CHAPTER SEVEN

PERFORMANCE OF METHODS IN LARGE SAMPLES

This chapter considers imbalance in the three methods for large samples, namely, samples of size 200, 400, 600, 800 and 1000.

7.1 Sample of Size 200:

In this section, imbalance of simulation data for three methods with sample size 200 is shown and discussed. Table (73) below represented as example from appendix A to show the imbalance data for three methods for the 1st single layer.

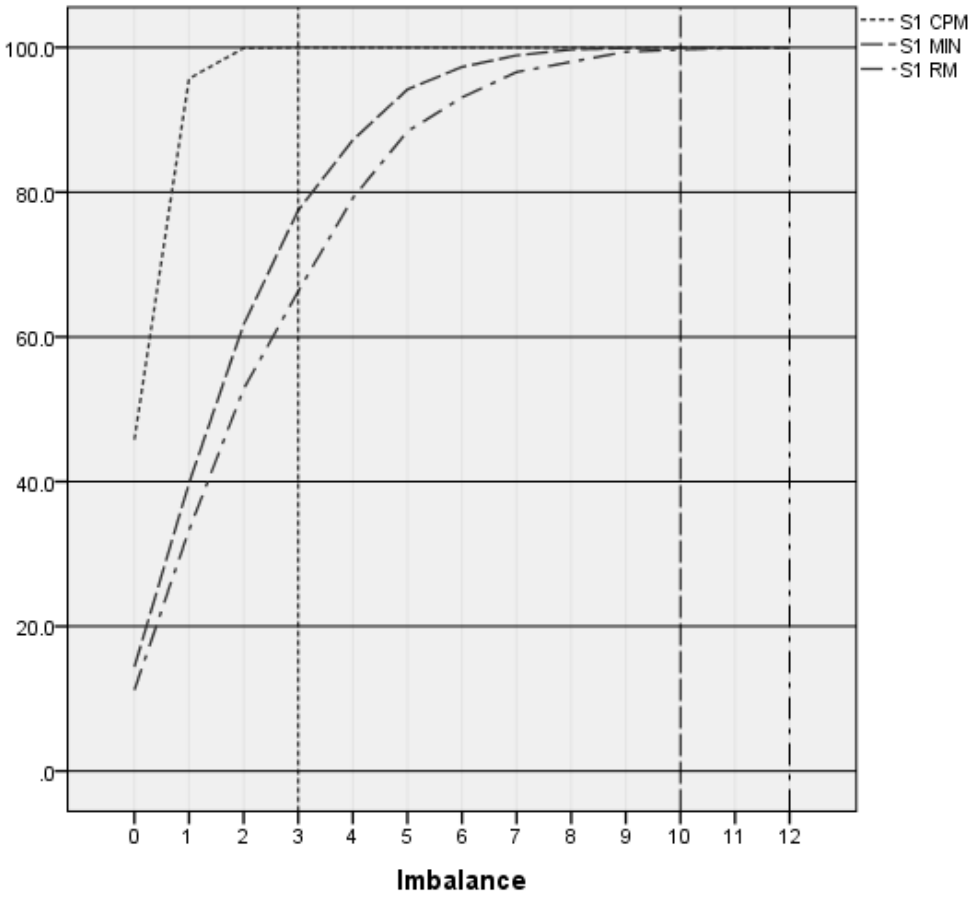
Table (73)

The frequency and percentages of imbalance of CPM, MIN and RM for the 1st single layer when sample size is 200. (Simulation repeated 1000 times)

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	458	45.8	144	14.4	112	11.2
1	499	49.9	254	25.4	221	22.1
2	42	4.2	219	21.9	195	19.5
3	1	0.1	158	15.8	135	13.5
4	0	0.0	97	9.7	129	12.9
5	0	0.0	70	7.0	92	9.2
6	0	0.0	31	3.1	47	4.7
7	0	0.0	16	1.6	35	3.5
8	0	0.0	8	0.8	14	1.4
9	0	0.0	2	0.2	14	1.4
10	0	0.0	1	0.1	3	0.3
11	0	0.0	0	0.0	2	0.2
12	0	0.0	0	0.0	1	0.1

It is clear that from table (73), the trials which had full balance from 1000 trials are 45.8% of CPM trials, compared with 14.4% of MIN trials and 11.2% of RM trials. The maximum imbalance is 3 in CPM compared with 10 in MIN and 12 in RM.

The following graph displays the imbalance and its cumulative percent for three methods to make the comparison clear.



Graph (7.1) The amount of imbalance and its cumulative percentage with sample size 200.

From table (73) and Graph (7.1), it is clear that CPM has the least amount of imbalance followed by MIN, and RM has the most amount of imbalance. So, CPM is the best method in this case which achieve the best imbalance.

Tables from (74) to (84) in appendix A show the imbalance data for 2^{nd} to 12^{th} single layers with sample size 200 categorized by randomization method.

In the 2^{nd} single layer, the trials which have full balance are 45.7% in CPM compared by 13.4% in MIN and 10.5% in RM. The maximum imbalance in CPM is 3 compared with 9 and 12 in MIN and RM respectively. In the 3^{rd} single layer 45.2% of CPM trials have full balance while MIN and RM just have 23.5% and 21.0% respectively. And the maximum imbalance is 3, 6 and 7 for three methods in the same above ordered.

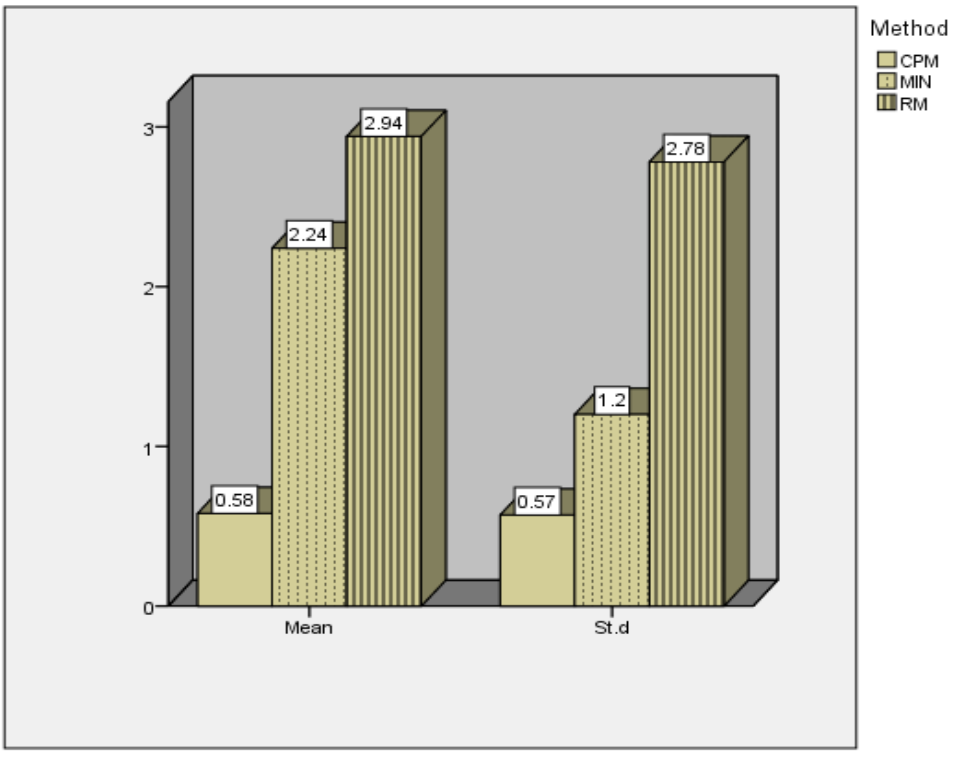
In the 4^{th} single layer, the full balance is 44.6%, 25.4% and 21.4% for CPM, MIN and RM respectively. While the maximum imbalance is 2 in CPM, is 6 in MIN and 8 in RM. The 5^{th} single layer has 47.6%, 10.8% and 7.0% full balance for CPM, MIN and RM respectively. But the maximum imbalance is more in this layer for MIN and RM when is 12 and 20 respectively, while is just 3 in

CPM. Full balance in the 6th single layer is 46.8% in CPM compared with 9.6% in MIN and 6.7% in RM. As well, maximum imbalance is 3 in CPM, but 14 in MIN and 18 in RM. In the 7th single layer 44.7% of CPM trials have full balance compared with 12.8% for MIN and 9.6% for RM. And the maximum imbalance is 3 for CPM compared with 9 for MIN and 11 for RM.

In contrast to MIN and RM, CPM has high full balance trials in the 8th single layer when is 44.0% compared with 12.0% and 12.9% in MIN and RM. And also there is big difference in maximum imbalance between methods, while is 3 in CPM and 11 for the other methods. In the 9th single layer the full balance is 45.8% in CPM, 24.6% in MIN and 22.6% in RM. And the maximum imbalance is 3 in CPM while is 5 in MIN and 7 in RM. 49.2% of CPM trials have full balance in the 10th single layer whereas 27.3% of MIN and 25.0% of RM trials have full balance. In this layer, the imbalance increased up to 6 in MIN and 7 in RM trials whilst is 3 in CPM trials. 45.8% is the percentage of full balance trials in the 11th single layer whereat trials have done by CPM compared with 10.5% in MIN and 7.6% in RM. It is clear that in this layer, the maximum imbalance 3 in CPM is very small in contrast to MIN when 13 and

RM where is 18. In the last single layer with sample size 200, the difference in full balance between methods is obvious. Where is 46.0% in CPM, 9.8% in MIN and 6.8% in RM. And there is a wide range in maximum imbalance where is 3 in CPM compared with 14 in MIN and 18 in RM.

The following graph display the mean and stander deviation of imbalance for randomization methods for single layers with sample size 200.



Graph (7.2): The mean and St.d of imbalance for randomization methods.

The following table displays the amount of imbalance with frequency and percentages by randomization methods with sample size 200 for total assigning in treatments A and B.

Table (7.1)

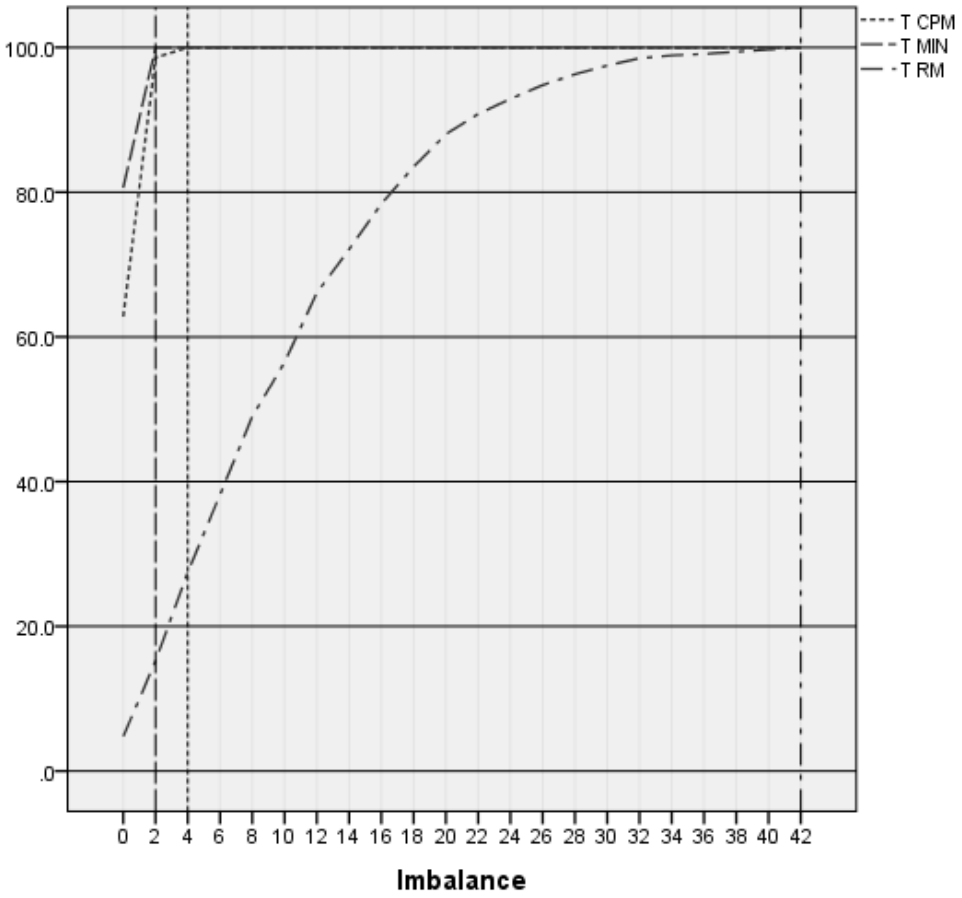
The amount of imbalance for total assigning with sample size 200 by randomization methods.

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	628	62.8	806	80.6	48	4.8
2	358	35.8	194	19.4	104	10.4
4	14	1.4	0	0.0	123	12.3
6	0	0.0	0	0.0	107	10.7
8	0	0.0	0	0.0	108	10.8
10	0	0.0	0	0.0	75	7.5
12	0	0.0	0	0.0	96	9.6
14	0	0.0	0	0.0	60	6.0
16	0	0.0	0	0.0	63	6.3
18	0	0.0	0	0.0	51	5.1
20	0	0.0	0	0.0	45	4.5

22	0	0.0	0	0.0	28	2.8
24	0	0.0	0	0.0	21	2.1
26	0	0.0	0	0.0	19	1.9
28	0	0.0	0	0.0	15	1.5
30	0	0.0	0	0.0	12	1.2
32	0	0.0	0	0.0	10	1.0
34	0	0.0	0	0.0	4	.4
36	0	0.0	0	0.0	2	0.2
38	0	0.0	0	0.0	3	0.3
40	0	0.0	0	0.0	3	0.3
42	0	0.0	0	0.0	3	0.3

From table (7.1) above is clear that, the imbalance of total assigning of patients between treatments when sample size is 200 is not more than 4 in CPM compared by 2 MIN while is 42 in RM.

The following graph display above data to be easy in comparison.



Graph (7.3): The amount of imbalance for total assigning with sample size 200 by methods.

The data in this section clearly show that, in all single layers, CPM has the least imbalance in contrast to MIN and RM. On the other hand, in the total assigning, MIN is a bit better than CPM according to their imbalance. And RM has the maximum imbalance whatever.

7.2 Sample of Size 400:

In this section, imbalance of simulation data for three methods with sample size 400 is shown and discussed. Table (85) below represented as example from appendix A to show the imbalance data for three methods for the 1st single layer.

Table (85)

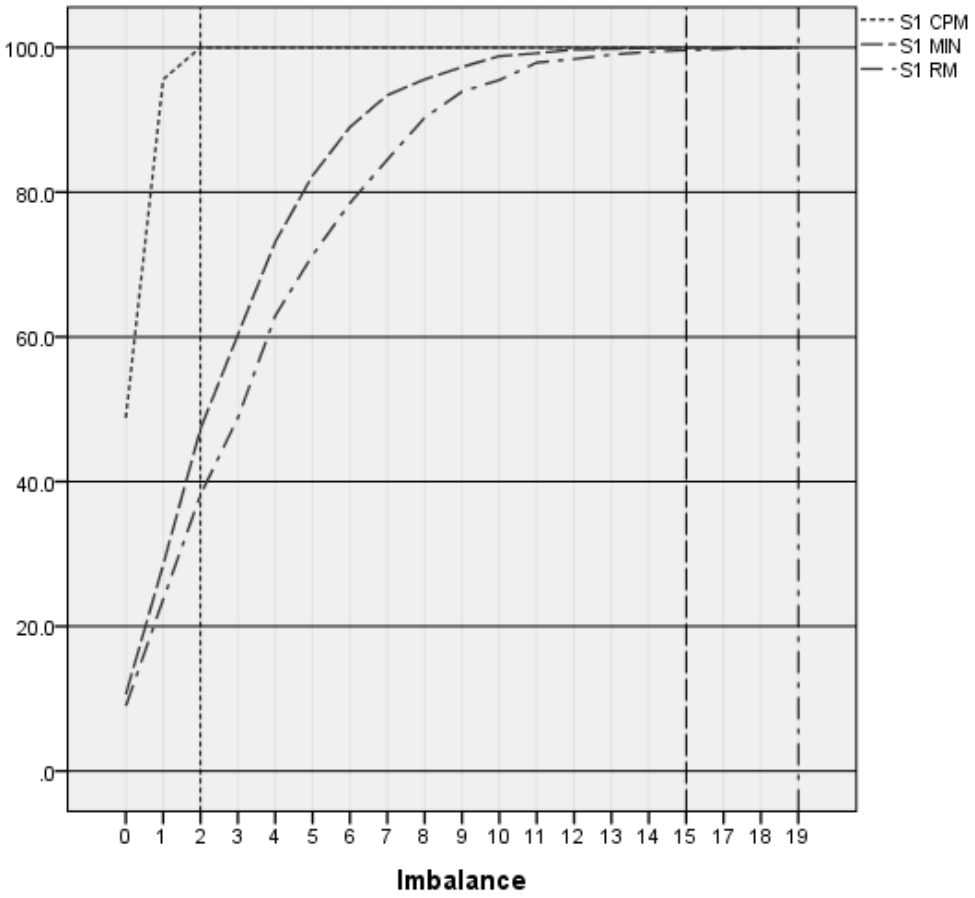
The frequency and percentages of imbalance of CPM, MIN and RM for the 1st single layer when sample size is 400. (Simulation repeated 1000 times)

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	488	48.8	106	10.6	90	9.0
1	468	46.8	179	17.9	147	14.7
2	44	4.4	188	18.8	145	14.5
3	0	0.0	130	13.0	106	10.6
4	0	0.0	128	12.8	141	14.1
5	0	0.0	92	9.2	84	8.4
6	0	0.0	67	6.7	70	7.0
7	0	0.0	44	4.4	60	6.0

8	0	0.0	22	2.2	58	5.8
9	0	0.0	17	1.7	36	3.6
10	0	0.0	15	1.5	16	1.6
11	0	0.0	4	0.4	24	2.4
12	0	0.0	5	0.5	5	0.5
13	0	0.0	1	0.1	6	0.6
14	0	0.0	1	0.1	4	0.4
15	0	0.0	1	0.1	2	0.2
16	0	0.0	0	0.0	2	0.2
17	0	0.0	0	0.0	2	0.2
18	0	0.0	0	0.0	1	0.1
19	0	0.0	0	0.0	1	0.1

It is clear that from table (85), the trials which had full balance from 1000 trials are 48.8% of CPM trials, compared with 10.6% of MIN trials and 9.0% of RM trials. The maximum imbalance is 2 in CPM compared with 15 in MIN and 19 in RM.

The following graph displays the imbalance and its cumulative percent for three methods to make the comparison clear.



Graph (7.4): The amount of imbalance and its cumulative percentage with sample size 400.

From table (85) and graph (7.4), it is clear that CPM has the least amount of imbalance followed by MIN, and RM has the most amount of imbalance. So, CPM is the best method in this case which achieve the best imbalance.

Tables from (86) to (96) in appendix A show the imbalance data for 2nd to 12th single layers with sample size 400 categorized by randomization method.

In the 2nd single layer, the trials which have full balance are 44.5% in CPM compared by 7.4% in both of MIN and RM. The maximum imbalance in CPM is 3 compared with 14 and 18 in MIN and RM respectively. In the 3rd single layer 48.4% of CPM trials have full balance while MIN and RM just have 17.5% and 15.2% respectively. And the maximum imbalance is 2, 8 and 9 for three methods in the same above ordered.

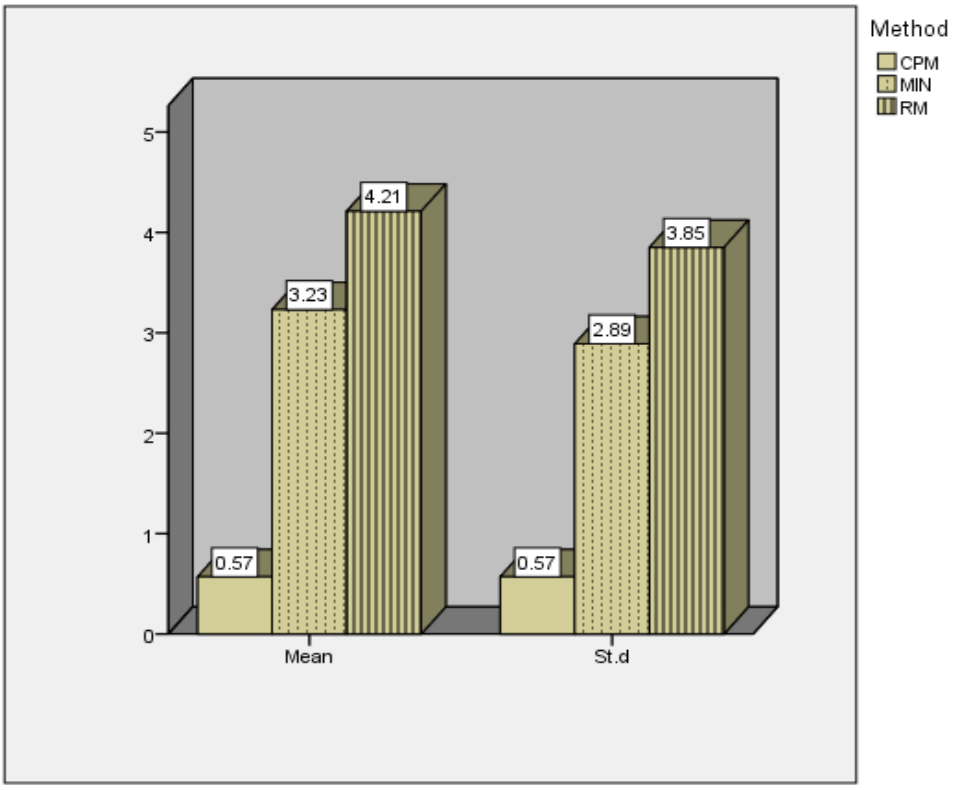
In the 4th single layer, the full balance is 46.8%, 20.3% and 15.4% for CPM, MIN and RM respectively. While the maximum imbalance is 3 in CPM, is 7 in MIN and 8 in RM. The 5th single layer has 46.8%, 8.9% and 5.3% full balance for CPM, MIN and RM respectively. But the maximum imbalance is more in this layer for MIN and RM when is 18 and 22 respectively, while is just 3 in CPM. Full balance in the 6th single layer is 45.4% in CPM compared with 6.4% in MIN and 4.3% in RM. As well, maximum imbalance is 3 in CPM, but 18 in MIN and 22 in RM. In the 7th single layer 46.6% of CPM trials have full balance compared with 9.7% for

MIN and 8.1% for RM. And the maximum imbalance is 3 for CPM compared with 12 for MIN and 18 for RM.

In contrast to MIN and RM, CPM has high full balance trials in the 8^{th} single layer when is 49.7% compared with 9.6% and 8.5% in MIN and RM. And also there is big difference in maximum imbalance between methods, while is 2 in CPM, is 15 for MIN and 18 for RM. In the 9^{th} single layer the full balance is 47.3% in CPM, 20.0% in MIN and 15.7% in RM. And the maximum imbalance is 3 in CPM while is 8 in MIN and 10 in RM. 48.4% of CPM trials have full balance in the 10^{th} single layer whereas 19.9% of MIN and 14.6% of RM trials have full balance. In this layer, the imbalance increased up to 8 in MIN and 10 in RM trials whilst is 3 in CPM trials. 48.4% is the percentage of full balance trials in the 11^{th} single layer whereat trials have done by CPM compared with 8.2% in MIN and 4.1% in RM. It is clear that in this layer, the maximum imbalance 3 in CPM is very small in contrast to MIN when 17 and RM where is 22. In the last single layer with sample size 400, the difference in full balance between methods is obvious. Where is 47.4% in CPM, 6.4% in MIN and 5.2% in RM. And there is a wide

range in maximum imbalance where is 3 in CPM compared with 20 in MIN and 22 in RM.

The following graph display the mean and stander deviation of imbalance for randomization methods for single layers with sample size 400.



Graph (7.5): The mean and St.d of imbalance for randomization methods.

The following table displays the amount of imbalance with frequency and percentages by randomization methods with sample size 400 for total assigning in treatments A and B.

Table (7.2)

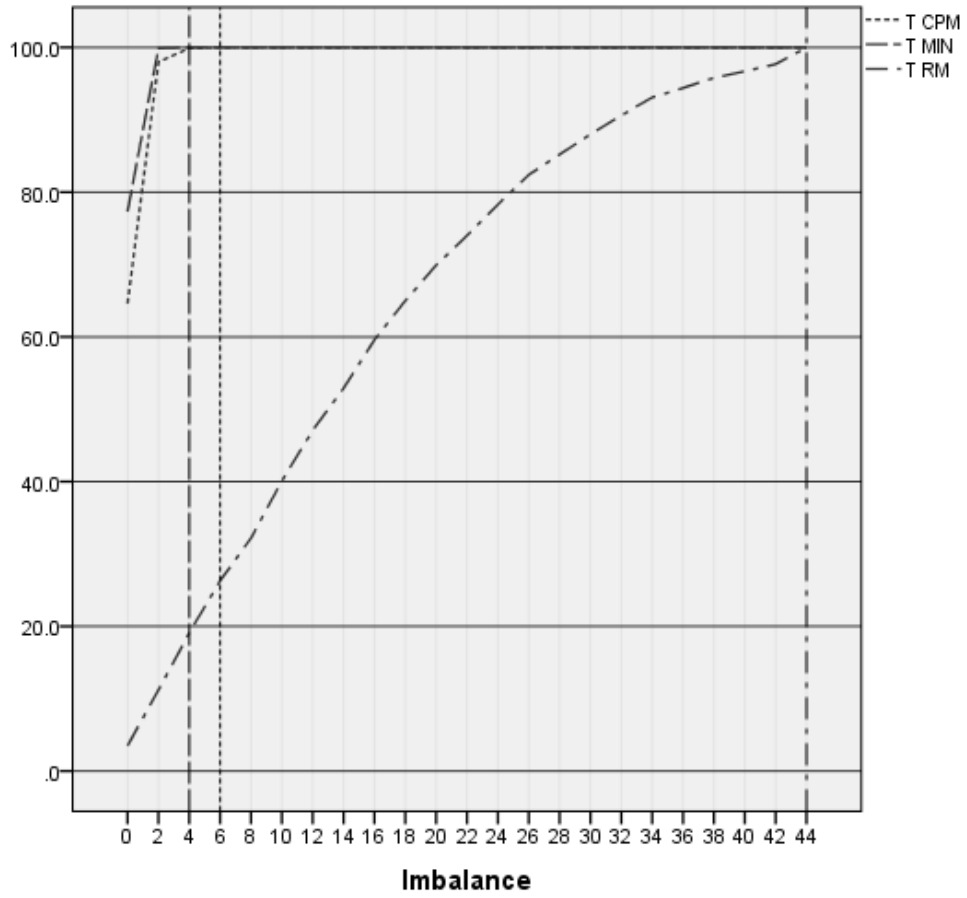
The amount of imbalance for total assigning with sample size 400 by randomization methods.

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	646	64.6	773	77.3	35	3.5
2	334	33.4	226	22.6	77	7.7
4	19	1.9	1	0.1	79	7.9
6	1	0.1	0	0.0	72	7.2
8	0	0.0	0	0.0	59	5.9
10	0	0.0	0	0.0	79	7.9
12	0	0.0	0	0.0	70	7.0
14	0	0.0	0	0.0	58	5.8
16	0	0.0	0	0.0	67	6.7
18	0	0.0	0	0.0	54	5.4
20	0	0.0	0	0.0	49	4.9

22	0	0.0	0	0.0	41	4.1
24	0	0.0	0	0.0	43	4.3
26	0	0.0	0	0.0	41	4.1
28	0	0.0	0	0.0	28	2.8
30	0	0.0	0	0.0	28	2.8
32	0	0.0	0	0.0	26	2.6
34	0	0.0	0	0.0	25	2.5
36	0	0.0	0	0.0	13	1.3
38	0	0.0	0	0.0	14	1.4
40	0	0.0	0	0.0	9	0.9
42	0	0.0	0	0.0	10	1.0
44	0	0.0	0	0.0	23	2.3

From table (7.2) above is clear that, the imbalance of total assigning of patients between treatments when sample size is 400 is not more than 6 in CPM, 4 in MIN compared with 44 in RM.

The following graph display above data to be easy in comparison.



Graph (7.6): The amount of imbalance for total assigning with sample size 400 by methods.

The data in this section clearly show that, in all single layers, CPM has the least imbalance in contrast to MIN and RM. On the other hand, in the total assigning, MIN is a bit better than CPM according to their imbalance. And RM has the maximum imbalance in each case.

7.3 Sample of Size 600:

In this section, imbalance of simulation data for three methods with sample size 600 is shown and discussed. Table (97) below represented as example from appendix A to show the imbalance data for three methods for the 1st single layer.

Table (97)

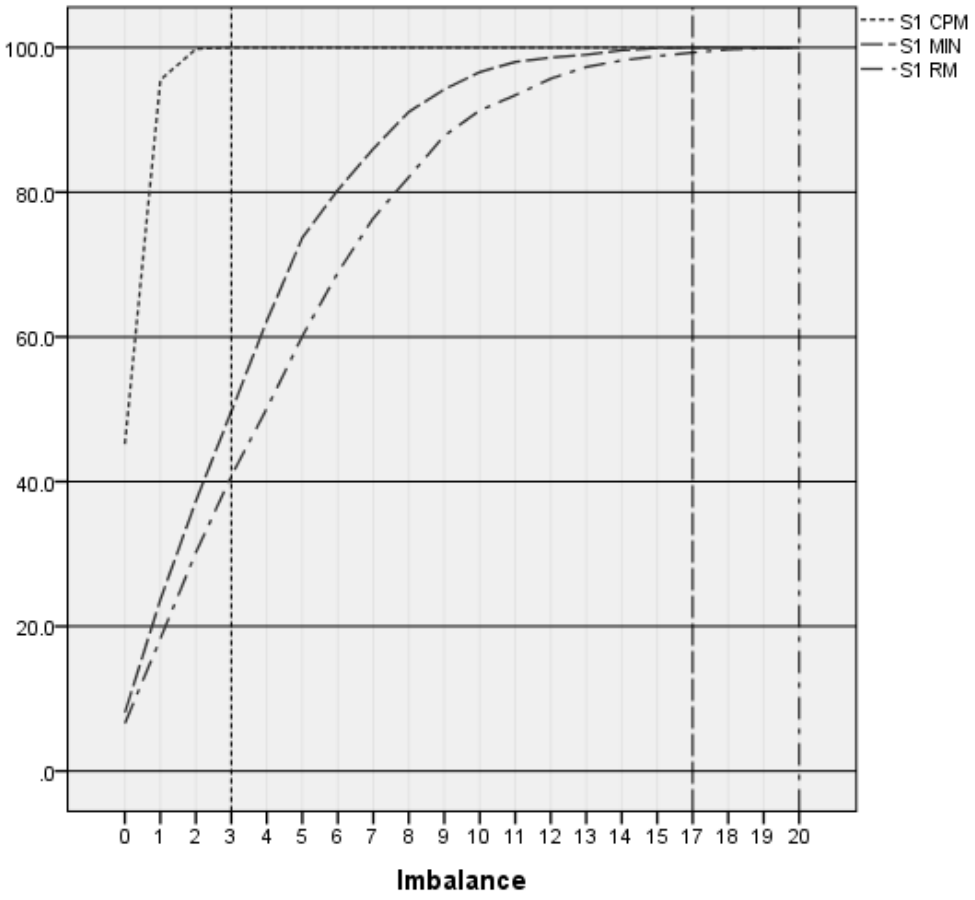
The frequency and percentages of imbalance of CPM, MIN and RM for the 1st single layer when sample size is 600. (Simulation repeated 1000 times)

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	452	45.2	81	8.1	66	6.6
1	503	50.3	156	15.6	117	11.7
2	43	4.3	136	13.6	119	11.9
3	2	0.2	124	12.4	106	10.6
4	0	0.0	125	12.5	93	9.3
5	0	0.0	115	11.5	100	10.0
6	0	0.0	65	6.5	81	8.1
7	0	0.0	57	5.7	75	7.5

8	0	0.0	51	5.1	57	5.7
9	0	0.0	31	3.1	57	5.7
10	0	0.0	24	2.4	35	3.5
11	0	0.0	14	1.4	21	2.1
12	0	0.0	6	0.6	23	2.3
13	0	0.0	4	0.4	16	1.6
14	0	0.0	6	0.6	9	0.9
15	0	0.0	3	0.3	6	0.6
16	0	0.0	1	0.1	7	0.7
17	0	0.0	1	0.1	5	0.5
18	0	0.0	0	0.0	4	0.4
19	0	0.0	0	0.0	2	0.2
20	0	0.0	0	0.0	1	0.1

It is clear that from table (97), the trials which had full balance from 1000 trials are 45.2% of CPM trials, compared with 8.1% of MIN trials and 6.6% of RM trials. The maximum imbalance is 3 in CPM compared with 17 in MIN and 20 in RM.

The following graph displays the imbalance and its cumulative percent for three methods to make the comparison clear.



Graph (7.7): The amount of imbalance and its cumulative percentage with sample size 600.

From table (97) and graph (7.7), it is clear that CPM has the least amount of imbalance followed by MIN, and RM has the most amount of imbalance. So, CPM is the best method in this case which achieve the best imbalance.

Tables from (98) to (108) in appendix A show the imbalance data for 2nd to 12th single layers with sample size 600 categorized by randomization method.

In the 2nd single layer, the trials which have full balance are 48.6% in CPM compared by 7.2% in MIN and 6.7% in RM. The maximum imbalance in CPM is 3 compared with 16 and 21 in MIN and RM respectively. In the 3rd single layer 46.9% of CPM trials have full balance while MIN and RM just have 15.5% and 12.6% respectively. And the maximum imbalance is 2, 10 and 10 for three methods in the same above ordered.

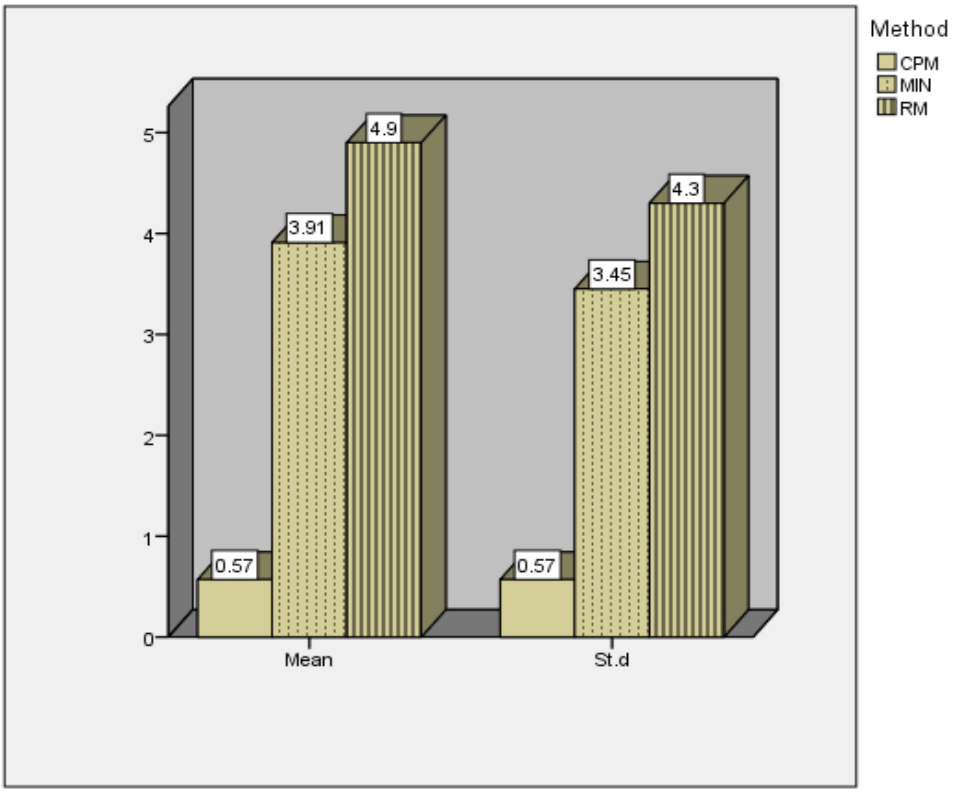
In the 4th single layer, the full balance is 46.6%, 14.5% and 12.8% for CPM, MIN and RM respectively. While the maximum imbalance is 3 in CPM, is 8 in MIN and 12 in RM. The 5th single layer has 44.7%, 7.3% and 4.5% full balance for CPM, MIN and RM respectively. But the maximum imbalance is more in this layer for MIN and RM when is 20 and 23 respectively, while is just 3 in CPM. Full balance in the 6th single layer is 45.9% in CPM compared with 5.8% in MIN and 4.5% in RM. As well, maximum imbalance is 3 in CPM, but 23 in each of MIN and RM. In the 7th single layer 44.9% of CPM trials have full balance compared with 8.2% for

MIN and 6.4% for RM. And the maximum imbalance is 4 for CPM compared with 16 for MIN and 21 for RM.

In contrast to MIN and RM, CPM has high full balance trials in the 8^{th} single layer when is 47.4% compared with 7.3% and 5.4% in MIN and RM. And also there is big difference in maximum imbalance between methods, while is 3 in CPM, is 18 for MIN and 20 for RM. In the 9^{th} single layer the full balance is 47.7% in CPM, 14.7% in MIN and 11.7% in RM. And the maximum imbalance is 3 in CPM while is 8 in MIN and 10 in RM. 48.4% of CPM trials have full balance in the 10^{th} single layer whereas 16.8% of MIN and 15.0% of RM trials have full balance. In this layer, the imbalance increased up to 9 in MIN and 11 in RM trials whilst is 3 in CPM trials. 46.1% is the percentage of full balance trials in the 11^{th} single layer whereat trials have done by CPM compared with 4.7% in MIN and 3.8% in RM. It is clear that in this layer, the maximum imbalance 3 in CPM is very small in contrast to MIN when 22 and RM where is 23. In the last single layer with sample size 600, the difference in full balance between methods is obvious. Where is 45.4% in CPM, 5.5% in MIN and 4.0% in RM. And there is a wide

range in maximum imbalance where is 3 in CPM compared with 23 in other methods.

The following graph display the mean and stander deviation of imbalance for randomization methods for single layers with sample size 600.



Graph (7.8): The mean and St.d of imbalance for randomization methods.

The following table displays the amount of imbalance with frequency and percentages by randomization methods with sample size 600 for total assigning in treatments A and B.

Table (7.3)

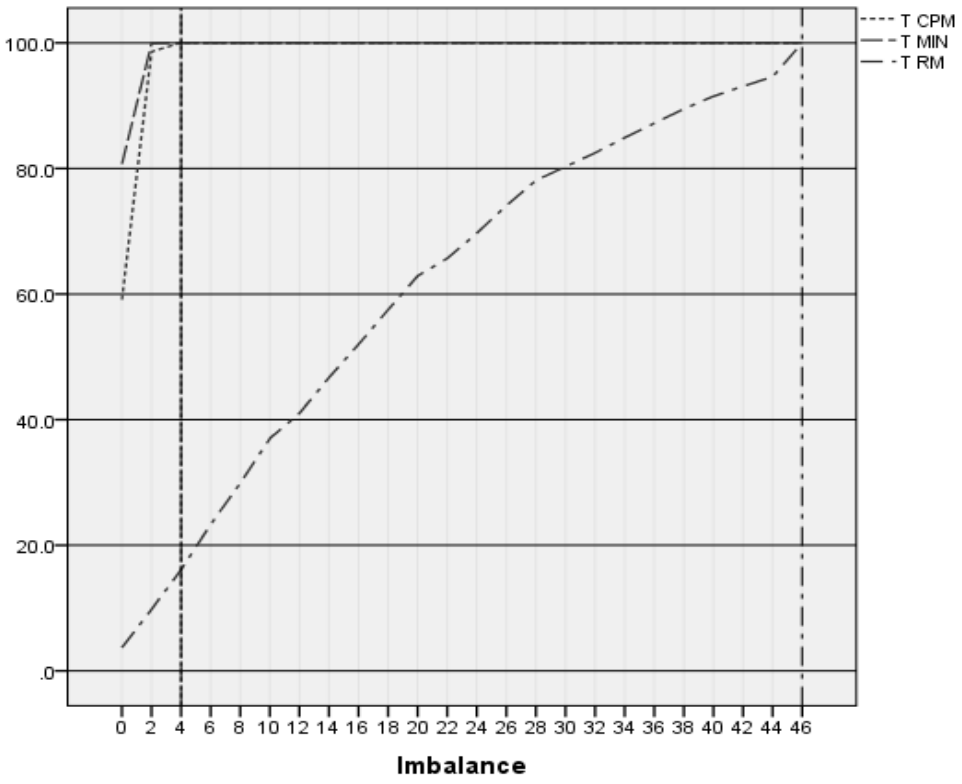
The amount of imbalance for total assigning with sample size 600 by randomization methods.

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	591	59.1	807	80.7	37	3.7
2	395	39.5	192	19.2	61	6.1
4	14	1.4	1	0.1	63	6.3
6	0	0.0	0	0.0	72	7.2
8	0	0.0	0	0.0	66	6.6
10	0	0.0	0	0.0	71	7.1
12	0	0.0	0	0.0	40	4.0
14	0	0.0	0	0.0	57	5.7
16	0	0.0	0	0.0	53	5.3
18	0	0.0	0	0.0	55	5.5
20	0	0.0	0	0.0	54	5.4

22	0	0.0	0	0.0	28	2.8
24	0	0.0	0	0.0	40	4.0
26	0	0.0	0	0.0	44	4.4
28	0	0.0	0	0.0	40	4.0
30	0	0.0	0	0.0	22	2.2
32	0	0.0	0	0.0	22	2.2
34	0	0.0	0	0.0	24	2.4
36	0	0.0	0	0.0	23	2.3
38	0	0.0	0	0.0	23	2.3
40	0	0.0	0	0.0	20	2.0
42	0	0.0	0	0.0	16	1.6
44	0	0.0	0	0.0	15	1.5
46	0	0.0	0	0.0	54	5.4

From table (7.3) above is clear that, the imbalance of total assigning of patients between treatments when sample size is 600, is not more than 4 in both of CPM and MIN compared with 46 in RM.

The following graph display above data to be easy in comparison.



Graph (7.9): The amount of imbalance for total assigning with sample size 600 by methods.

The data in this section clearly show that, in all single layers, CPM has the least imbalance in contrast to MIN and RM. On the other hand, in the total assigning, CPM and MIN are similar according to their imbalance. And RM has the maximum imbalance in each case.

7.4 Sample of Size 800:

In this section, imbalance of simulation data for three methods with sample size 800 is shown and discussed. Table (109) below

represented as example from appendix A to show the imbalance data for three methods for the 1st single layer.

Table (109)

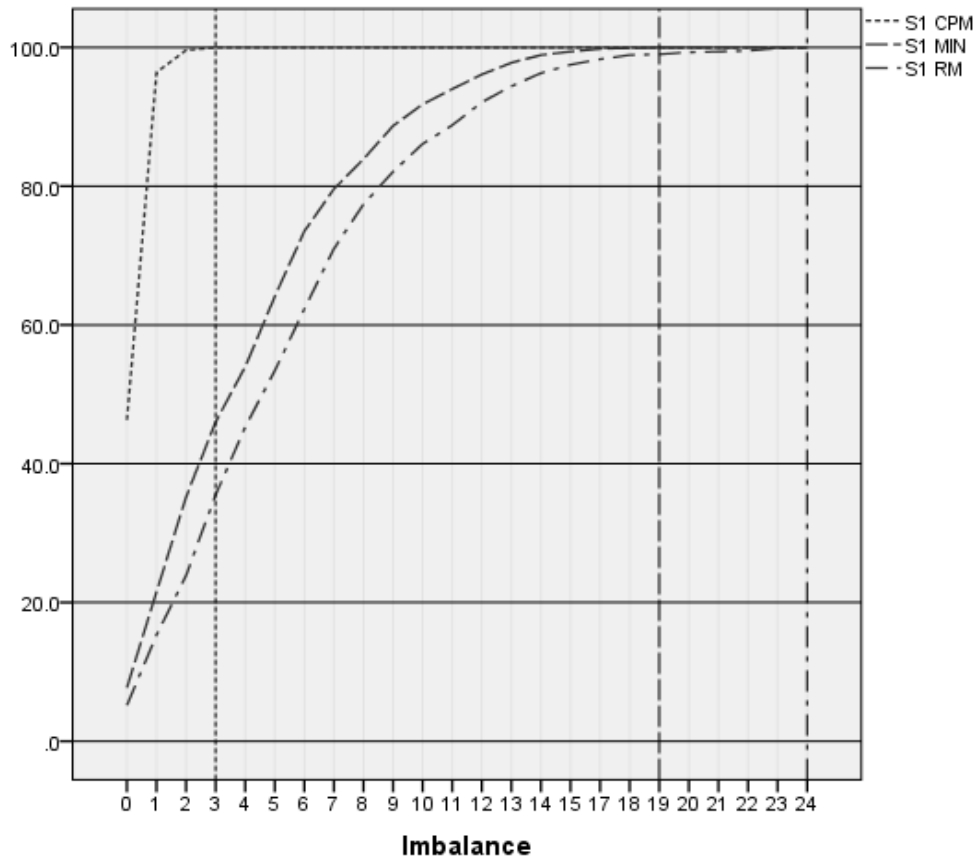
The frequency and percentages of imbalance of CPM, MIN and RM for the 1st single layer when sample size is 800. (Simulation repeated 1000 times)

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	463	46.3	77	7.7	52	5.2
1	501	50.1	138	13.8	101	10.1
2	32	3.2	137	13.7	86	8.6
3	4	0.4	108	10.8	116	11.6
4	0	0.0	80	8.0	98	9.8
5	0	0.0	101	10.1	81	8.1
6	0	0.0	88	8.8	83	8.3
7	0	0.0	61	6.1	87	8.7
8	0	0.0	43	4.3	64	6.4
9	0	0.0	48	4.8	47	4.7
10	0	0.0	31	3.1	40	4.0

11	0	0.0	22	2.2	27	2.7
12	0	0.0	21	2.1	33	3.3
13	0	0.0	17	1.7	23	2.3
14	0	0.0	11	1.1	19	1.9
15	0	0.0	5	0.5	12	1.2
16	0	0.0	6	0.6	6	0.6
17	0	0.0	4	0.4	8	0.8
18	0	0.0	1	0.1	6	0.6
19	0	0.0	1	0.1	1	0.1
20	0	0.0	0	0.0	3	0.3
21	0	0.0	0	0.0	1	0.1
22	0	0.0	0	0.0	1	0.1
23	0	0.0	0	0.0	4	0.4
24	0	0.0	0	0.0	1	0.1

It is clear that from Table (109), the trials which had full balance from 1000 trials are 46.3% of CPM trials, compared with 7.7% of MIN trials and 5.2% of RM trials. The maximum imbalance is 3 in CPM compared with 19 in MIN and 24 in RM.

The following graph displays the imbalance and its cumulative percent for three methods to make the comparison clear.



Graph (7.10): The amount of imbalance and its cumulative percentage with sample size 800.

From Table (109) and graph (7.10), it is clear that CPM has the least amount of imbalance followed by MIN, and RM has the most amount of imbalance. So, CPM is the best method in this case which achieve the best imbalance.

Tables from (110) to (120) in appendix A show the imbalance data for 2nd to 12th single layers with sample size 800 categorized by randomization method.

In the 2nd single layer, the trials which have full balance are 48.6% in CPM compared by 7.3% in MIN and 5.6% in RM. The maximum imbalance in CPM is 3 compared with 17 and 23 in MIN and RM respectively. In the 3rd single layer 44.9% of CPM trials have full balance while MIN and RM just have 13.1% and 10.3% respectively. And the maximum imbalance is 2, 9 and 13 for three methods in the same above ordered.

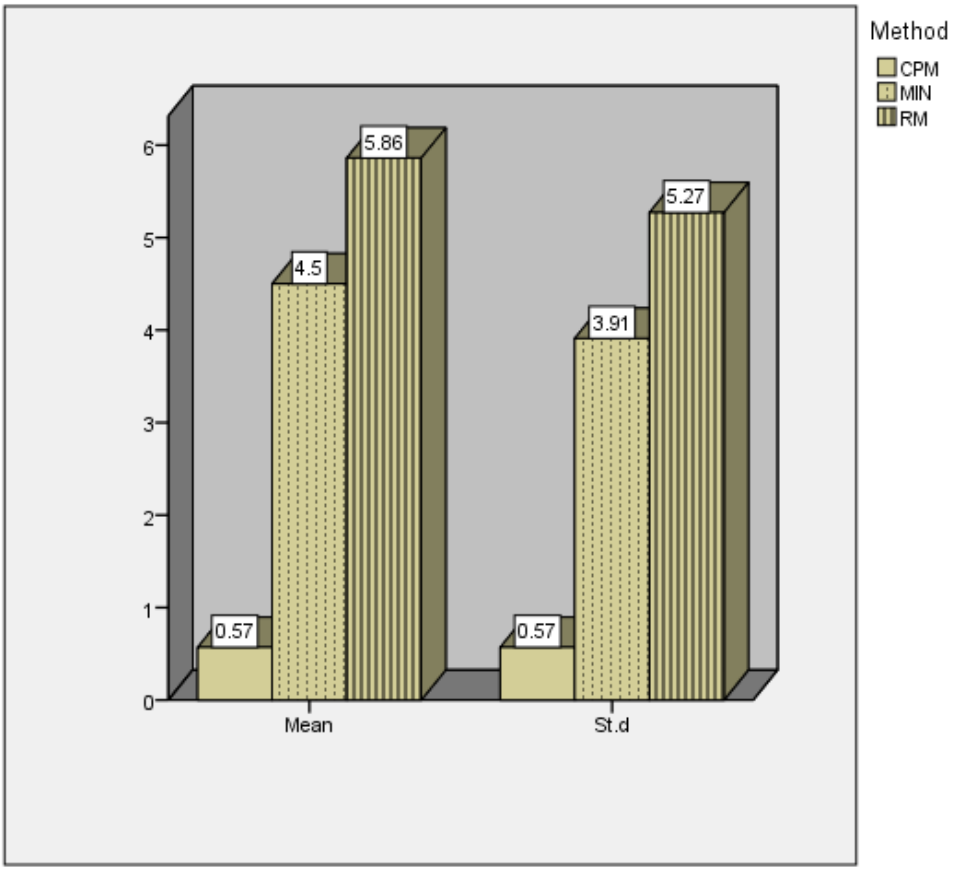
In the 4th single layer, the full balance is 46.7%, 11.9% and 10.9% for CPM, MIN and RM respectively. While the maximum imbalance is 3 in CPM, is 10 in MIN and 13 in RM. The 5th single layer has 44.8%, 4.0% and 2.7% full balance for CPM, MIN and RM respectively. But the maximum imbalance is more in this layer for MIN and RM when is 24 and 30 respectively, while is just 3 in CPM. Full balance in the 6th single layer is 46.9% in CPM compared with 4.5% in MIN and 3.6% in RM. As well, maximum imbalance is 3 in CPM, but 24 in MIN and 30 in RM. In the 7th single layer 50.6% of CPM trials have full balance compared with 7.8% for

MIN and 5.3% for RM. And the maximum imbalance is 3 for CPM compared with 17 for MIN and 23 for RM.

In contrast to MIN and RM, CPM has high full balance trials in the 8^{th} single layer when is 46.2% compared with 6.5% and 3.8% in MIN and RM. And also there is big difference in maximum imbalance between methods, while is 3 in CPM, is 20 for MIN and 24 for RM. In the 9^{th} single layer the full balance is 44.9% in CPM, 14.0% in MIN and 10.2% in RM. And the maximum imbalance is 3 in CPM while is 10 in MIN and 13 in RM. 47.9% of CPM trials have full balance in the 10^{th} single layer whereas 13.0% of MIN and 11.7% of RM trials have full balance. In this layer, the imbalance increased up to 10 in MIN and 13 in RM trials whilst is 3 in CPM trials. 47.1% is the percentage of full balance trials in the 11^{th} single layer whereat trials have done by CPM compared with 6.1% in MIN and 2.7% in RM. It is clear that in this layer, the maximum imbalance 3 in CPM is very small in contrast to MIN when 26 and RM where is 30. In the last single layer with sample size 800, the difference in full balance between methods is obvious. Whereat is 47.7% in CPM, 3.5% in MIN and 3.9% in RM. And there is a wide

range in maximum imbalance whereat is 3 in CPM compared with 28 in MIN and 30 in RM.

The following graph display the mean and stander deviation of imbalance for randomization methods for single layers with sample size 800.



Graph (7.11): The mean and St.d of imbalance for randomization methods.

The following table displays the amount of imbalance with frequency and percentages by randomization methods with sample size 800 for total assigning in treatments A and B.

Table (7.4)

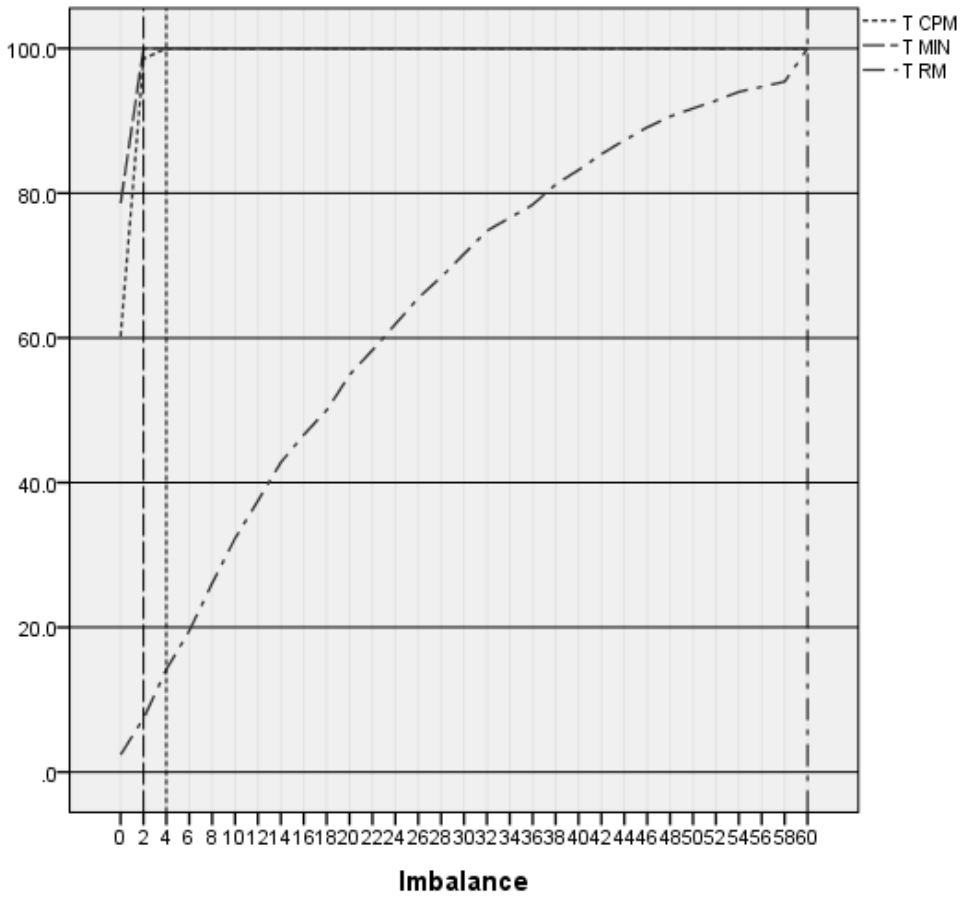
The amount of imbalance for total assigning with sample size 800 by randomization methods.

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	602	60.2	786	78.6	24	2.4
2	384	38.4	214	21.4	50	5.0
4	14	1.4	0	0.0	68	6.8
6	0	0.0	0	0.0	53	5.3
8	0	0.0	0	0.0	66	6.6
10	0	0.0	0	0.0	62	6.2
12	0	0.0	0	0.0	52	5.2
14	0	0.0	0	0.0	53	5.3
16	0	0.0	0	0.0	38	3.8
18	0	0.0	0	0.0	34	3.4
20	0	0.0	0	0.0	49	4.9
22	0	0.0	0	0.0	34	3.4

24	0	0.0	0	0.0	36	3.6
26	0	0.0	0	0.0	36	3.6
28	0	0.0	0	0.0	29	2.9
30	0	0.0	0	0.0	32	3.2
32	0	0.0	0	0.0	32	3.2
34	0	0.0	0	0.0	18	1.8
36	0	0.0	0	0.0	18	1.8
38	0	0.0	0	0.0	28	2.8
40	0	0.0	0	0.0	20	2.0
42	0	0.0	0	0.0	22	2.2
44	0	0.0	0	0.0	19	1.9
46	0	0.0	0	0.0	18	1.8
48	0	0.0	0	0.0	15	1.5
50	0	0.0	0	0.0	11	1.1
52	0	0.0	0	0.0	11	1.1
54	0	0.0	0	0.0	12	1.2
56	0	0.0	0	0.0	7	0.7
58	0	0.0	0	0.0	7	0.7
60	0	0.0	0	0.0	46	4.6

From table (7.4) above is clear that, the imbalance of total assigning of patients between treatments when sample size is 800 is not more than 4 in CPM compared with 2 MIN and 60 in RM.

The following graph display above data to be easy in comparison.



Graph (7.12): The amount of imbalance for total assigning with sample size 800 by methods.

The data in this section clearly show that, in all single layers, CPM has the least imbalance in contrast to MIN and RM. On the other

hand, in the total assigning, MIN is a little bit better than CPM according to their imbalance. And RM has the maximum imbalance in each case.

7.5 Sample of Size 1000:

In this section, imbalance of simulation data for three methods with sample size 1000 is shown and discussed. Table (121) below represented as example from appendix A to show the imbalance data for three methods for the 1st single layer.

Table (121)

The frequency and percentages of imbalance of CPM, MIN and RM for the 1st single layer when sample size is 1000. (Simulation repeated 1000 times)

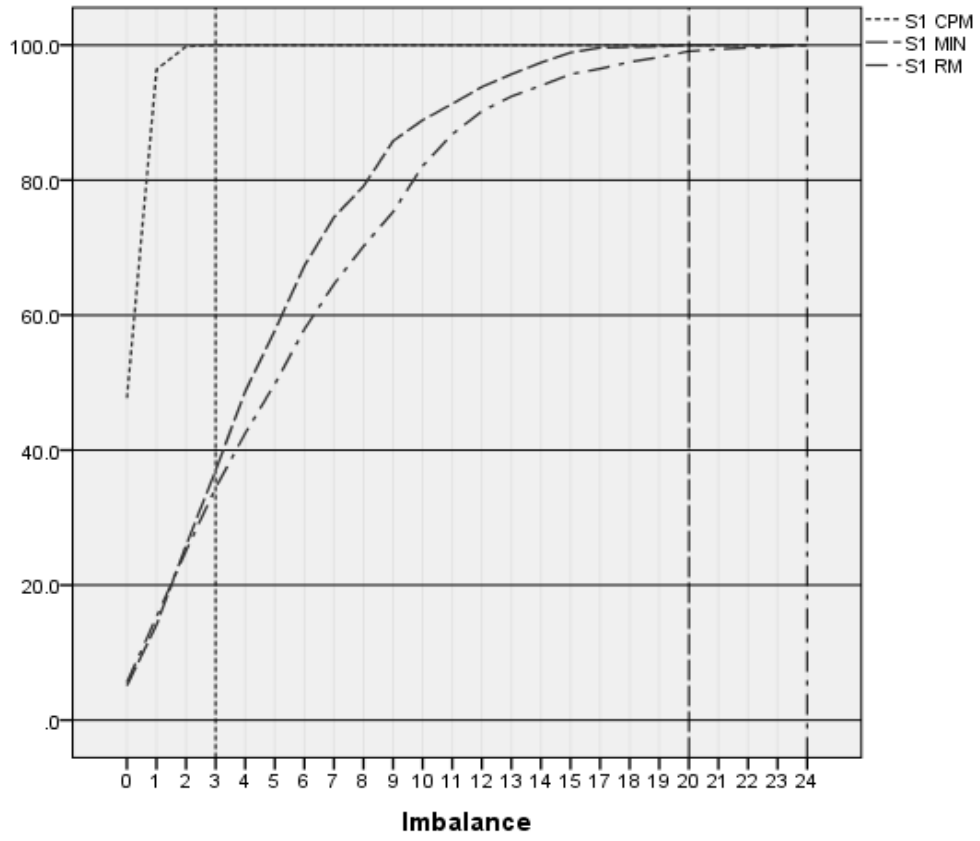
Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	477	47.7	51	5.1	56	5.6
1	487	48.7	90	9.0	97	9.7
2	34	3.4	118	11.8	98	9.8
3	2	0.2	111	11.1	93	9.3
4	0	0.0	117	11.7	81	8.1
5	0	0.0	90	9.0	73	7.3

6	0	0.0	84	8.4	69	6.9
7	0	0.0	72	7.2	67	6.7
8	0	0.0	46	4.6	56	5.6
9	0	0.0	67	6.7	51	5.1
10	0	0.0	31	3.1	68	6.8
11	0	0.0	24	2.4	47	4.7
12	0	0.0	25	2.5	34	3.4
13	0	0.0	19	1.9	22	2.2
14	0	0.0	17	1.7	16	1.6
15	0	0.0	15	1.5	17	1.7
16	0	0.0	12	1.2	12	1.2
17	0	0.0	7	0.7	8	0.8
18	0	0.0	1	0.1	10	1.0
19	0	0.0	1	0.1	7	0.7
20	0	0.0	2	0.2	9	0.9
21	0	0.0	0	0.0	3	0.3
22	0	0.0	0	0.0	2	0.2
23	0	0.0	0	0.0	2	0.2
24	0	0.0	0	0.0	2	0.2

It is clear that from Table (121), the trials which had full balance from 1000 trials are 47.7% of CPM trials, compared with 5.1% of

MIN trials and 5.6% of RM trials. The maximum imbalance is 3 in CPM compared with 20 in MIN and 24 in RM.

The following graph displays the imbalance and its cumulative percent for three methods to make the comparison clear.



Graph (7.13): The amount of imbalance and its cumulative percentage with sample size 1000.

From Table (121) and graph (7.13), it is clear that CPM has the least amount of imbalance followed by MIN, and RM has the most

amount of imbalance. So, CPM is the best method in this case which achieve the best imbalance.

Tables from (122) to (132) in appendix A show the imbalance data for 2nd to 12th single layers with sample size 1000 categorized by randomization method.

In the 2nd single layer, the trials which have full balance are 48.4% in CPM compared by 6.4% in MIN and 6.0% in RM. The maximum imbalance in CPM is 4 compared with 20 and 26 in MIN and RM respectively. In the 3rd single layer 45.1% of CPM trials have full balance while MIN and RM just have 10.9% and 8.2% respectively. And the maximum imbalance is 3, 10 and 14 for three methods in the same above ordered.

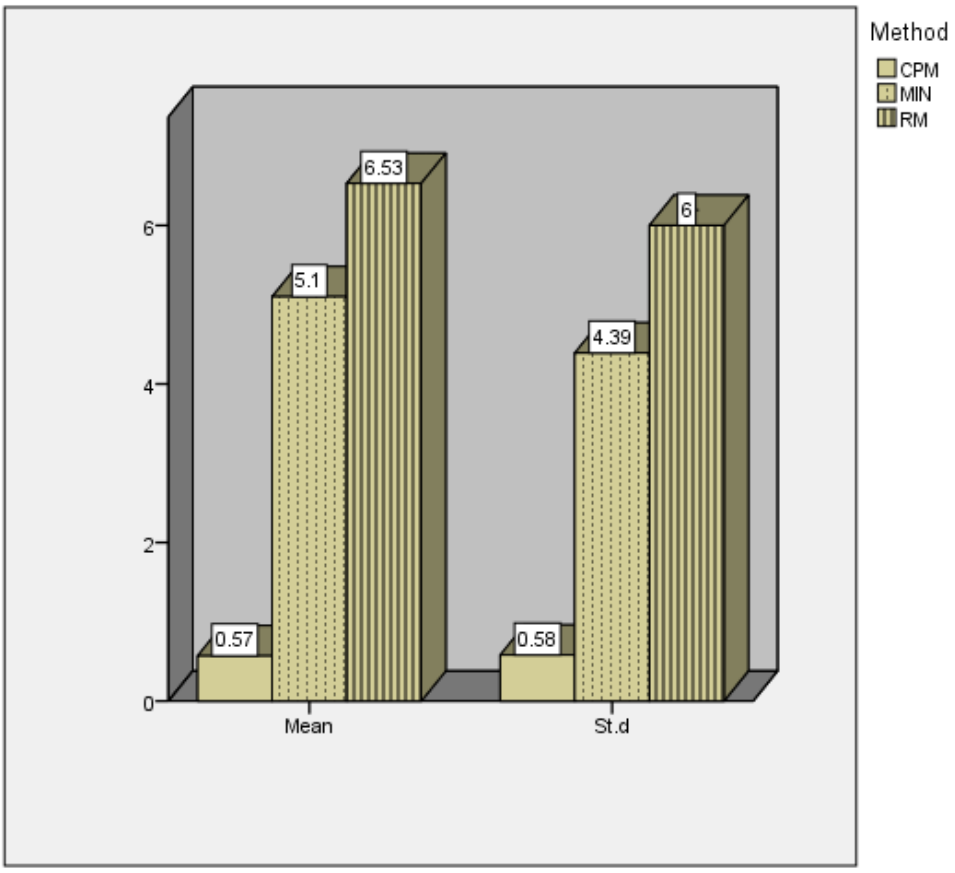
In the 4th single layer, the full balance is 48.3%, 12.1% and 10.0% for CPM, MIN and RM respectively. While the maximum imbalance is 3 in CPM, is 12 in MIN and 14 in RM. The 5th single layer has 47.6%, 4.4% and 3.5% full balance for CPM, MIN and RM respectively. But the maximum imbalance is more in this layer for MIN and RM when is 27 and 30 respectively, while is just 3 in CPM. Full balance in the 6th single layer is 46.8% in CPM compared with 3.2% in MIN and 3.6% in RM. As well, maximum imbalance

is 3 in CPM, but 28 in MIN and 30 in RM. In the 7th single layer 50.1% of CPM trials have full balance compared with 7.5% for MIN and 4.1% for RM. And the maximum imbalance is 3 for CPM compared with 21 for MIN and 25 for RM.

In contrast to MIN and RM, CPM has high full balance trials in the 8th single layer when is 45.4% compared with 4.5% and 5.5% in MIN and RM. And also there is big difference in maximum imbalance between methods, while is 3 in CPM, is 22 for MIN and 27 for RM. In the 9th single layer the full balance is 48.7% in CPM, 12.4% in MIN and 10.7% in RM. And the maximum imbalance is 3 in CPM while is 13 in MIN and 14 in RM. 46.0% of CPM trials have full balance in the 10th single layer whereas 11.7% of MIN and 8.9% of RM trials have full balance. In this layer, the imbalance increased up to 13 in MIN and 12 in RM trials whilst is 3 in CPM trials. 46.6% is the percentage of full balance trials in the 11th single layer whereat trials have done by CPM compared with 4.2% in MIN and 2.9% in RM. It is clear that in this layer, the maximum imbalance 3 in CPM is very small in contrast to MIN when 28 and RM where is 30. In the last single layer with sample size 1000, the difference in full balance between methods is obvious. Whereat is

47.7% in CPM, 3.8% in MIN and 2.8% in RM. And there is a wide range in maximum imbalance whereat is 3 in CPM compared with 30 in other methods.

The following graph display the mean and stander deviation of imbalance for randomization methods for single layers with sample size 1000.



Graph (7.14): The mean and St.d of imbalance for randomization methods.

The following table displays the amount of imbalance with frequency and percentages by randomization methods with sample size 1000 for total assigning in treatments A and B.

Table (7.5)

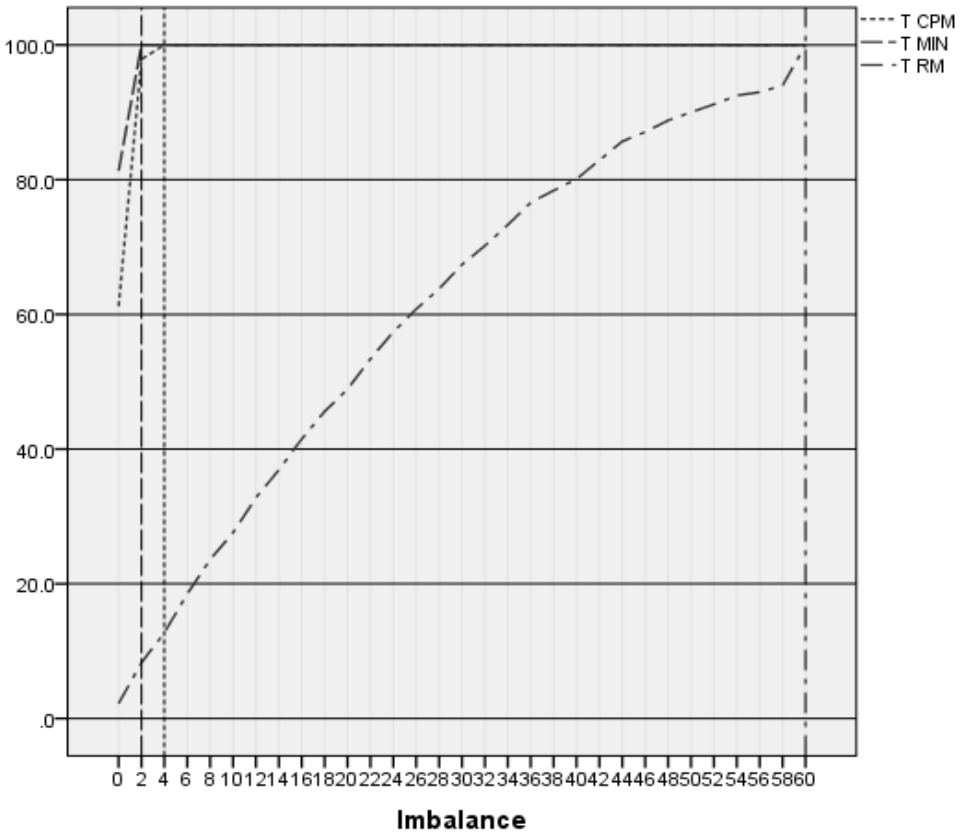
The amount of imbalance for total assigning with sample size 1000 by randomization methods.

Imbalance	CPM		MIN		RM	
	Freq.	Per.	Freq.	Per.	Freq.	Per.
0	612	61.2	813	81.3	22	2.2
2	367	36.7	187	18.7	61	6.1
4	21	2.1	0	0.0	44	4.4
6	0	0.0	0	0.0	58	5.8
8	0	0.0	0	0.0	51	5.1
10	0	0.0	0	0.0	40	4.0
12	0	0.0	0	0.0	52	5.2
14	0	0.0	0	0.0	41	4.1
16	0	0.0	0	0.0	46	4.6
18	0	0.0	0	0.0	41	4.1
20	0	0.0	0	0.0	33	3.3
22	0	0.0	0	0.0	45	4.5

24	0	0.0	0	0.0	40	4.0
26	0	0.0	0	0.0	34	3.4
28	0	0.0	0	0.0	30	3.0
30	0	0.0	0	0.0	36	3.6
32	0	0.0	0	0.0	28	2.8
34	0	0.0	0	0.0	31	3.1
36	0	0.0	0	0.0	33	3.3
38	0	0.0	0	0.0	18	1.8
40	0	0.0	0	0.0	17	1.7
42	0	0.0	0	0.0	28	2.8
44	0	0.0	0	0.0	28	2.8
46	0	0.0	0	0.0	14	1.4
48	0	0.0	0	0.0	17	1.7
50	0	0.0	0	0.0	12	1.2
52	0	0.0	0	0.0	12	1.2
54	0	0.0	0	0.0	13	1.3
56	0	0.0	0	0.0	5	0.5
58	0	0.0	0	0.0	10	1.0
60	0	0.0	0	0.0	60	6.0

From table (7.5) above is clear that, the imbalance of total assigning of patients between treatments when sample size is 1000 is not more than 4 in CPM compared with 2 in MIN and 60 in RM.

The following graph display above data to be easy in comparison.



Graph (7.15): The amount of imbalance for total assigning with sample size 1000 by methods.

The data in this section clearly show that, in all single layers, CPM has the least imbalance in contrast to MIN and RM. On the other hand, in the total assigning, MIN is a little bit better than CPM

according to their imbalance. And RM has the maximum imbalance in each case.

7.6 Hypotheses Testing:

Research hypotheses which are mentioned in (1.5) would be tested in this section.

Table (7.6)

T-test components for the research hypotheses.

Method	Imbalance		d.f	t-value	p-value
	Mean	St.d			
CPM	4.20	1.56	1998	-29.85	0.000
RM	6.52	1.91			
CPM	6.90	2.04	1998	-111.45	0.000
RM	61.74	15.43			
CPM	0.54	0.89	1998	-28.61	0.000
RM	2.42	1.88			
CPM	0.85	1.04	1998	-38.79	0.000
RM	19.23	14.95			
CPM	4.20	1.56	1998	-11.40	0.000

MIN	5.08	1.89			
CPM	6.90	2.04	1998	-82.19	0.000
MIN	47.49	15.49			
CPM	0.54	0.89	1998	5.01	0.000
MIN	0.36	0.77			
CPM	0.85	1.04	1998	11.03	0.000
MIN	0.39	0.80			

All tests show significant difference between means. This support the first four hypotheses which claim that mean imbalance for CPM is less than that for MIN. The test results do not support the last two hypotheses.

From results in the last three chapters, the following points could be made.

1. Imbalance mean in CPM is less than RM whatever.
2. Imbalance mean in CPM is less than MIN in single layers, and the difference between means is huge
3. . Imbalance mean in CPM is more than MIN in total assigning, and the difference between means is very small. So, CPM is

considered as the best method in covariate adaptive randomization.