

# Using Mixed Methods Effectively in Prevention Science: Designs, Procedures, and Examples

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**Abstract** There is growing interest in using a combination of quantitative and qualitative methods to generate evidence about the effectiveness of health prevention, services, and intervention programs. With the emerging importance of mixed methods research across the social and health sciences, there has been an increased recognition of the value of using mixed methods for addressing research questions in different disciplines. We illustrate the mixed methods approach in prevention research, showing design procedures used in several published research articles. In this paper, we focused on two commonly used mixed methods designs: concurrent and sequential mixed methods designs. We discuss the types of mixed methods designs, the reasons for, and advantages of using a particular type of design, and the procedures of qualitative and quantitative data collection and integration. The studies reviewed in this paper show that the essence of qualitative research is to explore complex dynamic phenomena in prevention science, and the advantage of using mixed methods is that quantitative data can yield generalizable results and qualitative data can provide extensive insights. However, the emphasis of methodological rigor in a mixed methods application also requires considerable expertise in both qualitative and quantitative methods. Besides the necessary skills and effective interdisciplinary collaboration, this combined approach also requires an open-mindedness and reflection from the involved researchers.

**Keywords** Prevention science · Prevention research · Mixed methods · Designs · Procedures

## Introduction

While the social sciences have been engaging in mixed methods research for decades, this methodological approach is becoming increasingly important in health science research (Halcomb et al. 2009; O’Cathain 2009). There is growing interest in using a combination of quantitative and qualitative methods to generate evidence of the effectiveness of health prevention, services, and intervention programs (Andrew and Halcomb 2009; Whitley 2007). In some studies, quantitative and qualitative data are collected concurrently because researchers needed to know the reasons behind the numbers obtained from a quantitative intervention [e.g., to study decisions regarding choices for colorectal cancer screening (Ruffin IV et al. 2009)]. In other studies, quantitative and qualitative data are collected sequentially to develop a quantitative instrument or gain in-depth understanding of qualitative results [e.g., to study barriers to mammogram screening (Puschel and Thompson 2011)]. The use of quantitative and qualitative methods together provides a better understanding of research problems than either approach alone (Bryman 2006).

With the emerging importance of mixed methods research across the social and health sciences, there has been an increased application of the mixed methods for addressing research questions in different disciplines. Researchers must be able to select appropriate mixed methods designs and understand the methodological issues they encounter in conducting the design process. In this article, we show the key design procedures necessary to use concurrent and sequential mixed methods approaches, with four example studies applied to prevention research. For each example, we discuss the types of mixed methods used, the reasons and advantages/disadvantages for using them, the procedures for

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qualitative and quantitative data collection and analysis, and benefits and challenges of using mixed methods.

### Defining Mixed Methods Research and Design Types

Mixed methods research combines elements of qualitative and quantitative research approaches to understand and corroborate study outcomes in terms of both depth and breadth (Johnson et al. 2007). A mixed methods research design is a set of procedures for collecting, analyzing, and mixing both quantitative and qualitative data in a single study to understand a research problem (Creswell and Plano Clark 2011).

Methodologists recommended a parsimonious typology of four mixed methods designs (Creswell and Plano Clark 2007). The four major designs are convergent parallel design, embedded design, explanatory design, and exploratory design. This typology is based on several distinguishing factors: whether quantitative and qualitative data are combined or merged (concurrent), whether one form of data type builds on the other (sequential), the intent of the design, and the procedures used within the design. An emphasis has been placed on the development of mixed methods design typologies to provide guidance to researchers when designing and conducting their mixed methods projects. Scholars suggest that the typology be organized by research questions (Newman et al. 2003; Yin 2006).

In this article, we focus on two commonly used mixed methods designs: concurrent and sequential mixed methods designs. In concurrent designs, the collection and analysis of both qualitative and quantitative data sets are carried out separately, and the findings are not consolidated until the interpretation stage; while in sequential designs, data sets are analyzed in a particular sequence to allow one method to inform another (Onwuegbuzie and Teddie 2003). The primary dimensions that distinguish these two types of designs: the priority given to qualitative or quantitative methods and whether these two methods are implemented concurrently or in sequence (Greene 2008).

### Developing Mixed Methods Design Procedures

Mixed methods research should be driven by the underlying principle that qualitative and quantitative data together can provide the best means to answer the research question. Researchers can collect quantitative and qualitative data either sequentially or concurrently. When data are collected sequentially, either qualitative or quantitative data can come first. The timing or sequence decision depends on the focus of the study. When qualitative data are collected first, the researcher may decide to develop and expand the understanding of the qualitative results through a second quantitative phase in which data are collected from a larger sample. When data are collected

concurrently, both quantitative and qualitative data are gathered at roughly the same point in the research project. When quantitative data are collected first, the researchers may want to identify specific quantitative findings that need additional explanation (e.g., statistical differences among groups, individuals who scored at extreme levels, or unexpected results.)

#### Collecting Quantitative Data and Qualitative Data Concurrently

Concurrent designs enable researchers to compare or complement open-ended qualitative data with close-ended quantitative data to determine if the two datasets provide similar, different, or contradictory information about a research problem. A qualitative component can also be nested concurrently within a quantitative component of an intervention trial. There are three options for integrating data in concurrent designs: analyzing both datasets separately and then comparing the results in a discussion, transforming one type of data into the other, or creating a table in which both forms of data are represented (Creswell and Plano Clark 2011). Data convergence is the most common mixing procedure used in the concurrent designs. The researcher often collects and analyzes quantitative and qualitative data separately on the same phenomenon and then converges the different results during interpretation. Researchers may compare, validate, confirm, or corroborate quantitative and qualitative findings. For example, DeVoe and colleagues (2008) used a concurrent design to investigate factors that influence children's unmet health care needs in Oregon. The quantitative component included survey data from a random sample of families from Oregon's food stamp population with children eligible for public insurance. The qualitative component included parents' written narratives. The authors analyzed the narrative data qualitatively and the survey data quantitatively and then merged the two sets of results. The quantitative and qualitative results were synthesized in the discussion and summary section. The results could be the discovery of contradictions between the qualitative and quantitative findings. Johnson and Turner (2003) pointed out that one benefit of mixed methods research is to elucidate divergent aspects of a phenomenon. Padgett (2004) suggested that if additional time or resources are not available to further the study, results should be presented together and directions for future research defined.

#### Collecting Quantitative Data and Qualitative Data Sequentially

The researchers collect qualitative and quantitative data in two or more phases in sequential designs, with subsequent phases built on earlier ones. When quantitative data collection precedes qualitative data collection, qualitative data can build on initial quantitative results. More often, the research objective is to use the qualitative data to help explain the quantitative findings, in which case the qualitative research component

can be incorporated into a quantitative experiment design, such as collecting qualitative data after an intervention trial in order to explain/explore the quantitative results. For example, Gipson and Hindin (2008) applied a sequential design to explore women's and couples' motivations to terminate pregnancies in rural southwestern Bangladesh. Quantitative data were derived from cross-sectional surveys and a longitudinal demographic surveillance system. Qualitative data were gathered subsequently through 84 in-depth interviews conducted with 19 couples. The sequential design can also be used when researchers want to identify participants or form groups based on quantitative results and follow-up with the individuals or groups through subsequent qualitative research (Creswell and Zhang 2009). Alternatively, when qualitative data collection precedes quantitative data collection, the intent is to use the quantitative method to expand the initial qualitative results with a large sample. The results of the first qualitative method can help develop or inform the second quantitative method. This design type often starts with the collection and analysis of qualitative data with a few subjects or sites. The second quantitative phase of the study is often developed based on or informed by the results of the first qualitative phase. For example, Lemaire and Wallace (2010) applied this design model to explore factors related to physician wellness within a large health region in Western Canada. The major themes extracted from the qualitative interviews were used to construct 12 survey items that were subsequently included in the quantitative questionnaire.

#### Integrating Quantitative and Qualitative data in Mixed Methods Designs

The integration or mixing of quantitative and qualitative data may occur at several stages in the research process, including data collection, data analysis, interpretation of results, or some combination of these stages. Methodologists have identified three main mixing procedures (Zhang and Creswell 2012): (1) the researchers analyze the two types of data separately and integrate the results during interpretation; (2) the researchers connect the two methods—one approach builds upon the findings of the other; or (3) the researchers embed the two data types during analysis by embedding the analysis of one data type within the other—this type of design is particularly useful when a researcher needs to include a qualitative component within a quantitative design (e.g., an experimental design). Mixing at the stage of data analysis and interpretation may involve transforming qualitative themes into numbers and comparing that information with quantitative results in the “Discussion” section of the study. Woltmann and Whitley (2007) applied a concurrent embedded procedure to examine strategies for overcoming staffing barriers during implementation of integrated dual disorders treatment. Quantitative data

included fidelity scores and measurement of the penetration rate over 24 months. Qualitative data were gathered through interviews and field observation while the implementation was in progress. Qualitative and quantitative data were integrated in the data analysis stage. Fidelity and penetration scores over time were displayed graphically for linkage with qualitative data. Both quantitative and qualitative results came together in the discussion section of this article. The choice of a certain mixing methods and techniques is informed by researchers' own perspective. What is important is what works best for a specific research problem in practice. The place where the mixing occurs is related to the design type and the phase of data collection and analysis.

#### Using Mixed Methods in Prevention Research

Research methods in prevention research using only a quantitative approach may be inadequate because these programs involve understanding human behavior and the decision-making process in complex social contexts. Mixed methods can be used in process evaluation to examine the participants' views, study how the program was implemented, and investigate contextual factors that affect an intervention (Oakley et al. 2006). A mixed methods study can serve as a formative evaluation in identifying the best practices for providing information to an existing prevention research program.

The Centers for Disease Control and Prevention reports that the screening rates for breast and cervical cancers are below national targets (Centers for Disease Control and Prevention 2012b). Both cervical and breast cancer screening rates have hit a plateau, and the colorectal cancer screening rate is very low, based on Behavioral Risk Factor Surveillance System prevalence and trends data (Centers for Disease Control and Prevention 2012a). A different approach, such as a mixed methods design, will be useful to develop better, more effective and relevant interventions.

Researchers used mixed methods approach to offer a more comprehensive understanding of the contexts and the processes involved in prevention research. Empirical mixed methods studies in prevention science have been published in peer reviewed journals on various topics such as substance abuse (e.g., Nagel et al. 2009), smoking cessation (e.g., Douglas et al. 2010), disease management (e.g., Esposito et al. 2009), and HIV prevention (e.g., Sahin-Hodoglugil et al. 2009). Mixed methods research can enhance the quality of health prevention programs and will help researchers understand the success of intervention strategies, the barriers to program implementation, and the effectiveness of program design. For example, a mixed methods study provided preliminary evidence regarding the feasibility, acceptability, and potential effect of a complex health education intervention for adults with a diagnosis of schizophrenia (Bradshaw et al. 2010).

## Research Examples

Below, we present research examples that use a mixed methods approach in prevention science. In selecting examples, we have sought variety in the types of mixed methods strategies and how they are combined.

### Example 1: Using Concurrent Design to Investigate Factors Related to Colorectal Cancer Screening

*Study Aim and Reason for Using Mixed Methods Design* Ruffin et al. (2009) aimed to investigate factors that influence choice of a colorectal cancer (CRC) screening test among previously unscreened African Americans and Caucasian Americans. They chose a concurrent mixed methods study design to obtain a more robust and complete understanding of the contextual factors that influence an individual's choice to seek and receive a preferred CRC test.

*QUAN and QUAL Data Collection and Integration* The quantitative (QUAN) component of this study included survey data from 93 focus group participants, and the qualitative (QUAL) component included 10 focus group interviews (Fig. 1). The authors analyzed the focus group data qualitatively and the survey data quantitatively and then integrated the two sets of results to investigate the complex factors associated with an individual's choice of a CRC screening test.

The QUAN survey included a CRC knowledge and beliefs instrument consisting of 21 multiple-choice items, such as risk factors related to lifestyle, personal characteristics, and family history; effectiveness of early detection; screening tests; and beliefs about risks of surgery. The QUAL data were collected through the focus group sessions regarding the reasons for participation and nonparticipation, the factors influencing participants to be screened, and participants' awareness of the CRC test. The facilitators led a discussion about the reasons for choosing and not choosing a CRC test, and the focus group participants wrote their decisions/reasons in their own words. To enhance validity, the researchers used the text generated from the QSR N6 software to corroborate the identified themes. In the results section of the study report, the authors explained how they converged and compared QUAL and QUAN findings.

*Benefits and Challenges of Using Mixed Methods* Ruffin and colleagues obtained a more dynamic and complete understanding of factors related to CRC tests among previously unscreened individuals by integrating the QUAN and QUAL results. Using chi-square comparisons, the analysis revealed intra-group variations in CRC screening preference but no statistically significant differences between African Americans and Whites as a whole. The QUAL findings

suggested the importance of patient-physician dialogue about CRC test options. The authors encountered some challenges in applying a mixed methods design, including the limited generalizability of their findings due to the number of participants and small focus group sizes.

### Example 2: Using Sequential Design to Implement Health Planning for Mammography Screening

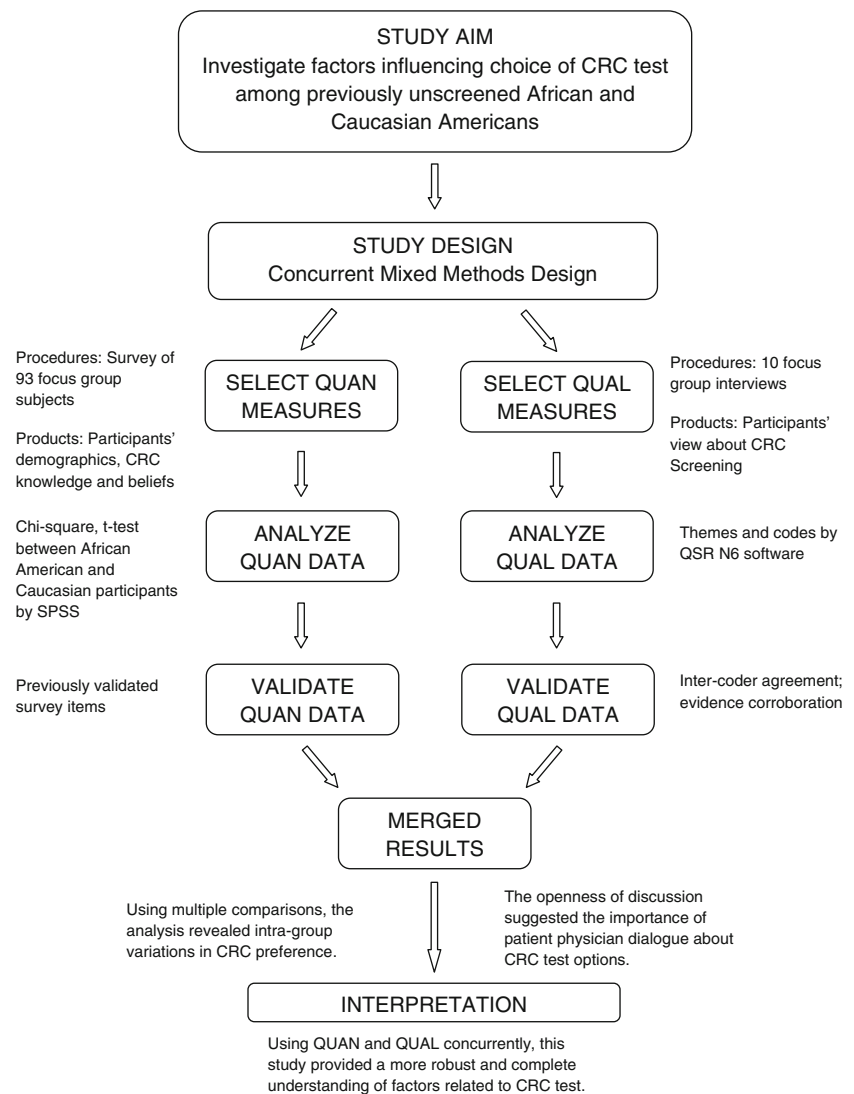
*Study Aim and Reason for Using Mixed Methods Design* Puschel and Thompson (2011) wanted to understand why women did not comply with mammography screenings and to encourage women to obtain mammography screenings. They chose a sequential mixed methods design to better understand the factors involved in the implementation of a breast cancer screening program.

*QUAN and QUAL Data Collection and Integration* The qualitative component included focus group sessions on women's experiences with breast cancer screening practices and diagnosis. The dominant quantitative component included a randomized clinical trial that compared opportunistic screening (usual care) with two intervention strategies of different intensity (Fig. 2).

The QUAL data were collected through seven focus groups with a total of 48 women that investigated the predisposing, enabling, and reinforcing factors associated with mammography screenings. The QUAL data, including semistructured interviews and field notes/observations, were audio and video recorded. The QUAN component used a randomized clinical trial of three intervention approaches for 500 women ages 50–70 years who had not had a mammogram in the past 2 years. The main outcome of the study was compliance with mammography screening as measured by self-report at baseline and 6 months. The QUAL and QUAN data were integrated by collecting QUAL data in phase 1 and using a randomized clinical trial design in phase 2 to test various interventions in a sequential strategy.

*Benefits and Challenges of Using Mixed Methods* The authors applied a two-phase, mixed methods sequential design for intervention development. The strength of this method was that results from the first phase raised questions and informed the design of the subsequent phase. A mixed methods approach was critical to ensure the feasibility and acceptability of complex interventions and to identify a number of challenges that needed to be addressed before conducting an effectiveness trial. Relevant information that could contribute to the effective application of health policies at a local level was obtained by integrating the QUAN and QUAL methods. The authors pointed out that the qualitative work may not be generalizable and suggested replicating the qualitative phase in another population.

**Fig. 1** Research example for using a concurrent design in colorectal cancer screening



### Example 3: Using Sequential Design to Conduct Cost Analysis

*Study Aim and Reason for Using Mixed Methods Design*  
Ekwueme et al. (2008) wanted to collect cost data on breast and cervical cancer screening and diagnostic services for low-income women enrolled in the National Breast and Cervical Cancer Early Detection Program (NBCCEDP). Findings from this study were expected to assist decision makers in allocating program resources equitably across the individual programs. The researchers used a mixed methods sequential design to fully address the research questions and developed a questionnaire to systematically collect activity-based costs on screening for breast and cervical cancer from nine participating programs in NBCCEDP.

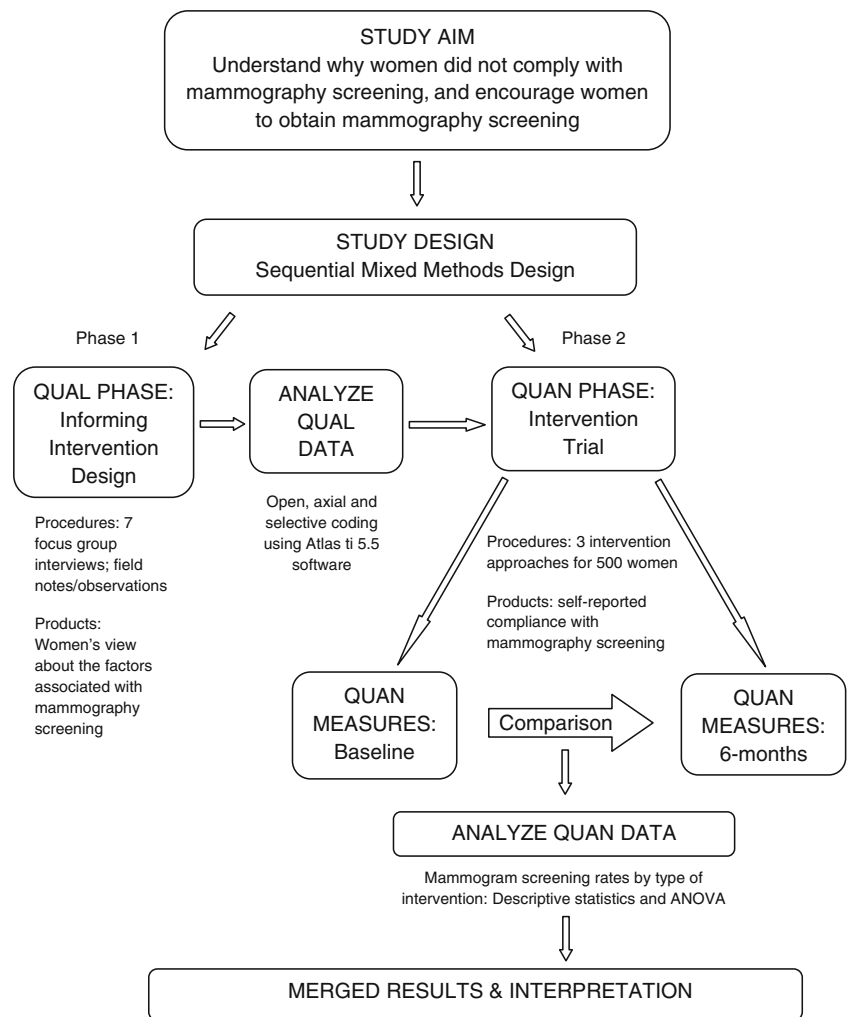
*QUAN and QUAL Data Collection and Integration*  
The authors applied an instrument development model of sequential exploratory design and proceeded in two data collection

and analysis phases. The first QUAL phase included a group interview with key staff members, and the second QUAN phase included a questionnaire to systematically collect activity-based cost data (Fig. 3).

The first QUAL phase data were obtained from the site visits. The researchers visited four programs and conducted QUAL group interviews with program directors and financial managers. Using these QUAL data in the first phase, the researchers developed a questionnaire to collect activity-based cost data. In the second QUAN phase, the authors systematically collected activity-based costs on breast and cervical cancer screening from nine participating programs. The QUAN and QUAL data from these two phases were then connected, which the themes derived from the QUAL phase were used to formulate the questions used in the second QUAN phase.

*Benefits and Challenges of Using Mixed Methods*  
The authors adopted a mixed methods sequential design approach in which qualitative data were collected during the first phase

**Fig. 2** Research example for using sequential design to implement health planning for mammography screening



An intervention based on qualitative information that addresses specific predisposing, enabling, and reinforcing factors can produce significant improvements in mammography screening practices.

of the study. The second phase incorporated findings from the first phase to develop a questionnaire for program evaluation. This study used both qualitative and quantitative data to address short-term economic costs in nine participating programs, and the results provided a good picture of the overall allocation of NBCCEDP resources in the selected programs. The authors indicated that the findings might help to promote informed decision-making in NBCCEDP once all programs had been surveyed. The authors were concerned about the generalizability of their findings. They pointed out that the average costs reported in this study may not be generalizable beyond the nine selected programs.

**Example 4: Using the Combination of Sequential and Concurrent Designs to Study the Effectiveness of an HIV Prevention Program**

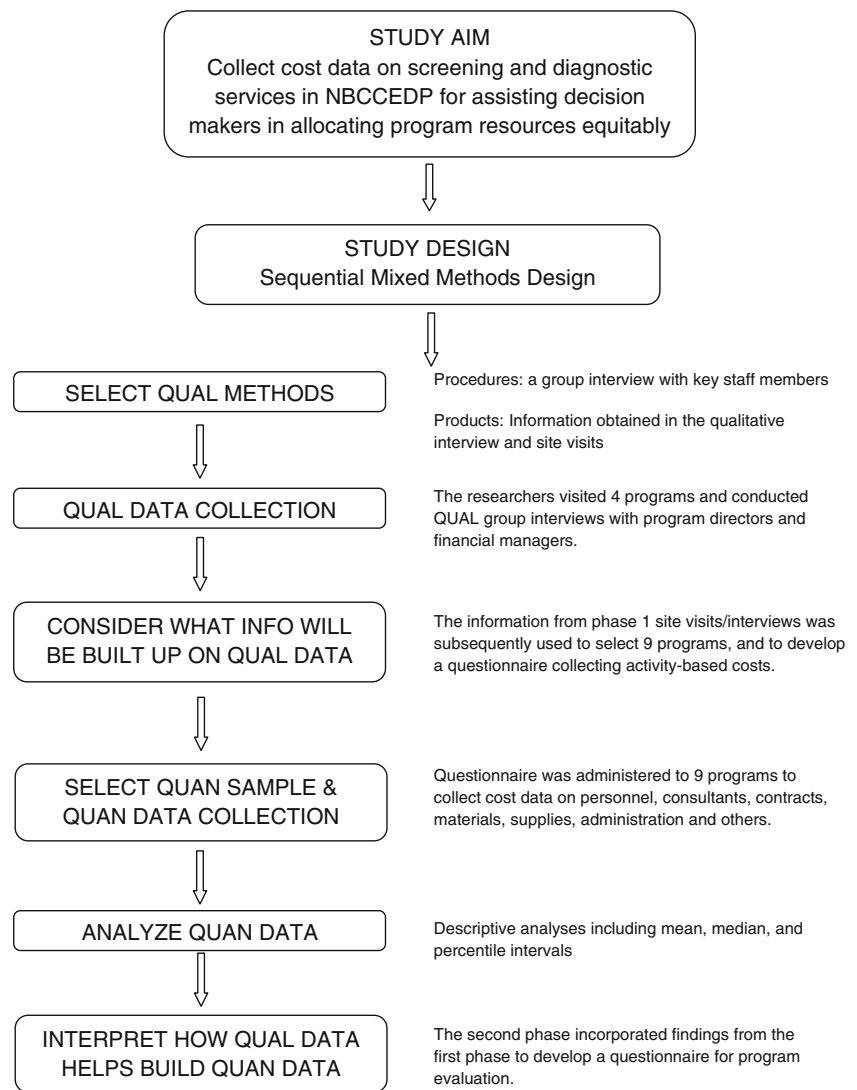
*Study Aim and Reason for Using Mixed Methods Design*  
The study of Sahin-Hodoglugil et al. (2009) was to explore the predictors and dimensions of covert use of the diaphragm

in a randomized controlled trial that tested its effectiveness for HIV prevention. The reason for including qualitative data collection during intervention was to provide a more comprehensive and nuanced understanding of covert use as a phenomenon, and the reason for conducting qualitative data collection after intervention was to explore the significant findings of the quantitative analysis after intervention.

*QUAN and QUAL Data Collection and Integration* This study was a secondary data analysis of quantitative and qualitative data from participants randomized to the intervention group and their male partners. The QUAN component included survey data from women participants. The QUAL data collection included focus group discussions conducted with selected women, and focus group discussions and in-depth interviews with the male partners (Fig. 4).

This study combined the features of both concurrent and sequential designs. First, a QUAL study was nested within an intervention study. Second, a QUAL study was conducted after the intervention to investigate female participants' and

**Fig. 3** Breast and cervical cancer screenings



their male partners' experiences with the trial. QUAL interview data during and after interventions were analyzed using a modified grounded theory approach to identify themes and patterns emerging from the data. The QUAL and QUAN data were integrated in the discussion section of this article.

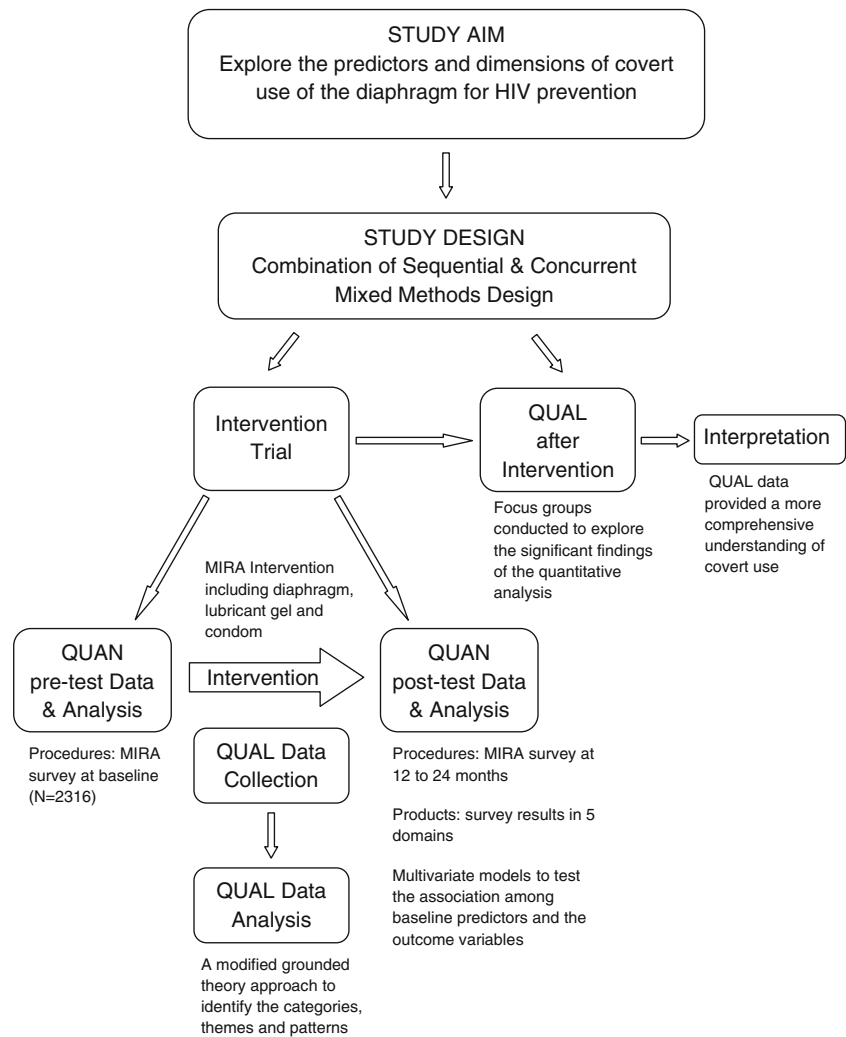
*Benefits and Challenges of Using Mixed Methods* The authors used both sequential and concurrent designs to study women's covert use of the diaphragm in an HIV prevention trial. Two main mixings occurred in the research process. During intervention, QUAN and QUAL data were collected concurrently to inform each other. After the intervention, structured interviews were conducted to gain additional understanding of the QUAN findings. The strength of this study was that it drew a more complete picture of covert use of the diaphragm. The authors pointed out that women's and their partner's experiences could be different outside of the MIRA trial setting.

## Discussion

In-depth information obtained from qualitative data is helpful when designing and evaluating a health prevention program for specific population groups, as shown in CRC and mammogram screening studies. The mixed methods approach can also be applied in health economics studies, as illustrated in the cost analysis of NBCCEDP. Qualitative information is needed because different NBCCEDP-funded programs serve different populations. Certain factors (e.g., support network) and specific funding needs may vary across programs.

Some major challenges have been identified in using mixed methods in several disciplines across the health sciences: lack of qualitative methodological rigor; lack of training in qualitative research; and barriers, such as word limits to publishing mixed methods studies (Zhang 2011). Mixed methods studies require more time and resources, and both quantitative and

**Fig. 4** Research example for using the combination of sequential and concurrent designs to study the effectiveness of an HIV prevention program



qualitative skill sets. Researchers wishing to use mixed methods research designs need to be proficient in both qualitative and quantitative research methods (e.g., basic assumption, data collection analysis procedures, interpretation of results), either as individuals or across a team of researchers. In addition to acquiring both quantitative and qualitative skills, researchers need to understand the conceptual framework underlying the mixed methods. Therefore, researchers can make informed choices about what methods to use. One of the most comprehensive publications of mixed methods is the “Handbook of Mixed Methods in Social and Behavioral Research” by Tashakkori and Teddlie (2010). The Annual International Mixed Methods Conference has become a central resource for mixed methods researchers. The emphasis of methodological rigor in a mixed methods application also requires considerable expertise in both qualitative and quantitative methods. Rigor is just as important in qualitative research as it is in quantitative research, but distinctive procedures must be used to assess it. Triangulation can be used to obtain a more trustworthy description of the qualitative data. For example, Ruffin et al. (2009) used evidence from the text to corroborate

the identified themes to enhance validity. One concern highlighted in the research examples examined in this paper is lack of generalizability of study findings resulting from non-representative sample in qualitative study components. The essence of qualitative research is to explore complex dynamic phenomena. The advantage of using mixed methods is that quantitative data can yield generalizable results and qualitative data can provide extensive and in-depth insights. Besides the necessary skills and effective interdisciplinary collaboration, this combined approach also requires an open-mindedness and reflection from the involved researchers.

Before designing and conducting a mixed methods study, researchers should carefully consider the aim of the study; the reason(s) for including a qualitative component; and researchers’ skill, time, and financial resources. Plans for data integration should be taken into consideration during the study design phase. We believe that the methodological considerations presented here will help to advance understanding of the application of mixed methods in prevention science.

Studies exploring prevention behavior and program implementation that are based purely on quantitative studies



may benefit by adding a qualitative perspective. Despite the additional time and costs involved, the mixed methods approach, using concurrent and/or sequential designs, is vital to evidence-based health science research.

**Conflict of Interest** None of the authors have any conflicts of interest to disclose.

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