



Single-Case Design Research Methods

SINGLE-CASE DESIGNS (SCDs): WHAT THEY ARE

Studies that use a single-case design (SCD) measure outcomes for cases (such as a child or family) repeatedly during multiple phases of a study to determine the success of an intervention. The number of phases in the study will depend on the research questions, intervention, and outcome(s) of interest (see Types of SCDs on page 4 for examples). For the Home Visiting Evidence of Effectiveness (HomVEE) review, the interventions of interest are early childhood home visiting models, and outcomes of interest must fall within at least one of eight domains.¹

Features of a Single-Case Design

- Researchers administer the intervention and collect data for an **individual case** (such as a child or family).
- Each case serves as its **own control**, so there is no need for a comparison group in the study design.
- The outcome is **measured repeatedly** throughout the study.

SCDs rigorously test the effectiveness of an early childhood home visiting model using a relatively small sample. Researchers can compare (a) outcomes measured when the child or family *is receiving services* from the home visiting model with (b) outcomes measured *before and after the child or family receives services* from the home visiting model. This allows each child or family to serve as its own comparison. This feature of SCDs enables researchers to isolate the impact of the home visiting model on the outcome of interest from changes that could occur naturally because of child development or for other reasons.

SCDs: WHAT THEY ARE NOT

SCDs are **not** group design studies (such as randomized controlled trials or non-experimental designs) in which researchers recruit large samples to participate in the research.

Although they often focus on a small sample of children or families, SCDs are **not** necessarily inexpensive evaluation designs. Researchers allocate substantial resources to tracking participants over time and repeatedly measuring outcomes. They collect multiple data points per child or family, per phase of the study, to ensure they have enough data to determine the success of the home visiting model. In group designs, researchers spend time and resources on recruiting a large sample to collect data at a few points; in SCDs,

¹ HomVEE reviews research that use measures that fall into at least one of the following outcome domains: child development and school readiness; family economic self-sufficiency; maternal health; reductions in child maltreatment; child health; linkages and referrals; positive parenting practices; and reductions in juvenile delinquency, family violence, and crime. See <https://homvee.acf.hhs.gov/outcomes> for additional information on outcome domains.

researchers spend time and resources on repeated data collection over more time points for a rigorous study with a small sample.

SCDs do **not** require creating groups within the study sample to determine if the home visiting model was successful. To determine the success of a home visiting model, group design studies separate participants into at least two groups—an intervention group (those who receive or are offered services from the home visiting model) and a comparison group (those who do not receive or are not offered services from the home visiting model). Instead of relying on a comparison group, in SCD research, each child or family serves as its own control; repeated data collection helps show each child or family’s business-as-usual pattern or outcome trend during phases when they are not receiving services from the home visiting model. Researchers then compare these data with outcomes collected when the child or family is receiving services from the home visiting model to determine how the intervention impacts outcomes for each child or family. As another benefit, because there is no comparison group in SCDs, all participants can receive the intervention during the study; in a group design study, participants in the comparison group do not receive the intervention.

SCDs VERSUS GROUP DESIGNS AND HOW HOMVEE HANDLES EACH

In the context of the research on early childhood home visiting models that HomVEE reviews, both SCDs and group designs must:

- Study a service that meets HomVEE’s definition of an early childhood home visiting model to be eligible for review
- Aim to determine if an early childhood home visiting model is effective
- Study the impact of the early childhood home visiting model on specific outcomes of interest specified by HomVEE (such as child health, child development and school readiness, and positive parenting practices)
- Be rated using design-specific standards to assess **internal validity** (confidence that the early childhood home visiting model is responsible for changes in outcomes)

Both types of designs can contribute to the evidence base for an early childhood home visiting model for which the HomVEE team applies the U.S. Department of Health and Human Services’ criteria for an “evidence-based early childhood home visiting service delivery model.”² (Note: Regardless of design type, only designs rated moderate or high when the design-specific standards were applied are considered part of the evidence base.)

Despite many similarities, SCDs and group design research have important differences, including differences in how HomVEE assesses the internal validity of research using each design. Exhibit 1 presents key characteristics of both designs.

²See <https://homvee.acf.hhs.gov/about-us/hhs-criteria> for additional information on the U.S. Department of Health and Human Services criteria for an “evidence-based early childhood home visiting service delivery model.”

Exhibit 1. Key characteristics of SCDs and group designs for HomVEE

Research component	SCDs	Group designs (RCTs and NEDs)
Dependent variable – <i>the outcome researchers expect to change because of the early childhood home visiting model</i>	Measured repeatedly before, during, and after participants receive services from the early childhood home visiting model	Often measured before and after participants receive services from the early childhood home visiting model
Independent variable – <i>the intervention or early childhood home visiting model that is being tested</i>	The presence or absence of the early childhood home visiting model in various phases	The presence or absence of the early childhood home visiting model is by group (present in the intervention group and absent in the comparison group)
Baseline period – <i>phase(s) of the study during which the early childhood home visiting model is not being administered</i>	Researchers measure initial data until there is a consistent pattern in results to serve as the comparison condition (and implement the early childhood home visiting model after that point)	Researchers measure data in intervention and comparison groups before participants receive services from the early childhood home visiting model to assess whether the groups look similar for comparison purposes before the intervention group receives services from the childhood home visiting model
Internal validity – <i>the degree to which one is confident that the early childhood home visiting model is responsible for driving changes in outcomes</i> <i>Note: The HomVEE study rating of low, moderate, or high comes from the assessment of internal validity based on the application of the appropriate design standards. For more information on the design standards, see the HomVEE Handbook Version 2.1.</i>	HomVEE's rating depends on whether researchers considered design elements such as the following: <ul style="list-style-type: none"> ❖ Controlling when participants are offered services from the early childhood home visiting model ❖ Ensuring the introduction of the early childhood home visiting model is the only difference between the baseline and intervention phases ❖ Collecting enough data points per case in each phase to capture any effects of the early childhood home visiting model ❖ Collecting data consistently in all phases of the study 	HomVEE's rating depends on whether researchers considered design elements such as the following: <ul style="list-style-type: none"> ❖ Controlling when participants receive services from the early childhood home visiting model ❖ Ensuring the intervention and comparison groups were similar at baseline ❖ Collecting data from enough participants after administering the early childhood home visiting model to capture any effects of the intervention
Analysis of causal effects – <i>methods that researchers use to draw conclusions about the study</i>	Researchers systematically review the visual patterns in the data, analyzing trends in data points and whether trends differ by phase For some SCDs*, researchers also can estimate an effect size to determine how large the difference in outcomes is	Researchers often calculate an effect size to determine how large the difference in outcomes is
Causality - <i>the claim that one thing led to another, such as participation in an early childhood home visiting model causing changes in participant outcomes</i>	With strong internal validity, researchers can make causal claims about how a model affects <i>a small sample of individuals or families</i>	With strong internal validity, researchers can make causal claims about how a model affects <i>a group of individuals or families</i>
External validity – <i>the degree to which the study results apply to various settings and populations</i>	Can be stronger for populations that are similar to the specific study sample, however, can be limited in SCDs because of the focus on a smaller and more specific sample	Can be stronger in group designs because they often include larger and possibly more diverse samples

* An effect size cannot be calculated for all types of SCDs because of methodological limitations.

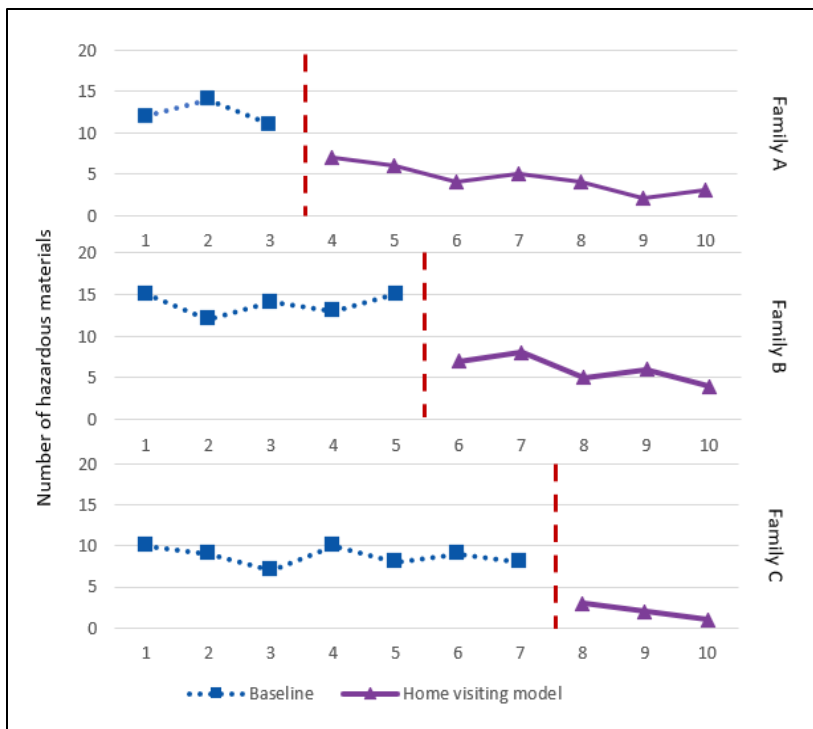
HomVEE = Home Visiting Evidence of Effectiveness; NEDs = non-experimental designs; RCTs = randomized controlled trials; SCDs = single-case designs

TYPES OF SCDs

Researchers commonly use four types of SCDs to determine the success of an intervention: (1) multiple baseline/multiple probe, (2) treatment reversal/withdrawal (ABAB), (3) changing criterion, and (4) alternating treatment. In HomVEE, multiple baseline/multiple probe and treatment reversal/withdrawal (ABAB) are the two most-used designs among early childhood home visiting models that have been prioritized for review to date.

In a **multiple baseline/multiple probe design**, researchers collect data for cases (such as a child or family) in the baseline phase before they receive the intervention. Researchers collect baseline data to determine the level, pattern, or trend of the measure(s) of interest before administering the intervention, which they then compare with outcome data collected during the intervention to determine the intervention's effects.

Exhibit 2. HomVEE example of multiple baseline design



HomVEE example of a multiple baseline design

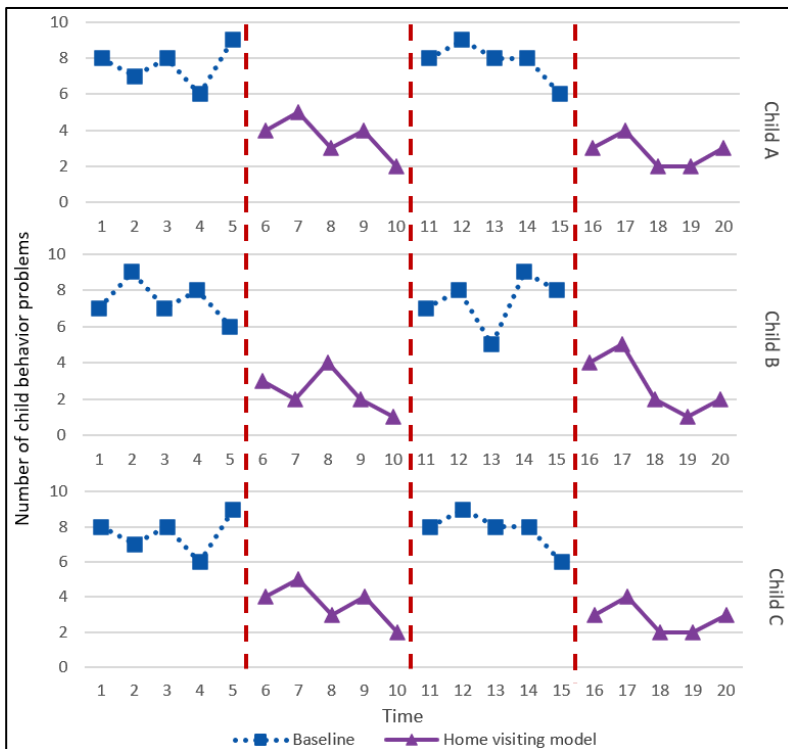
An early childhood home visiting model wants to decrease the number of hazardous materials in the homes of families with young children. The researchers recruit three different families to participate in the study—Family A, Family B, and Family C. All three families begin the study in the baseline phase, when none of them receives the early childhood home visiting model. Researchers collect outcome data on the number of hazardous materials in the home repeatedly to determine each family's baseline or business-as-usual condition. The researchers then begin administering the early childhood home visiting model to Family A and continue to collect data from all three families (intervention data from Family A and baseline data from Family B and Family C). After a phase of repeated measurement, the researchers then begin administering the early childhood home visiting model to Family B and continue to collect data from all three families (intervention data from Family A and Family B and baseline data from Family C). Again, after a phase of repeated measurement, the researchers then begin administering the early childhood home visiting model to Family C and collect intervention data for all three families.

In these studies, researchers can review the impact of the intervention on multiple cases (for example, the impact of the intervention on three different children) or they can look at the impact of the intervention on the same case across different settings (for example, the impact of the intervention on the same child in three different rooms in the house). Researchers stagger the introduction of the intervention to each case (or to the same case in multiple settings) to examine the impact on outcomes.

Multiple probe designs are structured in the same way as multiple baseline designs, but researchers do not collect data for each case during each time point or session of the study.³ This design can examine outcomes when it might be harmful to the child or family to measure outcomes frequently (such as physical child abuse) or when it is less feasible, because of study resources and processes, to collect more frequent data.

In a **treatment reversal/withdrawal (ABAB) design**, researchers first collect data during a baseline phase before the case receives the intervention. Researchers then collect data over a series of at least three more phases to determine the success of the intervention: a phase during which the intervention is applied, a withdrawal phase during which the case returns to the baseline condition, and then a second intervention phase.

Exhibit 3. HomVEE example of a treatment reversal/withdrawal (ABAB) design



HomVEE example of a treatment reversal/withdrawal (ABAB) design

An early childhood home visiting model aims to work with parents to reduce the number of child behavior problems. The researchers recruit three different children to participate in the study. Each child begins in the baseline phase, during which they do not receive the early childhood home visiting model. Researchers repeatedly collect outcome data on the number of negative child behaviors to determine children's behavior during the business-as-usual condition. For each child, the researchers then begin to administer the early childhood home visiting model, collect repeated data during intervention administration, and then remove the model, so that the child returns to the baseline phase. Following the second baseline phase, researchers re-administer the model to collect additional data during the intervention phase to determine the success of the early childhood home visiting model.

BENEFITS AND DRAWBACKS OF CONDUCTING SCD RESEARCH

As with all research designs, there are benefits and drawbacks to SCD research (Exhibit 4). HomVEE researchers and model evaluators should weigh the benefits and drawbacks and consider their research goals and available resources when determining the appropriate research design to assess the success of an early childhood home visiting model.

³Although researchers do not need to collect data in every session in a multiple probe design, they must collect at least three data points per phase (in addition to meeting other design requirements) to be rated moderate or high in the HomVEE review. This is also a requirement for multiple baseline designs.

Exhibit 4. Benefits and drawbacks to SCDs

<p>Benefits</p>	<ul style="list-style-type: none"> ❖ Researchers can conduct a rigorous study without requiring a large sample or withholding the intervention from some children or families. ❖ Researchers can use SCDs to explore the effect of an early childhood home visiting model on participants with characteristics that are relatively uncommon (such as developmental delays or specific behavioral challenges) or on a small population. ❖ SCDs can be more flexible than other designs. Researchers can increase the number of times they collect data during a phase to promote a stable set of observations, which might provide additional information about participant change. ❖ Specific information about which types of research participants responded to the intervention under specific conditions might be obscured when reporting results from a larger group design study (Horner et al. 2005). ❖ When using SCDs, researchers can provide detailed documentation of the study setting and characteristics of the cases (such as children and families) that responded to the intervention and those that did not, which can help improve external validity (that is, whether someone implementing the home visiting model with different cases outside of the testing setting would get similar results).
<p>Drawbacks</p>	<ul style="list-style-type: none"> ❖ Like findings from group design studies with small samples, findings from SCD research might not apply to populations or settings outside the study. ❖ The repeated measurement needed to ensure a rigorous design can be costly and challenging, even for the small samples SCD researchers examine.

REFERENCE

Horner, Robert H., Edward G. Carr, James Halle, Gail McGee, Samuel Odom, and Mark Wolery. "The Use of Single-Subject Research to Identify Evidence-Based Practice in Special Education." *Exceptional Children*, vol. 71, no.2, 2005, pp.165–179.

ADDITIONAL RESOURCES

The views expressed in these resources do not necessarily reflect the views or policies of the Office of Planning, Research, and Evaluation, the Administration for Children and Families, or the U.S. Department of Health and Human Services.

SCD Standards Online Training (What Works Clearinghouse): <https://ies.ed.gov/ncee/wwc/SingleCaseTraining> Note: This resource is intended for reviewers conducting systematic reviews of SCD research, but the standards can be used to help researchers design and execute strong SCDs.

Advanced Training on Single-case Research Methods (Institute for Education Science and University of Oregon): <https://singlecaseinstitute.uoregon.edu/sample-page/>

Single Subject Research (University of Connecticut): <https://researchbasics.education.uconn.edu/single-subject-research/#>

Evidence and Equity: Challenges for Research Design (Office of Planning, Research, and Evaluation): https://www.acf.hhs.gov/sites/default/files/documents/opre/whitesell_opre_brief_clean_508.pdf

Example of a rigorous SCD study in educational research (What Works Clearinghouse): <https://ies.ed.gov/ncee/wwc/Study/127>

Design Options for Home Visiting Evaluation – Single-Case Design Brief (JBA). <https://www.jbassoc.com/wp-content/uploads/2018/03/Selecting-Single-Case-Designs.pdf>

Submitted to:

Amanda Coleman, Project Officer
 Shirley Adelstein, Project Officer
 Jesse Coe, Project Specialist, Jefferson Solutions
 Office of Planning, Research, and Evaluation
 Administration for Children and Families
 U.S. Department of Health and Human Services

Contract Number:

GS-10F-0050L/HHSP23320150115G
 Mathematica Reference Number:
 50096.05.T09.090.000

Submitted by:

Project Director: Emily Sama-Miller
 Mathematica
 1100 1st Street NE,
 12th Floor, Washington, DC, 20002

This brief is in the public domain. Permission to reproduce is not necessary. Suggested citation:

DeLisle, D., M.C. Bradley, and E. Sama-Miller. (2021). "Single-Case Design Research Methods." OPRE Report #2021-219. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2021.