Construction Of Incomplete Counterbalancing For Immediate Sequential Effects Crossover Design

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ABSTRACT: Crossover designs are useful in many areas such as pharmaceutical industry, clinical trial, educational experiment and so on. Different construction methods for crossover design have been developed so far. In this paper, our purpose is to construct incomplete counterbalancing for immediate sequential effects where all treatments do not occur within the same subject or the same period. Here we constructed incomplete sequentially counter balanced crossover design by removing the last period and the last subject for column and row method approach respectively. The result shows that all treatments do not occur within the same subject and each treatment is precede by each other treatment once and unequal number of times for even number and odd number respectively for column method approach, also all treatments do not occur within the same period and each treatment is precede by each other treatment twice and unequal number of times for even number and odd number respectively for row method approach. It is not uniform design for not all the treatments appear in each subject and each period for column and row method respectively.

KEYWORDS: Incomplete, Crossover, Counterbalancing, Sequential.

1.0 Introduction.

Crossover design is a design in which subjects are exposed to order of treatment administration of different treatments over several periods of time. These designs have been used in clinical trials, pharmaceutical industry and many others. A number of authors have discussed construction methods of crossover design. William **(1)** discussed method of construction of balanced crossover design for more than two treatments. Mithilesh and Archana**(2)** introduced method of construction for balanced incomplete sequence crossover design of first order residual effect. Mausumi **(3)** and Durso**(4)** discussed the method of construction of counterbalancing for immediate sequential effects crossover designs and their method of construction was reviewed by Adebara and et al **(5)** Therefore, construction method of incomplete counterbalancing for immediate sequential effects for the number of treatment N is even and odd that utilizes column and row approaches shall be introduced below.

2.0 Construction Method

The clue for the procedure of method of construction of incomplete counterbalancing for immediate sequential effects emanated taken from the procedure for method of construction of complete counterbalancing for immediate sequential effects by Mausumi(2002) and that of William(1949) for method of construction of balanced crossover design for more than two treatment for the number of treatment, N is even and odd that utilizes column and row approaches. The only difference will introduced to obtain incomplete counterbalancing for immediate sequential effects is that we remove the last period and last subject of sequentially counter balanced design for column and row method respectively.

2.1 (i) Write down the N conditions in some order, say 1,2,3, …, and its N-1 cyclic development.
(ii)Apply the interleaving permutation 1, 2, N, 3, N-1, 4, N-2, … to obtain sequentially
counter balanced design
(iii) Remove the last period/subject of sequentially counter balanced design.

N represents the number of treatments and the method is not obtainable for $N < 2$

3.0 Column Method Approach for the Number of Treatment N is Even

Cyclic Matrix

For subject 1 the treatment
(i) 1, 2, …, N occur in the period 1, 2, …N respectively
(ii) Cyclic development(adding of one mode N) for subjects 2, 3, …N are obtained

Sequentially Counter Balanced Design For subject 1 the treatment
(i) 1, 2, N, 3, N-1, … occur in the cyclic matrix period 1, 2, 3, 4, 5, … N respectively
(ii) Obtain cyclic development (adding of one mode N) for subjects 2, 3, …N
(iii) By removing the last period we get incomplete sequentially counter balanced N-1 x N crossover design

3.1 Construction for the number of treatment, N=4

Cyclic Matrix

Subject

Period	1 2 3 4
1 2 3 4	1 2 3 0 2 3 0 1 3 0 1 2 0 1 2 3

Every treatment occurs in each subject and each period, and each treatment precedes every other treatment three times. Incomplete sequentially counter balanced 3 x 4 design

Subject

Period	1 2 3 4
1 2 3	1 2 3 0 2 3 0 1 0 1 2 3

All treatments do not occur within the same subject and each treatment is preceded by each other treatment once.

3.2 Column Method Approach for the Number of Treatment N is Odd

Cyclic Matrix

For subject 1 the treatment

(i) 1, 2, …, N occur in the period 1, 2, …N respectively

(ii) Cyclic development(adding of one mode N) for subjects 2, 3, …N are obtained

Sequentially Counter Balanced Design

For subject 1 the treatment

(i) 1, 2, N, 3, N-1, … occur in the cyclic matrix period 1, 2, 3, 4, 5, … N respectively

(ii) Obtain cyclic development (adding of one mode N) for subjects 2, 3, …N

(iii) The subject (N+1) is the mirror image(reverse order) of the subject N arrangement and the rest subject is again obtain through cyclic development.

(iv) By removing the last period we get incomplete sequentially counter balanced N-1 x 2N crossover design

3.3 Construction for the number of treatment, N= 5

Cyclic Matrix

Subject

Period	1 2 3 4 5
1 2 3 4 5	1 2 3 4 0 2 3 4 0 1 3 4 0 1 2 4 0 1 2 3 0 1 2 3 4

Every treatment occurs in each subject and each period, and each treatment precedes every other treatment four times

Incomplete sequentially counterbalanced 4 x10 design

Subject

Period	1 2 3 4 5 6 7 8 9 10
1 2 3 4	1 2 3 4 0 2 3 4 0 1 2 3 4 0 1 4 0 1 2 3 0 1 2 3 4 1 2 3 4 0 3 4 0 1 2 0 1 2 3 4

All treatments do not occur within the same subject and each treatment is preceded by each other treatments unequal number of times

4.0 Row Method Approach for the Number of Treatment N is Even

Cyclic Matrix

For period 1 the treatment

(i) 1, 2, …, N occur in the subject 1, 2, …N respectively

(ii) Cyclic development(adding of one mode N) for period 2, 3, …N are obtained

Sequentially Counter Balanced Design

For period 1 the treatment

(i) 1, 2, N, 3, N-1, … occur in the cyclic matrix subject 1, 2, 3, 4, 5, … N respectively

(ii) Obtain cyclic development (adding of one mode N) for period 2, 3, …N

(iii) By removing the last subject we get incomplete sequentially counter balanced N x N-1crossover design

4.1 Construction for the number of treatment, N= 4

Cyclic Matrix

Subject

Period	1 2 3 4
1 2 3 4	1 2 3 0 2 3 0 1 3 0 1 2 0 1 2 3

Every treatment occurs in each subject and each period, and each treatment precedes every other treatment three times Incomplete sequentially counter balanced 4 x 3 design

Subject

Period	1 2 3
1 2 3 4	1 2 0 2 3 1 3 0 2 0 1 3

All treatments do not occur within the same period and each treatment is preceded by each other treatment twice.

4.2 Row Method Approach for the Number of Treatment N is Odd

Cyclic Matrix

For period 1 the treatment

(i) 1, 2, …, N occur in the subject 1, 2, …N respectively

(ii) Cyclic development(adding of one mode N) for period 2, 3, …N are obtained

Sequentially Counter Balanced Design
For period 1 the treatment

(i) 1, 2, N, 3, N-1, … occur in the cyclic matrix subject 1, 2, 3, 4, 5, … N respectively
(ii) Obtain cyclic development (adding of one mode N) for period 2, 3, …N
(iii) The period (N+1) is the mirror image (reverse order) of the period 1 arrangement and the rest period is obtained through cyclic development.
(iv) By removing the last subject we get incomplete sequentially counter balanced 2N x N-1 crossover design

4.3 Construction for the number of treatment, N= 5
Cyclic Matrix

Subject

Period	1 2 3 4 5
1	1 2 3 4 0
2	2 3 4 0 1
3	3 4 0 1 2
4	4 0 1 2 3
5	0 1 2 3 4

Every treatment occurs in each subject and each period, and each treatment precedes every other treatment four times
Incomplete sequentially counter balanced 10 x 4 design

Subject

Period	1 2 3 4
1	1 2 0 3
2	2 3 1 4
3	3 4 2 0
4	4 0 3 1
5	0 1 4 2
6	3 0 2 1
7	4 1 3 2
8	0 2 4 3
9	1 3 0 4
10	2 4 1 0

All treatments do not occur within the same period and each treatment is preceded by each other treatment unequal number of times.

5.0 Discussion of Result

It was discovered that the order of treatments allocation changed under incomplete sequentially counter balanced design from that of cyclic matrix and all treatment do not occur within the same subject and the same period for column and row method respectively. For column method approach, all treatments do not occur within the same subject and each treatment is preceded by each other treatment once for the number of treatment, N=4; all treatments do not occur within the same subject and each treatment is preceded by each other treatments unequal number of times for the number of treatment, N=5. For row method approach, all treatments do not occur within the same period and each treatment is preceded by each other treatment twice for the number of treatment, N=4; all treatments do not occur within the same period and each treatment is preceded by each other treatment unequal number of times for the number of treatment, N=5

6.0 Conclusion

Constructing incomplete counterbalancing for immediate sequential effects through complete counterbalancing for immediate sequential effects will leads to change in the order of treatment allocation and all treatment do not occur within the same subject or period. Therefore, it is not uniform design for not all the treatments appear in each subject and each period for column and row method respectively.

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Author Profile

Adebara Lanre received the BSc and MSc degrees in Statistics from the University of Ilorin, Ilorin, Kwara State, Nigeria in 2002 and 2006 respectively. He began his lecturing career in 2013 at The Federal Polytechnic, Ado Ekiti, Ekiti State, Nigeria. He is happily married with children.