Prevention Science (2019) 20:566–574
https://doi.org/10.1007/s11121-018-0958-6

Integrating Retention Rates into Economic Analyses of Prevention Interventions

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Published online: 28 November 2018

Abstract
Evidence-based prevention interventions hold great promise for enhancing the well-being of individuals, families, and society. As these interventions are implemented in new contexts and at wider scales, policymakers and private sector organizations are increasingly interested in understanding the economic returns that programs produce through reductions of burden on public service systems, such as criminal justice and human services. Thus, it is important to ensure that economic models account for factors, such as retention, which are important when interventions are implemented in real-world contexts with selective populations and voluntary participation. Yet the field of prevention has provided little guidance to help researchers and policymakers analyze the economics of interventions so that estimates reflect the impact of implementation factors on intervention cost-effectiveness. This paper discusses the role retention plays in the economic efficiency of interventions when the prevention of child maltreatment is the primary motivation for funding these programs. We present a conceptual model to serve as a guide for explicit inclusion of retention rates when calculating cost estimates to be used in cost-effectiveness analysis. A case study is presented, demonstrating the variability in estimates dependent on the definition of retention and the estimated retention rate. The results underscore the importance of improving our understanding of factors underlying and related to retention, such as engagement, which may improve the precision of cost and cost-effectiveness analysis in applied settings.

Keywords Retention · Cost analysis · Implementation · Evidence-based prevention · Successful service

Prevention researchers are increasingly highlighting the potential for evidence-based prevention interventions (EBPIs) to reduce the burden on social service programs (Costa 2012; Drake et al. 2009; Lee et al. 2012). The potential for EBPIs to save taxpayer money has resulted in the development of organizational enterprises, such as the Results First Initiative supported by the Pew and Macarthur foundations, which identify promising interventions and then generate estimates of the financial return that states can expect to accrue through investing in them (Dube and Pendergrass 2017). Furthermore, funding mechanisms that encourage private investment in prevention programs in exchange for a predetermined return on investment, such as Pay for Success financing, are increasing in popularity (Greenblatt and Donovan 2013).

Considering the increased spending on prevention programming, along with potentially paying public funds to private enterprises for investment in EBPIs, it is important that policymakers measure the impact of EBPIs on fiscal budgets and the return on investment that is generated from implementation trials in real-world settings. Cost analysis is therefore instrumental to policymakers when evaluating the performance of EBPIs because it details how limited resources are being used and serves as a precursor to estimating EBPIs' subsequent impact on public system costs (Results First 2014). When combined with outcomes analysis to determine the cost-effectiveness of an EBPI, cost analysis can be used to estimate the additional resource investment required to meet prevention goals, for example, preventing a certain number of cases of child maltreatment through the implementation of comparative EBPIs. As such, cost analysis and cost-effectiveness analyses are frequently included in evaluations during replication and wide-scale trials of these programs because they can provide an idea of EBPIs' economic efficiency compared to system and "treatment as usual" costs (Hoffmann et al. 2002).

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Overall, the existing literature on evaluations of EBPIs has revealed that effects typically dissipate when these programs are implemented in new contexts or wider scales. In general, results have been so poor that some researchers have called for a moratorium on the development of new programs until this problem can be solved (Kessler and Glasgow 2011).

Others have suggested that the emphasis on developing new interventions, as opposed to continually improving existing ones, creates barriers to researching methods of effectively implementing EBPIs at scale (Spoth et al. 2013; Woolf 2008). As a result, translational research, or the study of successfully transitioning EBPIs from "bench to bedside" and then "bedside to practice," is an emerging field with tremendous promise (Crowley and Jones 2015; Spoth and Greenberg 2011; Spoth et al. 2013). This includes research on implementation trials that replicate and take EBPIs to scale in new contexts, defined by Crowley and Jones (2015) as types 3 and 4 stages of development. During these stages, research that includes cost analysis should account for factors that are important considerations to practitioners but may not have been addressed during prior stages of development. However, research on the economics of EBPIs during implementation trials has been slow to emerge.

Recognizing the dearth of literature on the economics of EBPIs in implementation trials, a panel of scientists at the 19th annual meeting of the Society for Prevention Research (SPR) provided a set of research priorities on the economics of preventive interventions. The priorities include developing a better understanding of the impacts of scale-up on program efficiency, conducting economic analysis of EBPIs in real-world settings, and identifying promising areas of further research for economic analysis (Crowley et al. 2014). More recently, SPR's Mapping Advances in Prevention Science III Committee on Economic Analyses of Prevention updated these priorities to include evaluating program costs within different public systems, identifying moderating factors of economic impact, and using prevention versus natural environmental processes to evaluate economic impact (Crowley et al. 2018). These are broad and important issues, yet more guidance for using economic analysis methods in evaluating the economic efficiency of EBPIs is needed, as current economic estimates of EBPIs are more likely to represent optimal scenarios where implementation factors are not significant, rather than their true returns to the taxpayer (McKay 2013).

One factor that has received little attention in the economics literature is program retention, which is an important consideration for policymakers. Decreased retention rates may limit the cost-effectiveness of interventions, yet there has been surprisingly little guidance on how to account for retention when conducting economic analysis beyond comparing intent-to-treat results to treatment on the treated (Crowley et al. 2014; Crowley and Jones 2015; Foster and Jones 2006; Welsh et al. 2010; Yates 2018). Given that EBPIs tend to lose effects when they transition to implementation trials, economic researchers typically apply "scale-up penalties" to published effect sizes when evaluating EBPIs' potential economic impact (Welsh et al. 2010). For example, when evaluating the potential economic impact of child welfare interventions, the Washington State Institute for Public Policy (WSIPP) assesses a penalty greater than 50% on effect sizes published by researchers who are also developers of the program (WSIPP 2017). Other researchers have applied similar discounts to effect sizes from studies of efficacy trials of EBPIs, yet there have been few explanations for how these discounts are calculated and what they specifically account for, beyond publication bias (researcher as developer) and loss of generalizability (Welsh et al. 2010).

Publication bias and selective reporting may be especially pertinent to EBPIs, as there is evidence suggesting a "decline effect," or the tendency for program effects to be smaller during replication trials than effect sizes reported by program developers (Gorman 2017).

During the translational stages of research, it is therefore important for prevention researchers to integrate implementation factors into economic analyses of EBPIs to confirm, enhance, and refine estimates of the economics of EBPIs, particularly when interventions have yet to be evaluated independent of primary stakeholders (e.g., Henggeler et al. 2006; Littell 2006).

The purpose of this study is to begin addressing these gaps through a focus on home visitation programs. First, we briefly review the literature on program retention, highlighting evidence suggesting that retention rates are generally low in implementation trials, and that this is one of many factors contributing to limited effects because few families are receiving the recommended program content. Second, we describe cost analysis, which is an important element to evaluating the implementation of promising programs in new contexts and large scales (Crowley and Jones 2015). This includes the quantification of resources used to implement the program, including direct costs (e.g., staff salary, materials) and indirect costs (e.g., office space, administrative staff) (Haddix et al. 2003). In implementation trials, selective EBPIs (e.g., home visitation programs) operate at a large scale and may aim to serve specific populations that differ from those participating in efficacy trials. In these cases, variations in factors, specifically retention rates, increase in importance when evaluating the costs of a program. Finally, using data from the implementation of an evidence-based parental education program in a statewide trial, we provide an example of how program retention rates can change the economics of EBPIs in implementation trials. This example illustrates the importance of factoring retention rates into cost and cost-effectiveness analysis when participation is voluntary. We conclude with recommendations that may help spur additional research on using economic theory and analysis to improve the economic efficiency and cost-effectiveness of EBPIs.

Retention Rates in Prevention Programming

Central to prevention programming is the premise that receiving enough dosage of a program's content is necessary for the intended outcomes to be realized (Cicchetti and Hinshaw 2002). However, recruitment and retention rates of EBPIs historically have been low when participation is voluntary (Ingoldsby 2010). For example, a randomized controlled trial (RCT) of the universal component of the Triple-P program yielded an average recruitment rate of 23 and 27% in neighborhoods with a high or moderate number of social problems, respectively, while the recruitment rate was 44% in more advantaged neighborhoods (Heinrichs et al. 2005). Another intervention, the Healthy Families America (HFA) program, has experienced average attrition rates of 55% by the end of the first year of participation, and 62% by the end of the second year (Gomby 2007). An RCT of the Nurse-Family Partnership (NFP) occurring in Colorado yielded attrition rates of 38%, while concurrent implementation trials in three states yielded attrition rates between 60 and 70% (O'Brien et al. 2012). Overall, attrition rates from home visitation programs can be as high as 80% (Boller et al. 2014).

Retaining participants through the duration of a program's content is one of many challenges prevention programs face when transitioning to types 3 and 4 stages of translational research (Ingoldsby 2010; Ingoldsby et al. 2013). Many individuals do not fully participate in program activities, yet still receive a substantial portion of the content, and it remains unclear how to account for their participation in outcomes analyses (Yates 2018). Prior research on partial program completion has provided conflicted results, ranging from little effect without full participation (Duggan et al. 2004) to a positive linear trend between increases in participation and benefits (Lyons-Ruther & Melnick 2004). As such, there is no clearly accepted definition of participation in prevention programming. For instance, among home visitation programs, participation has been referred to as the number of visits a family attends, their time enrolled in the program, the quality of the engagement by participants, or a combination of all three factors (Holland et al. 2014).

More recent research focuses on the complex interactions occurring at and between the individual, program, and community levels, seeking to identify factors critical to designing and optimizing prevention programs to be more efficient and effective (Supplee et al. 2018). While still in the early stages, this portfolio of studies provides important insights into the variability inherent in the benefits and lessons participants take from their experiences with prevention programs, and thus provides a roadmap for future work to be done. For example, participation patterns and differences in practitioner-family relations have been proposed to more accurately explain the complexities of participants' experiences with programs, and how context may influence the benefits obtained from receiving a program's content (Holland et al. 2014, 2018). Importantly, these advances in the literature highlight the program-by-individual interactions that likely occur.

The Costs of Low Retention

Overall, it is apparent that home visitation programs are struggling to reach or retain populations of interest (Gomby 2007; Holland et al. 2018; Ingoldsby et al. 2013; Olds et al. 2013). This is problematic given the large amounts of public funds that are dedicated towards home visitation programs. For example, in 2010, the Maternal, Infant, and Early Childhood Home Visiting Program contributed $1.5 billion over 5 years to implement evidence-based programs across the USA. To monitor and evaluate this investment, the US Department of Health and Human Services (USDHHS) required research on implementation and economic evaluation of these programs (Michalopoulos et al. 2015).

In addition to understanding the overall costs of implementing EBPIs at scale, policymakers are also interested in what it may take to successfully serve a population the established content of an EBPI such that the program's intended effects can take place. This may be especially true when the primary justification for a program's funding is its documented effectiveness in preventing particularly costly outcomes from occurring, such as child abuse and neglect. Resource constraints and uncertainty in targeting potential participants result in the need to understand how retention rates factor in the overall costs of implementing programs at scale.

Researchers commonly cite the shifting of critical resources to recruitment and retaining efforts as the primary cost driver resulting from low retention and may be more likely to report average service costs using a study's total sample (i.e., intent to treat) rather than treated sample (Crowley et al. 2014; Miller and Hendrie 2015). Rather, researchers should report the total, per-participant average, and marginal costs of the program (Crowley et al. 2018). Providing a range of costs in such a manner provides a more complete view of the resources that may be required if policymakers desire to take an intervention to a wider scale, particularly in applied settings where factors such as retention are key. As such, estimating the costs to *successfully* serving participants is an important consideration as well. We define *successfully* served as the number of participants who have completed enough of the program's curriculum such that the intervention effects can take place. When program completion is not required and retention is not 100%, successfully served may be an indication of the required resource investment to administer meaningful amounts of program content to greater segments of a population. Estimating the cost to successfully serve a participant can help

policymakers understand how program economics may be expected to vary from previous estimates.

Modeling Costs as a Function of Retention

Few researchers have distinguished between the costs of *serving* and *successfully serving* families in contexts outside of carefully controlled experiments where researchers take extra efforts to ensure participation. In a study conducted by Mathematica Policy Research, Burwick et al. (2014) estimated NFP per-visit cost to be $477 (in 2010 dollars), with a range across sites of $251–$1074. Given that the average number of visits during RCTs of the NFP was 31 (Miller and Hendrie 2015), this would amount to a cost of $14,787, with a range of $7781–$33,294. However, Burwick et al. (2014) did not discuss the costs of successfully serving families, and instead counted a family as served if they completed at least one home visit.

Miller and Hendrie (2015) investigated the costs of six NFP program implementations in community settings, finding that community-level per-family costs were $8500 (in 2010 dollars), while costs per family in trial runs in Denver were substantially higher at $12,398.

They attributed this difference to families receiving services during the community replications receiving fewer visits than those that participated in research trials (24 visits compared to 31 visits, on average). Miller and Hendrie also noted that per-family costs were minimally affected by low retention rates because the majority of costs were primarily determined by the number of days that a family was in the program. Although the per-visit costs were relatively unchanged due to low retention rates, the costs per successful service were increased.

Presenting differences in costs between efficacy and implementation trials is important but can lead to miscalculations of the resources required to reach a population and administer program content. Using cost estimates from implementation trials and effect sizes from RCTs, Peterson et al. (2017) concluded that the NFP would need a minimum retention rate of 67% in order for the intervention to yield a neutral return on investment from a taxpayer perspective and 19% from a societal perspective. However, as Miller and Hendrie (2015) point out, families in implementation trials were less likely to complete the program. Peterson et al. (2017) do not appear to account for this in cost or effect size estimates, and thus their conclusions are likely too optimistic.

We need a conceptual framework that distinguishes between clinical and economic models of interventions. Clinical models are used to illustrate the processes and mechanisms of interventions that relate successful engagement (e.g., nurse retention leading to greater client retention) and service provision (dosage) with subsequent outcomes across the translational research cycle. Alternatively, economic models are primarily used by prevention scientists and policymakers to understand the efficiency of programs in achieving their stated goals. Distinctively, clinical models focus on explaining *why* translational factors, such as retention, arise and influence outcomes, while economic models can explain and quantify the magnitude of translational factors' saliency on program economics. As such, an economic framework may be helpful in answering relevant policy questions including what is the expected cost to achieve a successful service, and what is the expected cost to achieve a unit outcome? In the case of voluntary home visitation programs, where specific segments of populations are targeted and retention rates can be as low as 20%, the number of participants (families) needing to be enrolled and successfully served before achieving a unit outcome (e.g., case of maltreatment prevented) may be large (in some cases ratios of 5:1) (Boller et al. 2014). Given uncertainties in accurately identifying families at risk of experiencing maltreatment and enrolling families that will actively participate in the program, selecting participants into programs such as NFP is an imprecise process. This uncertainty may not increase overall costs, but it increases the costs per family successfully served and should be presented for policymakers to consider. As a result, the costs per family served may differ from the costs per family successfully served:

$$P = \frac{T}{N} \tag{1}$$

In Eq. (1), T is total program costs, and N is the number of families who are served, defined as any family that receives at least one home visit (following Burwick et al. 2014 in the definition of a served family). This may also be described as the number of families considered in an intent-to-treat framework. Therefore, P is the cost per family served. In the case where participation is voluntary and not all families receive treatment, consider that a program has retention rate r, which is greater than zero and less than or equal to one. This may also be described as the subsample for which a treatment on the treated analysis may be completed. The number of families successfully served, C, is therefore

$$C = rN \tag{2}$$

or that the number of families successfully served are only the families who are retained and have completed at least a predefined portion of program content (for instance, attending 50% of home visits). Now, replace N with C in Eq. (1):

$$Ps = \frac{T}{C} \tag{3}$$

and then substitute Eq. (2) into (3).

$$Ps = \frac{T}{rN} \tag{4}$$

The cost per family successfully served, *Ps*, is a function of the retention rate. Again, note that the cost per family successfully served may also be described as the cost per family accounted for in treatment on the treated analyses, and that the definition of retention will vary according to the program in question. Given that $0 < r \leq 1$, then $C \leq N$. Additionally, since $rN = C$, it is true that when $r < 1$, then $Ps > P$, or the cost to successfully serve a family is greater than the cost to serve a family. Finally, it is apparent that *Ps* decreases as *r* increases.

Case Study

This paper focuses on conceptualizing the costs of implementing EBPIs, particularly selective programs, as a function of retention rates. We demonstrate how retention rates impact the costs of home visitation programs and present a method for incorporating program retention into economic analyses, primarily when participation is voluntary. In the following case study, we use cost and retention data from an actual statewide implementation of an evidence-based parental education program to illustrate the utility of factoring retention in economic estimates. Ultimately, we show that retention rates are an important consideration for policymakers when making funding decisions, particularly when budgets are a limiting factor in funding levels for prevention programs.

Program Description

The evidence-based early childhood maltreatment prevention program is home-based and voluntary, with a parent education curriculum consisting of units centered on child health and safety, and family relationships. Each unit was conducted over six 1–1.5 h sessions, with sessions typically occurring weekly. For each unit, a home visitor conducted an initial assessment, completed the unit's content over the course of four training sessions with the caregiver, and then completed a final assessment. Families demonstrating mastery of a given unit then moved on to the next.

The demographics of the sample illustrate that participants were high-risk due to economic distress. For example, a quarter of the caregivers had less than a high school diploma, while 36% had a GED or high school diploma. Almost half (49%) of participating caregivers were enrolled in the Supplemental Nutrition Assistance Program, with 65% receiving Medicaid, and 70% receiving some form of public assistance. Almost 42% of caregivers had annual household incomes less than $10,000.

Program Costs

We estimated the costs of implementing the program across 13 counties in a Western state over the course of a 3-year pilot program. To maintain consistency in estimating the costs of the intervention with previous work, we obtained permission from Mathematica Policy Research to modify their cost surveys for our own purposes. The approach is the "ingredient" method, which includes identifying all resources used by the intervention that have a cost (Haddix et al. 2003). For the current study, we included costs related to personnel, facilities, equipment, and materials. Specifically, we collected data for (1) non-durable and durable goods; (2) salaries and fringe benefits of all relevant employees; (3) donated labor, supplies, and materials; (4) equipment and capital assets; (5) contracted services (e.g., IT staff); (6) buildings and facilities; (7) miscellaneous costs (e.g., mileage reimbursement); and (8) indirect costs. Most sites were unable to provide full information on costs pertaining to durable equipment and office space; therefore, the costs presented below leave out those related to durable equipment including furniture, desks, copiers, printers, etc., and assumes that these resources were covered under indirect expenses. Computer costs were included and amortized because they had a projected useful life of 5 to 7 years.

Total costs were comprised of the market value of all resources used to start up and operate the program across all sites for the 3-year pilot period. All costs were inflation-adjusted to reflect 2017 dollars. As displayed in Table 1, the total costs of the program were $12,742,446.

Table 2 displays curriculum completion rates. For the present intervention, participating families did not proceed to another unit until they successfully completed an assessment from the prior one. Thus, the number of units that families completed was our best indicator of content mastery. Families could complete up to three units that centered on parenting practices. Overall, 27% of participating families completed the entire curriculum, or all three units, while over 40% of families enrolled had at least one visit but never completed a unit.

Table 3 presents costs per family served as a function of retention rates. Referring to Eq. (1), the cost per family served, *P*, is calculated using the intent to treat sample, or all 2107 families that completed at least one home visit. The cost per intent to treat family was $12,742,446/2107 = $6048.

Table 1 Intervention costs

Personnel	$8,597,381
Indirect	$1,983,446
Training and travel	$650,728
Supplies and operational	$783,089
Other costs	$727,802
Total costs	$12,742,446

Table 2 Number of units by number of completing families

Number of Units	Number of completing families	Cumulative number of families	Cumulative percent completing (%)
0	860	860	40.8
1	429	1289	61.2
2	255	1544	73.3
3	563	2107	100
Total	2107		

Before describing the costs per successful service, we note that participating families were grouped based on the number of units of the program that they voluntarily completed, namely one, two, or three units. Then, propensity score matching techniques were used to construct control groups. Finally, groups were compared on child welfare involvement during the year following participation. These results are included only to illustrate the conceptual model and should not be interpreted as indicative of any particular program's retention rate. Identifying the treatment on the treated subsample may vary depending on a given program's curriculum, the population it serves, and the outcomes of interest. As previously discussed, more research is needed to better understand the continuum of benefits that participants may garner as they increasingly participate in programs, and how to better engage families to increase retention (Holland et al. 2018).

For the purposes of the current study, the outcome analyses suggested that child welfare re-involvement (as measured by subsequent out-of-home placement) was reduced *only* when families completed the full curriculum; that is, there was no meaningful reduction in re-involvement rates when families completed zero, one, or two units of the program's curriculum. Thus, for a family to be successfully served, they needed to complete all three units. For the prevention program, 27% of 2107 families completed all three units. From Eq. (2), the number of successfully served families was therefore 2, 107 $*$ .27 = 563. From Eq. (4), the cost per family *successfully* served (*Ps*) was \$12,742,446/563 = \$22,633. This cost is almost 3.5 times greater than the cost per family served, as it accounts for the uncertainty that occurs as voluntary families elect to continue participation or drop out before completing the intended curriculum. As shown in Table 3, we did not estimate the cost to successfully serve participants one or two units because no meaningful reduction in recidivism was demonstrated, and the funding agency considers their resource consumption from partial participation to be sunk costs if no other benefits can be demonstrated.

Discussion

This paper conceptualized how retention rates may influence the costs of implementing EBPIs as they transition into types 3 and 4 stages of development. We used data from the implementation of an evidence-based prevention program in a statewide trial to demonstrate that low retention rates increase the costs of successfully serving individuals and families, particularly when participation is voluntary. When considering families as "served," or those who completed at least one home visit, the cost per family served was just over \$6000 in 2017 dollars. However, the cost per family successfully served increases as the retention rate decreases, and in the case where full program completion was required, the cost per successful service was \$22,633, almost four times greater than the cost per family served. This substantial difference demonstrates the importance of recruiting families and retaining them in order to increase the economic efficiency of selective programs such as home visitation interventions. As such, economic models that account for the influence of implementation factors, such as retention, on program efficiency, may be particularly useful for policymakers (e.g., Peterson et al. 2017).

Table 3 Cost per family successfully served

Number of units	Number of completing families	Retention rate	Cost per family successfully served (\$)	Outcome analysis type
3	563	27%	22,633	*P*
2	255	39%	Null	
1	429	59%	Null	
0	860	100%	6048	*Ps*
Total	2107	100%	6048	*Ps*

P represents cost per service, *Ps* represents cost per successful service

Limitations

The conceptual framework outlined in this paper has several limitations to be addressed by the prevention field in future research. First, modeling costs as a function of retention rates are subject to variations in the definition of program participation, including the potential for nonlinearities in benefits resulting from increased engagement. As the field advances our view of the complex program-by-individual interactions that likely occur within diverse environments, it will be important to ensure that methods of economic analysis are updated to reflect these findings. For instance, though families may not complete an intervention's full curriculum, it is likely that they receive at least some form of benefit (e.g., Holland et al. 2014; Lyons-Ruth and Melnick 2004). Therefore, in instances where increasing levels of participation are associated with increasing benefits, costs may be modeled such that differing levels of participation result in different costs. For example, estimating the cost for a participant to complete one unit of a parenting curriculum may accurately demonstrate differences in costs between participation levels by multiplying average cost per unit by number of units completed.

However, when benefits are not a linear function of participation, cost estimates will need to be adjusted to account for such findings, such as applying weights to participants in different categories when calculating costs. While including these benefits from partial completion in simulations and projections of the returns to prevention programs is important in demonstrating their potential, we believe that *assuming* these benefits occur in new contexts and at larger scales is too strong. Therefore, future work evaluating economic models of programs at the implementation stages of development should also report costs per successful service in order to include conservative estimates of what it may cost to achieve unit outcomes (e.g., prevention of a case of child maltreatment) through a given program. As such, it is important that future research focus on the relationship between participation and program benefits (Holland et al. 2014).

A second shortcoming of our conceptualization is that, for interventions potentially influencing multiple outcomes, developing accurate estimates of participation is unclear. Just as with the parental education program example, there may be segments of interventions that influence particular outcomes, such as addressing drug use in one topic and parenting strategies in another. Future research may address this issue by expanding on our model to incorporate retention into economic evaluations of comprehensive programming. For this to occur, common problems occurring in real-world contexts, such as the existence of data silos across government systems, must be overcome.

Recommendations

Economic analysis has been instrumental in demonstrating the potential for EBPIs to have positive and measurable impacts on overall public health. This is true of universal, selective, and indicated interventions (Drake et al. 2009; Heckman et al. 2017). It is also important to acknowledge that prevention programming has yet to achieve the promised public health benefits (Holland et al. 2018; Spoth et al. 2013), and that translational factors appear to discount the effects (Barnett 2011; Corbacho et al. 2017; Gorman 2017). Given these shortcomings, along with the continued work on types 3 and 4 stages of developmental research, we believe the field may benefit from a more guided approach to economic analysis, including additional work in the following areas.

Independent Evaluations of EBPIs To date, there have been few evaluations of EBPIs that have been conducted independently of individuals who have a vested interest in program success (e.g., Gorman 2017; Wilson et al. 2012). This results in shortcomings that limit policymakers' ability to make informed funding decisions, particularly when organizations have to consider issues such as publication bias, which may result in inaccurate simulations of future costs and benefits related to a particular program. Furthermore, the lack of publications for evaluations of EBPIs during implementation trials limits knowledge of the true costs of implementing these programs. We agree with Crowley and Jones (2015) that evaluators should be encouraged to disseminate their findings through academic and public venues, including scientific journals. In doing so, knowledge can be disseminated that reduces publication bias and leads to the adoption of programs that are as effective as expected.

Estimating Marginal Costs of Achieving Outcomes Prevention researchers have traditionally employed methods of economic analysis that are popular with public health researchers (Haddix et al. 2003). However, much of public health research focuses on universal prevention, such as initiatives aimed at improving overall well-being through interventions that are applicable to whole populations. For example, all children stand to benefit from immunization against illnesses such as polio, and nearly all children in the US receive these immunizations. As such, immunization efforts are cost-effective, and the marginal costs related to achieving these outcomes are easily calculated (Zhou et al. 2005). However, in cases where an intervention may only be effective when a threshold of participation is met, or when varying levels of participation result in varying benefits, it is important that these factors be incorporated. Future work should focus on improving our understanding of a participation-response relationship (i.e., dose-response) such that the marginal benefits from completing an additional unit of a program can be compared to the marginal costs of inducing participants to complete the unit. In doing so, researchers and practitioners can

compare varying levels of program participation to determine where allocating additional resources may result in the best "bang for the buck." In the example provided above, if the marginal benefit from completing the full curriculum, rather than two-thirds of it, results in the greatest reduction in child welfare re-involvement, resources may be best allocated to encouraging families who are on the margin between majority and full completion, as opposed to focusing on participants who are reluctant to continue participation after completing the first unit.

Research to Improve Retention in Voluntary Interventions

Retention rates of EBPIs have been exceptionally low when participation is voluntary, with attrition rates sometimes as high as 80% (O'Brien et al. 2012). For selective interventions to be cost-beneficial, retention rates will need to be improved, and sunk costs minimized. To this end, future research should be focused on improving retention or targeting potential participants in diverse populations (Holland et al. 2014). In addition, improving the efficiency of program inputs, such as increasing nurse retention, stand to improve participant retention while also reducing overall costs. Importantly, advancing our understanding of individual, program, and community factors will help to reduce barriers to participation for some families, while for other families, developing new innovative and quality engagement practices may be required (Supplee et al. 2018). Low rates of retention are prohibiting EBPIs from being cost-effective to the taxpayer. Thus, it may be time for researchers and policymakers to focus on quality of services to selective individuals and families, rather than only on the quantity of those served.

Funding Funding for this research was provided by the Office of Early Childhood, Colorado Department of Human Services.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Research Involving Human Participants and/or Animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent The Colorado State University IRB ruled informed consent was not required given the present study's exclusive use of secondary de-identified administrative data.

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