
280
260
240
220
200
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
KM (t)
Gamma ROS (BCA)
H-ROS (Jackknife)
KM (%)
KM (BCA)
KM (Chebyshev)
KM (Jackknife)
H-ROS (BCA)
H-ROS (%)