Understanding Studies with a Single Level of Clustering

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Learning Objectives

Define a level of data.

Define a single level study.

Describe how single level cluster designs induce correlation.

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Learning Objectives

Recognize a single level study.

Recognize that some authors use the terms group- or cluster-randomized trial or observational cluster or hierarchal study, rather than using the level terminology.

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A level of data is a position within a hierarchy of units

Study designs can have any number of levels.

We will examine both single- and multi-level models.

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To better understand levels of data, consider the hierarchical structure of a school

School

Classroom within school

Students within classrooms

Two levels within each school

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Single level studies involve only one layer of correlation

Levels of correlation:

1. Classrooms within schools are correlated.

Single level design

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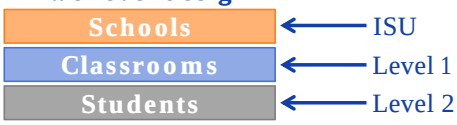
Multilevel designs can involve any number of levels

Levels of correlation:

1. Classrooms within schools.
2. Students within classrooms.

Two level design



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Single level studies contain just one layer of correlation

Units of observation within the independent sampling unit are correlated.

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Recognize a single level study

Some authors use the terms group- or cluster-randomized trial or observational study, instead of using the level terminology.

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To better understand single level designs, we discuss an example

Vignette

A single level study examined the efficacy of a workplace training program to reduce alcohol consumption. Researchers randomized workplaces to two treatment groups.

Adapted from Reynolds, G. Shawn and Joel B. Bennett, 2015

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To better understand single level designs, we discuss an example

Vignette, continued

The first treatment included a workplace training program and the second treatment included no training. Post-treatment drinking rate for each worker was measured as the outcome of interest.

Adapted from Reynolds, G. Shawn and Joel B. Bennett, 2015

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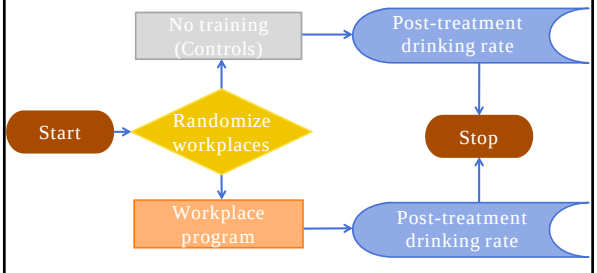
Employees were surveyed after randomization to study groups



Adapted from Reynolds, G. Shawn and Joel B. Bennett, 2015

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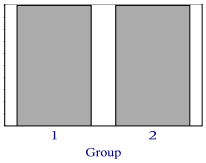
Researchers hoped to observe an association between treatment and reduction in drinking

Null hypothesis:

There is no difference in post-treatment drinking frequency between workers who receive no training and workers who receive the workplace program.



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This was a single level design with one outcome measurement in time

The sampling feature in the design that created correlations was the clustering of workers within the workplace.

Adapted from Reynolds, Shawn and Bennett, 2015

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The study is a single level design with one outcome measurement

Independent sampling unit: Workplace

Unit of observation: Drinking rate for each employee after treatment

Adapted from Reynolds, G. Shawn and Joel B. Bennett, 2015

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The scientists evaluated the impact of treatment on employee behaviors

Between-independent sampling unit factor:

Intervention (standard-of-care or workplace drinking program)

Within-independent sampling unit factor:

Cluster membership

Interest in factor levels depends on setting

Adapted from Reynolds, G. Shawn and Joel B. Bennett, 2015

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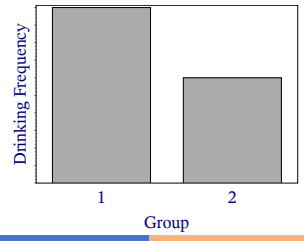
Analysis compared post-treatment drinking frequency between the two treatment groups

Scientific goal: **REJECT** the null hypothesis



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Measurements of drinking frequency of workers within a workplace are correlated

Some workers drink together.

Some workers attend sobriety programs together.

Workers discuss drinking habits with each other.

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Exchangeability is the defining feature of cluster members

Worker identification numbers (IDs) are assigned randomly within a workplace.

Labels (ID values) are arbitrary and can be exchanged.

Exchangeable sampling defines a level of clustering.

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Exchangeable sampling induces a pattern of equal correlation

The correlation between any pair of workers is the same as the correlation between any other pair.

The common correlation is described as the intraclass correlation coefficient (ICC).

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In turn, random assignment of clusters allowed making two important assumptions

1. The correlation between any pair of workers in the intervention group **is equal to** the correlation between any pair of workers in the control group.

2. Pre-existing employee factors did not bias study outcomes.

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Some authors use the terms group- or cluster randomized trial or observational study

Authors use these terms instead of using the level terminology.

You will find it helpful to recall the alternative terminology when reviewing manuscripts.

Murray, D. M., 1998

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Groups are collections of smaller units which share similarities

Groups are non-random, naturally occurring features of hierarchies, "identified by some physical, geographic, social, or other connection among their members"

p. 1, Murray, D. M., 1998

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Groups are collections of smaller units which share similarities

Examples of groups include:

- Worksites
- Schools
- Hospitals
- Clinics
- Neighborhoods
- Cities

Murray, D. M., 1998

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Research designs often involve groups

A group randomized trial involves random assignment of "identifiable groups that are not constituted at random"

The randomization of groups to treatment and random labeling of members within groups (creating exchangeability) leads to meeting the assumptions of cluster designs.

p.1, Murray, D. M., 1998

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The special properties of cluster designs can be achieved with groups

Consistent with their focus on controlling the sample process, survey sampling authors prefer the term cluster to group.

The terms "multilevel" and "hierarchal" are also used by some authors.

What matters is the validity of the assumption of exchangeability of members at a level. If so, the terms are synonymous.

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Review Summary

- A single level study involves only one hierarchical level, or one level of correlation (ex. students within a classroom)
- Remember that some authors use the terms group- or cluster-randomized trial or observational cluster or hierarchal study, rather than using the level terminology.

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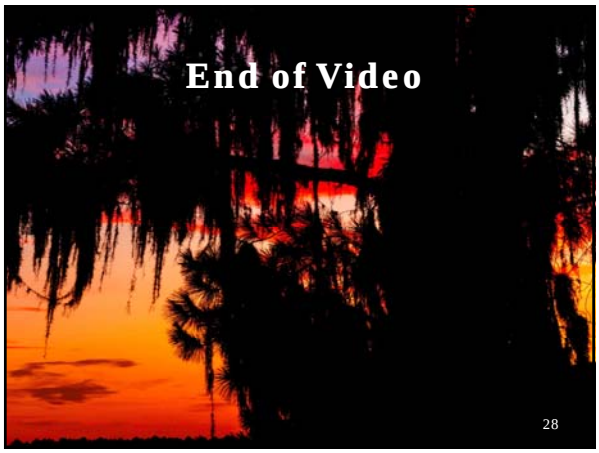
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