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Supporting implementation of universal prevention initiatives in K-12 schools: impacts on fidelity through organizational readiness and team functioning in a cluster-randomized trial

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Abstract

Background Rural School Support Strategies (RS3) is a bundle of implementation supports (including training, technical assistance, and a virtual learning collaborative) designed for the scale-up of universal prevention initiatives. This study addresses mechanisms of action, exploring whether positive effects of RS3 on implementation fidelity are attributable to improvements in functioning of school implementation teams, and increases in organizational readiness.

Methods Data are from a cluster-randomized hybrid Type 3 implementation-effectiveness trial of RS3 among rural Idaho schools implementing Positive Behavioral Interventions and Supports (PBIS). Forty public K-12 schools in Idaho, located in rural areas or townships, were recruited for the trial and were equally randomized to either the basic supports condition, including standard trainings, or to the RS3 condition. Condition was not masked. The mechanistic aims were hypothesized prior to the trial and tested with survey data from individuals on each school's implementation team ($n = 205$). Surveys were collected in spring 2019 and 2020 regarding organizational readiness and team functioning. The outcome measure was PBIS implementation fidelity, measured by school teams during the summers of 2019 and 2020 using the Tiered Fidelity Inventory. School-level path models tested the effect of RS3 on implementation fidelity, controlling for baseline, school grade level, and school location. Multilevel (2–1–2) mediation models tested the degree to which individual team members' perceptions of organizational readiness and team functioning mediated the relationship between school-level experimental condition and fidelity, controlling for the team members' role.

Results Schools receiving RS3 reported significantly greater implementation fidelity, although effects were slightly reduced ($b = 8.40$, $p = .056$, 95% CI [-0.22, 17.01], $\beta = 0.54$) after inclusion of baseline and demographic controls. Models indicated a significant indirect effect of RS3 on fidelity through increased team productivity ($b = 6.30$, $SE = 2.63$, $p = .017$, MC 95% CI [0.83, 13.86], $\beta = 0.21$), and effects through organizational readiness, change commitment, team culture, and team goal setting.

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Conclusions External supports may improve implementation of universal prevention initiatives in rural schools through improvements in readiness and fostering teaming in organizations.

Trial registration This research was prospectively registered on ClinicalTrials.gov ([NCT03736395](https://clinicaltrials.gov/ct2/show/study/NCT03736395)), on November 9, 2018.

Contributions to the literature

- A bundle of strategies delivered by a trained implementation support practitioner can improve implementation fidelity for universal prevention initiatives in schools
- Teams are a central—but understudied—component of implementing universal prevention initiatives in schools, but can strengthen implementation fidelity with greater productivity, team unity, and goal setting
- Organizational readiness and change commitment are strong drivers of fidelity, but are understudied in school environments
- We find that the implementation strategies' effects on implementation fidelity are partially attributable to improvements in a-priori theorized mechanisms, including team productivity, and to a lesser extent, team culture, goal setting, and change commitment

Introduction

Universal prevention initiatives improve school environments and promote positive academic and behavioral health outcomes for students. When implemented with fidelity, these initiatives are more likely to achieve intended effects [1, 2]. Multiple factors influence implementation, including organizational capacity (i.e., resources, shared vision, and staff openness to change), and specific practices such as forming implementation-focused teams who share decision-making and strategic planning [1, 3]. Implementation strategies, such as those detailed within the School Implementation Supports, Translating ERIC Resources (SISTER) taxonomy [4], can improve the fidelity of school-based initiatives, especially when matched to the needs of schools and the phase of implementation [5]. Strategies such as 'ongoing training' and 'coaching/technical assistance' are particularly well-evidenced [6], and are helpful for schools that are newly adopting evidence-based practices [7] or have limited resources [8]. As implementation can be particularly challenging for rural schools, which are often under-resourced [8], trainings and remote technical assistance can fill this gap. However, the mechanisms through which such strategies improve fidelity are not clear [9].

Mechanisms of implementation success

Team-based implementation models have long been used for prevention and management of behavioral issues in schools [10]. These teams are typically composed of teachers and mental health professionals, as well as school administrators [11], as leadership is integral to the success of school initiatives [2]. Implementation teams have numerous responsibilities, including the selection, implementation, and evaluation of evidence-based programming [12]. Research has explored the contribution of team effectiveness to implementation outcomes [13, 14]. The factors that determine an effective team are not well operationalized but are generally defined by both traits and processes, and can include team cohesion, collective efficacy, and clear, consistent communication [15, 16]. Aspects of effective team functioning are associated with sustained implementation [17, 18], implementation climate [19], fidelity [15], and student outcomes [20].

Research has less-frequently examined the ways that school implementation teams (hereafter referred to as teams) prepare the organization. Organizational readiness is considered instrumental in the adoption of evidence-based programming [21], comprised of the motivation or commitment of individuals to implement change, and their capacity or efficacy in creating that change [3, 22]. In schools, organizational readiness requires alignment of systems, resources, and staff buy-in, all of which is managed by the team [23]. In particular, gaining approval and commitment among a majority of teachers and staff is necessary [6].

Process models for implementation

Implementation frameworks seldom incorporate strategies for enhancing team effectiveness, despite the central role of teams in the implementation of prevention programming [24]. Nevertheless, such frameworks can guide the alignment of stages and systems for implementation strategies. The Interactive Systems Framework for Dissemination and Implementation [25] and Quality Implementation Framework [5] describe systems and stages through which external supports could be used to improve team functioning and organizational readiness. These frameworks informed the current study. ISF describes three interactive systems that contribute to the successful implementation of

evidence-based programming: the synthesis and translation system; the delivery system; and the support system. Built on the ISF, the QIF [5] further identifies critical steps and activities at each of four stages of the implementation process, ranging from preparatory assessment and organizational capacity-building phases to implementation and evaluation phases.

Together, these frameworks identify specific leverage points through which implementation strategies may improve fidelity by fostering team effectiveness. Based on the ISF, support systems would provide training, technical assistance, and monitoring to the delivery system (i.e., implementation teams at the organization). Aligning with the team functioning elements of states and processes, the support system fosters team functioning by building both innovation-specific (e.g., targeted knowledge and skills of the intervention) and general capacities (e.g., functional factors, such as effective communication) [5, 26]. Support systems can thus build team capacity by providing content expertise and improving team processes throughout the critical steps outlined by the QIF, including building organizational preparedness during initial implementation phases, developing implementation plans during the structural phase, and providing technical assistance and feedback during ongoing implementation, each of which are critical to faithful implementation. Although prior research has found some positive evidence for external supports on improved team functioning [13], as well as associations between team functioning and implementation fidelity [15, 19], no research has yet examined the degree to which team functioning and organizational readiness are targetable mechanisms for implementation strategies.

The current study

The present study tests whether a bundle of implementation supports (training, technical assistance, and a virtual learning collaborative) improved implementation fidelity of a school-based universal prevention initiative, Positive Behavioral Interventions and Supports (PBIS), via improved team functioning and organizational readiness. The mechanistic aims were part of the original design in this cluster-randomized trial, exploring how team functioning and organizational readiness characteristics, measured at the individual/team level, serve as mechanisms for improved implementation fidelity at the school-level. The main outcomes analysis for this trial showed improved fidelity [27], and we anticipate that this improvement can be at least partially explained by the implementation supports' effects through these mechanisms.

Method

Procedure

The Rural K-12 project is a cluster-randomized, hybrid Type 3 implementation-effectiveness trial examining the effectiveness of Rural School Support Strategies (RS3), a bundle of implementation supports designed to aid rural schools' implementation and scale-up of evidence-based interventions [28]. Informed by the specific needs of rural schools and based on the frameworks of the ISF [25] and the QIF [5], RS3 provides schools with supplemental trainings to support initial capacity-building and the development of implementation structures, as well as ongoing specialized technical assistance and a dynamic virtual learning collaborative. The present analyses test hypothesized mediational pathways of the effect of RS3 at 40 rural schools in their first year of implementation of PBIS.

Positive behavioral interventions and supports

PBIS is a school-based, data-driven system of support which is effective in improving student behavioral and emotional health outcomes [29] as well as organizational and staff outcomes [30, 31]. Using a multi-tiered approach, Tier 1 of PBIS focuses on universal prevention, which is estimated as adequate for preventing most problem behaviors in the student population, and Tiers 2 and 3 offer targeted and intensive supports for students with greater behavioral challenges [32]. PBIS is a flexible framework that allows schools to identify their own behavioral and climate priorities and to address them with consistent, inclusive, and supportive disciplinary strategies [33]. Core components include: 1) defining and teaching three to five behavioral expectations for all students; 2) establishing acknowledgment systems for students when they engage in desired behaviors; 3) establishing predictable consequences when students engage in problem behaviors; and 4) using data-based decision-making.

PBIS implementation relies on a school team consisting of three to seven staff including administrators, teachers, counselors, and other staff [34]. The team is responsible for coordinating PBIS systems issues, such as funding and personnel preparedness, as well as practice issues, such as professional development and evaluation [23]. The team also coordinates PBIS implementation by assessing school-level data, establishing priorities, and setting school-wide behavioral and disciplinary guidelines, as well as monitoring progress and providing feedback on implementation.

Basic implementation supports

All schools in the study received guidance in forming a PBIS team, and the team members then attended an

initial four-day, in-person training on PBIS Tier 1. Tier 2 training was delivered the following year, virtually due to COVID-19 restrictions. Trainings were delivered during the summers of 2019 and 2020 to teams, grouped by study condition and geographic region. Trainings were similar in content and delivery method for both conditions, delivered by three implementation support practitioners [35].

Enhanced implementation supports: rural school support strategies

In addition to the trainings, schools assigned to the intervention condition received Rural School Support Strategies (RS3). Supports included three eight-hour trainings, including a leadership institute and two trainings on coaching skills. In addition, RS3 schools received tailored technical assistance (TA) via in-person and virtual meetings, phone calls, and emails. RS3 schools were also offered participation in a monthly one-hour professional learning collaborative (hosted virtually), and access to an online resource portal.

RS3 was devised as an external Support System to help schools build on existing strengths and to help the Delivery System—the school teams—navigate implementation challenges. During the initial phases of implementation, in which school teams focus on needs assessments, selection, and adoption of evidence-based programs, RS3 provides an external Support System to deliver resources, such as trainings, that provide critical information to guide teams in pre-intervention capacity building, including strategizing and planning. In the structural phase, RS3 coordinates content experts to provide technical support and coaching for the creation of implementation teams and strategic planning. During ongoing implementation, supports include the provision of expert technical assistance and feedback, as well as help with monitoring PBIS fidelity.

Training and technical assistance approaches align with the strategies presented in the Expert Recommendations for Implementing Change [36] taxonomy of implementation strategies, and the school-adapted SISTER taxonomy [4], published after the start of the present study. The full protocol of the trial and alignment with the SISTER taxonomy are discussed in further detail in Turner et al. [28].

Recruitment

By design (see Turner et al. [28]), the trial focused on rural settings. Schools were eligible if they were located in a rural area or township (per the National Center for Education Statistics (NCES) [37] locale codes), had at least 100 students, and had received no prior PBIS training. The study set no limitation on the grade levels served

by each school, as rural schools vary in grade composition and the focus of the study was on school-level implementation. This yielded 156 potential public K-12 schools. Recruitment materials were sent by mail and email to principals of each school, and outreach was conducted by project staff. The first 40 eligible schools that agreed to participate were enrolled in the trial and one group of three schools that applied to participate after the deadline was placed on a waitlist. Additional details are provided in Turner et al. [28].

Randomization

Randomization occurred in October 2018. Most schools ($n=25$) were the only ones enrolling from their district; however, some schools were from the same district. To avoid potential within-district contamination if schools were randomized to different conditions, a first step before randomizing was to group by district so that all schools within a district would receive the same intervention condition. Demographic data regarding the number of students enrolled per school and percentage of students eligible for free or reduced-price meals at each school were used to match individually-participating schools into 12 similar pairs. One of the individual schools was paired with a two-school district, resulting in a pair of three-school groups. The groups of schools within districts were also each paired with a similar district group. Thereafter, a series of coin flips was used to determine the allocation of one school (or district group) from each pair into the RS3 condition, with the other school (or district group) in the pair assigned to basic supports. One district in the RS3 condition containing three schools withdrew from the study immediately following assignment, but prior to the start of the intervention, and was replaced with a different district—also with three schools—from the waitlist (see Fig. 1 for details). No significant differences were observed in baseline demographic characteristics between schools in the two conditions [28]. The randomization procedure was overseen by an independent statistician, and the coin flip procedure was observed and documented by two independent researchers. Because schools were aware as to whether they received enhanced supports, the intervention condition was not masked. See Additional file 1 for the completed Standards for Reporting Implementation Studies (StaRI) checklist [38] and Additional file 2 for the completed Consolidated Standards of Report Trials (CONSORT) extension to cluster randomized trials checklist [39].

Participants

Schools were generally small, with 18.7 ($SD=7.0$) teachers per school on average and 348.8 ($SD=178.0$) students.

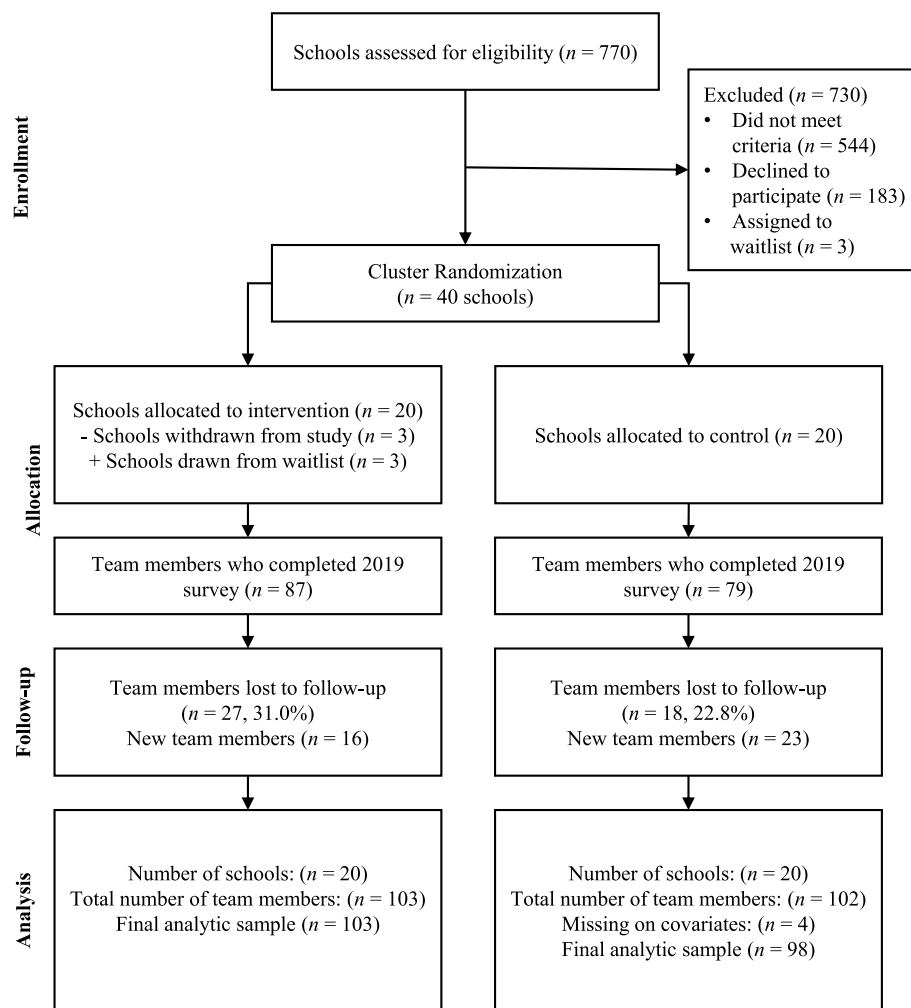


Fig. 1 CONSORT diagram

Per the NCES locale codes, seven schools (18.0%) were considered ‘Fringe’ schools (within five miles of a metropolitan area), 17 (43.0%) were ‘Distant’ (5–25 miles from a metropolitan area), and 16 (40.0%) were “Remote” (> 25 miles from a metropolitan area). Most schools (58.0%, $n=23$) were elementary or combination elementary and middle schools. Eight (20%) were middle or combination middle and high schools, while four (10%) were high school only. Five schools (13%) included kindergarten to Grade 12. The average eligibility for free or reduced-price lunches (a proxy for poverty) across schools was 48.5% ($SD=17.8$).

Schools participating in the study were required to form PBIS teams that included the school principal and a team coach (ideally a counselor or behavior specialist), as well as other staff. Across schools, 205 staff comprised the teams. Of these respondents, 166 (81.0%) responded to a brief survey in 2019, and 160 (78.0%) responded in 2020. Similar to the rural Idaho school workforce, 78% of

the sample identified as female and 97% as being of non-Hispanic white race/ethnicity. Among respondents, 62% were teachers, 20% administrators, 8% counselors, and 9% other school staff.

Data collection and measures

Fidelity

At the end of the 2019 and 2020 summer trainings, school teams completed the Tiered Fidelity Inventory (TFI) [40]. The TFI is a fidelity self-assessment instrument created by PBIS developers for schools to assess their implementation of PBIS. The TFI is widely used and has strong psychometric properties, including good inter-rater and test–retest reliabilities, construct validity, and convergence with other fidelity measures [41]. Each assessment was completed by the team and took approximately 45–60 min to complete. Teams completed the TFI on paper in 2019 and through an online portal in 2020.

For the present study's focus on universal implementation (schoolwide PBIS), we examined only the 15-item Tier 1 index of the TFI. The Tier 1 scale is a summative composite of items assessing universal implementation in three areas: Teams (two items), Implementation (nine items), and Evaluation (four items). Each item is coded 0 to 2 points, representing a gradation wherein the PBIS feature is either not being implemented (0), implemented in part (1), or implemented in full (2). The current analyses assess each school's total score on the Tier 1 scale as a percentage of the 30 possible points, thus ranging from 0 to 100%.

Mediators

In Spring 2019 and 2020, all team members were emailed links via Qualtrics to online surveys regarding their perceptions of the school's readiness to implement PBIS. In 2020, these surveys were updated to include additional team functioning items, selected from the PROSPER (PROmoting School-community-university Partnerships to Enhance Resilience) [18] project surveys. Informed consent was obtained each year prior to completion of surveys.

Seven scales were used to examine aspects of organizational readiness and team functioning as mechanisms of implementation fidelity. Respondents provided their level of agreement, from "Strongly disagree" (1) to "Strongly agree" (6), with statements reflecting each construct. Scales with multiple items used the average score, with negatively worded items being reverse coded. Item wording is included in the Appendix.

Organizational readiness and change commitment were assessed in 2019 and 2020 and were derived from the Organizational Readiness for Implementing Change scales [42]. Items were reoriented to focus on perceptions of team and school staff preparedness to implement schoolwide PBIS (SWPBIS). Organizational readiness was created as the average of six items ($\alpha_{2019}=0.94$; $\alpha_{2020}=0.97$) and included items regarding the team's capacity to navigate the staff environment regarding evidence-based programming, such as "I am confident that our team can manage the politics of implementing SWPBIS." Change Commitment was created using three items ($\alpha_{2019}=0.92$; $\alpha_{2020}=0.95$) that assessed the school culture's commitment to implement prevention programming, with items such as, "Staff (including teachers) at this school will do what it takes to implement SWPBIS."

Team functioning measures included team culture, efficacy, goal setting, productivity, and tension and were assessed in 2020 only. Team culture was a 6-item scale ($\alpha=0.88$) adapted from Chilenski et al. [13] and Kessler et al. [43] that measured team cohesion and purpose, with items such as "There is a strong emphasis on

practical tasks in the team." Team efficacy was a 5-item scale ($\alpha=0.87$) adapted from Chilenski et al. [13] and Moos and Moos [44]. The scale assesses the respondent's perceptions of the team's mutual capacity for work with statements such as "This is a highly efficient, work-oriented team." Three single items measured goal setting, productivity, and tension. These items, respectively, were: "The PBIS Team has developed clear goals and objectives," "Our team meetings are productive," and "There is a lot of tension at team meetings because of things like differences of opinions, personality clashes, hidden agendas, and power struggles."

Covariates

Three dichotomous covariates were included in analyses to adjust for potential confounds. At the staff level, the team member's role was coded as administrator (e.g., principal, vice principal=1) versus another role (coded 0). At the school level, covariates included grades served (elementary and elementary/middle school=1; other school types=0) and school location (fringe rural=1; distant or remote rural=0).

Analyses

We assessed the effects of the intervention on fidelity, mediated through organizational readiness and team functioning, in two steps. First, we identified the direct effect of the intervention condition on fidelity at the school-level in 2020 via path analysis, including by observing the effects adjusted for baseline control variables and covariates (see Fig. 2, part A). Results from prior analyses [27] showed a mean difference of 8.48 ($p=0.07$, 95% CI [-0.56,17.52]) on the TFI scale between schools receiving RS3 and those receiving only basic supports (controlling for school level). To maintain consistency across tests in the present study, we reexamine that result within a structural equation model framework and with the inclusion of school location as an additional covariate, due to its expected effects on mediators.

Next, we included hypothesized staff-level mediators in separate multilevel mediation models. This approach, referred to as a 2-1-2 mediation model (see [45, 46]), is a structural equation model approach that separates the within-level variance from the between-level variance of the level-1 mediator to provide estimates of the between-level relationships among all three constructs (see Fig. 2, part B). This approach has an advantage over mediation testing via multilevel regression approaches, as this approach specifically allows for estimation of level-2 outcomes by level-1 predictors. This method is also superior to path models that aggregate level-1 data, as the multilevel path model avoids confounding the between-level and within-level variance of the level-1 mediator

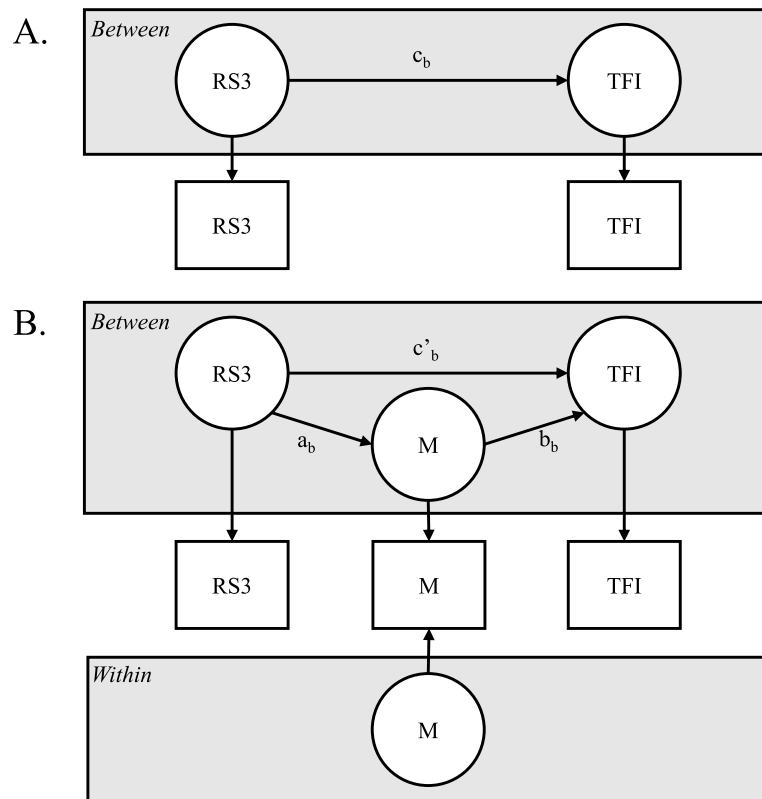


Fig. 2 Multilevel mediation conceptual model. Abbreviations: RS3, Rural School Support Strategies condition; TFI, Tiered Fidelity Inventory; M, Mediator. Baseline controls and covariates not shown

by explicitly estimating each. This is particularly useful for the present study, which seeks to examine how individual perceptions of organizational readiness and team functioning relate to a team-created, but singular, school-level assessment. We thus use this approach to identify whether variations between schools in how individuals report these mechanisms explain the association between the school-level intervention condition and implementation fidelity.

To test the intervention effect on TFI within the context of the pre-test/post-test design, a baseline control for TFI is included as a covariate in each model. Likewise, to assess intervention effects on organizational readiness and change commitment within the pre-test/post-test design, a baseline control for each is included in the within-level component of each model. As team functioning variables were available only in 2020, these models lack a baseline control and are therefore tested in the context of a post-test only design.

Mediators were first assessed for their intraclass correlations (ICCs), a metric identifying the ratio of the variance attributable to differences between clusters relative to the variance attributable to differences between individuals. Mediators were then included within separate

path models, such that the level-2 predictor (intervention effect) predicts the level-2 outcome (TFI), both directly and through each level-1 mediator. Confidence intervals for the indirect effects used Monte Carlo estimation simulations with 20,000 repetitions. This approach provides more robust estimation of confidence intervals of indirect effects, similar to those derived from bootstrapping methods, but is available for multilevel models [47].

Model fit was assessed with chi-square statistics and within- and between-level Standardized Root Mean Squared Residuals (SRMR_w and SRMR_b, respectively). Unlike the Comparative Fit Index and Root Mean Standard Error of Approximation, which can confound the between- and within-level parts of multilevel structural equation models [48], SRMR metrics provide robust, separate assessments of model specification for each level, provided that the Level-1 variable has sufficient intraclass correlations of >0.23 [49].

Both the intervention and TFI variables at the school-level contained complete data for both waves. Missingness in the mediators ranged from 25.9% ($n=53$) to 27% ($n=55$); in addition, 2% ($n=4$) were missing on the school role variable and 23.4% ($n=48$) and 24.9% ($n=51$) were missing on the baseline controls for organizational

readiness and change commitment, respectively. Logistic regressions tested whether covariates, intervention condition, or demographic factors were associated with missing data on the mediators; respondents at primarily elementary-serving schools were significantly ($p < 0.05$) less likely to be missing on all mediators, but no other associations were observed. Models used robust maximum likelihood estimation with Full Information Maximum Likelihood to maintain standard errors in the presence of missing data and reduce bias that would come from listwise deletion. Because cases are removed when missing on exogenous variables, estimation of the means and variances of the baseline controls was included in the models to maximize available data. This approach is beneficial when the inclusion of the variables would restore information to the outcome variables, and when the included variables are normally distributed [50]. Due to missing data on the school role variable, the final analytic sample size for all models was $n = 201$. All analyses were conducted in Mplus v8.8 [51].

Results

Descriptive statistics of the school-level study variables and unadjusted between-condition statistical tests for each are presented in Table 1. In line with the sample matching process, control and intervention schools were not statistically different in terms of school size (number of students, number of teachers) or proportion of students eligible for free/reduced-price meals. Additionally, schools did not significantly differ between conditions by remoteness or school level. The Tier 1 TFI score did not

significantly differ by condition at baseline (T1); intervention schools had average TFI scores of 25.7% ($SD = 10.7\%$) compared to 19.0% ($SD = 12.8\%$) in control schools. In 2020 (T2), this difference was significantly greater (76.5% ($SD = 10.9\%$) vs. 66.7% ($SD = 18.5\%$)).

Table 2 presents descriptive statistics of staff-level variables and unadjusted between-condition statistical tests. Similar to school-level variables, no significant differences by intervention condition were observed for any demographic characteristics. Respondents in control schools perceived significantly greater change commitment at Time 1 than those in intervention schools ($M = 3.42$ ($SD = 0.99$) vs. $M = 3.13$ ($SD = 0.85$)), but perceived organizational readiness was similar between groups. Respondents in intervention schools had significantly greater levels of all variables at Time 2, except for team efficacy and team tension.

Main effects

Regression analyses examined the association between the intervention condition and Tier 1 TFI percent score at Time 2. An unadjusted path model identified a significant effect ($b = 9.83$, $p = 0.01$, 95% CI [0.68,18.99], $\beta = 0.63$) of the intervention condition on TFI, indicating that intervention schools had an increase of 9.8 percent in TFI score at Time 2. Including a baseline control for TFI slightly reduced the intervention effect ($b = 8.58$, $p = 0.085$, 95% CI [-1.19,18.36], $\beta = 0.55$). A final model, including baseline controls and covariates for school level and fringe rural locale, maintained a similar effect ($b = 8.40$, $p = 0.056$, 95% CI [-0.22,17.01], $\beta = 0.54$).

Table 1 Descriptive statistics and comparison of school-level study variables by condition

Variable	Control			Intervention			t	χ^2	df	p
	N	M/%	SD	N	M/%	SD				
TFI T1	20	19.00	12.76	20	25.67	10.66	1.79		38	.081
TFI T2	20	66.67	18.45	20	76.50	10.89	2.05		30.81 ^a	.049
Students	20	363.40	173.19	20	334.20	185.90	0.51		38	.610
Teachers	20	19.60	6.11	20	17.85	7.85	0.79		38	.436
Free/Reduced Price Lunch	20	51.04	16.66	20	46.02	19.00	0.89		38	.380
Location								0.45	2	.798
Fringe	20	20.0%	-	20	15.0%	-				
Distant	20	45.0%	-	20	40.0%	-				
Remote	20	35.0%	-	20	45.0%	-				
School Level								0.74	3	.863
Elementary/Middle	20	55.0%	-	20	60.0%	-				
Middle/High	20	25.0%	-	20	15.0%	-				
High only	20	10.0%	-	20	10.0%	-				
K-12	20	10.0%	-	20	15.0%	-				

Abbreviations: TFI Tiered Fidelity Inventory Tier 1 Percentage of total possible points, T1 Wave 1, T2 Wave 2

^a Fractional df used for unequal variances

Table 2 Descriptive statistics and comparison of team-level study variables by condition

Variable	Control			Intervention			t	χ^2	df	p
	N	M/%	SD	N	M/%	SD				
T1 Organizational Readiness	75	4.06	0.71	82	4.10	0.63	0.39		155	.698
T2 Organizational Readiness	82	3.63	1.01	70	4.06	0.80	2.91		149.16 ^a	.004
T1 Change Commitment	72	3.42	0.85	82	3.13	0.85	2.12		152	.036
T2 Change Commitment	82	3.03	0.99	70	3.36	0.83	2.23		150	.027
T2 Team Culture	82	3.51	0.89	70	3.90	0.77	2.83		150	.005
T2 Team Efficacy	82	3.64	0.82	70	3.83	0.76	1.51		150	.133
T2 Productive Team Meetings	82	3.57	1.16	70	4.07	0.71	3.25		136.92 ^a	.001
T2 Team Tension	80	3.85	1.41	70	3.90	1.50	0.21		148	.833
T2 Team Goal Setting	82	3.51	1.14	70	4.03	0.82	3.25		145.93 ^a	.001
Female	102	80.4%		103	75.7%			0.65	1	.420
White	87	95.4%		93	97.8%			0.84	1	.361
Age								0.65 ^b	1	.421
20–30	89	14.6%		96	17.7%					
31–40	89	25.8%		96	28.1%					
41–50	89	34.8%		96	35.4%					
51–60	89	22.5%		96	14.6%					
60+	89	2.2%		96	4.2%					
School Role								2.92	3	.404
Administrator	98	22.4%		103	17.5%					
Teacher	98	63.3%		103	61.2%					
Counselor	98	8.2%		103	8.7%					
Other role	98	6.1%		103	12.6%					

Abbreviations: T1 Wave 1, T2 Wave 2

^a Fractional *df* used for unequal variances

^b Linear-by-linear test statistic

Intraclass correlations

We examined intraclass correlations of the staff-level team functioning items to identify the proportion of variance in each attributable to school-level differences. Importantly, because not all the 205 respondents were available in 2020, the average cluster size for each variable is approximately 3.8. As such, a sizable fraction of the variance of each variable is attributable to between-school variation. ICCs were 0.41 for organizational readiness, 0.35 for change commitment, 0.42 for team culture, 0.39 for team efficacy, 0.40 for team productivity, 0.23 for team tension, and 0.32 for goal setting. Because SRMR_b may be less sensitive to misspecification when ICCs are at or below 0.23 [49], model fit may be difficult to discern for the mediation model including team tension.

Mediation

We examined whether each of the seven team functioning constructs mediated the observed relationship between the intervention condition and the Tier 1 TFI score. Modeling of organizational readiness and change

commitment included a baseline control for each to the within-level component of the path models, allowing a more robust assessment of intervention effects on each mediator (see Table 3). Both models had significant *a* paths, indicating that after adjusting for baseline and the respondent’s role at the school, the intervention had a positive effect on respondents’ perceptions of both organizational readiness and change commitment. The models also had significant *b* paths, indicating significant positive associations between each mediator and fidelity, as well as non-significant *c*’ paths, suggesting full mediation of the intervention’s effects on implementation fidelity. However, the indirect paths for change commitment ($b=5.87, SE=3.52, p=0.095, \beta=0.19$), and for organizational readiness were nonsignificant ($b=7.09, SE=4.53, p=0.118, \beta=0.23$). Although the approach cannot be used to infer significance, Monte Carlo estimates of these indirect effects produced more robust confidence intervals, with estimates of 5.90 (95% CI [0.24,13.69]) and 7.08 (95% CI [0.82,16.04]), respectively. Both models had non-significant chi-square values, acceptable within-level SRMR values, and acceptable (change commitment) or

Table 3 Multilevel mediation model results with mediator baseline controls

Path	Organizational Readiness			Change Commitment		
	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Between-level						
M on Intervention (<i>a</i>)	0.44*	0.18	0.41	0.39*	0.19	0.34
TFI on M (<i>b</i>)	16.15**	5.60	0.56	15.16**	4.86	0.56
TFI on Intervention (<i>c'</i>)	1.86	5.19	0.06	2.43	4.53	0.08
Indirect (<i>a*b</i>)	7.09	4.53	0.23	5.87†	3.52	0.19
M on Fringe	0.55**	0.20	1.02	0.47*	0.22	0.84
M on Level	0.25	0.18	0.46	0.17	0.19	0.29
TFI on Baseline	0.04	0.18	0.03	0.13	0.18	0.10
TFI on Fringe	-9.00	5.81	-0.58	-8.05	5.46	-0.52
TFI on Level	8.73†	4.93	0.57	9.90*	4.48	0.64
M Intercept	1.75**	0.56	3.27	1.57***	0.34	2.79
TFI Intercept	30.75*	13.34	2.00	33.68**	9.82	2.19
Residual variances						
TFI	129.74***	36.04	0.55	120.30**	35.20	0.51
M	0.18**	0.07	0.63	0.24**	0.08	0.76
Within-level						
M on Baseline	0.38**	0.14	0.35	0.37***	0.08	0.45
M on Role	0.24*	0.12	0.34	0.18	0.12	0.26
Residual variances						
M	0.45***	0.09	0.86	0.40***	0.06	0.79
$\chi^2(df)$	7.693(5)			8.305(5)		
SRMR within	0.053			0.069		
SRMR between	0.102			0.076		

Abbreviations: M Mediator, TFI TFI Total Percentage at 2020, SRMR Standardized Root Mean Squared Residual

*** $p < .001$ ** $p < .01$ * $p < .05$ † $p < .10$; *b* = unstandardized coefficient, β = standardized coefficient

marginal (organizational readiness) between-level SRMR values.

Of the five post-test-only mediators (see Table 4), significant intervention effects were observed in the *a* paths for team culture, team goal setting, and team productivity. Team productivity significantly mediated the relationship between the intervention and the Tier 1 TFI score, with both significant *a* and *b* paths, a significant indirect (*a*b*) path ($b = 6.30$, $SE = 2.63$, $p = 0.017$, $\beta = 0.21$), and a non-significant *c'* path, with Monte Carlo estimates of indirect effects of 6.34 (95% CI [0.83,13.86]). Team culture and goal setting both had significant *a* and *b* paths and a non-significant *c'* path, as well as non-significant indirect paths. Monte Carlo estimates of these indirect effects were more robust, with estimates of 5.38 (95% CI [0.29,12.53]) and 11.20 (95% CI [1.23,24.97]), respectively. Team efficacy had non-significant *a* and *c'* paths, as well as a non-significant indirect effect, and team tension had only non-significant paths, suggesting that neither team efficacy nor team tension mediated the relationship between intervention condition and TFI. Model fit was like that of the prior models, with non-significant

chi-square tests, acceptable within-level SRMR, and acceptable or marginal between-level SRMR.

Discussion

Prior research examining strategies to promote the implementation of universal prevention initiatives, such as training and technical assistance, has found positive effects on implementation fidelity [6]. Our study extends this research by testing mechanisms of this improvement in the context of PBIS implementation in rural schools. This study provides evidence that a bundle of supports, including training, technical assistance, and a virtual learning collaborative, can improve Tier 1 implementation fidelity of a school-based universal prevention initiative by fostering greater team functioning and organizational readiness. Aligning with our hypotheses, we find significant mediation effects of the external supports on universal implementation fidelity through team productivity, as well as effects through organizational readiness, change commitment, team culture, and team goal setting.

Table 4 Multilevel mediation model results

Path	Team Culture			Team Efficacy			Team Goal Setting			Team Productivity			Team Tension		
	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Between-level															
M on Intervention (a)	0.40*	0.19	0.36	0.21	0.18	0.21	0.55**	0.20	0.49	0.52*	0.22	0.40	0.14	0.30	0.10
TFI on M (b)	13.47**	4.14	0.49	14.63***	3.74	0.47	20.29*	7.83	0.73	12.24**	3.66	0.51	5.69†	3.45	0.25
TFI on Intervention (c')	3.29	4.15	0.11	5.50	4.16	0.18	-2.17	6.56	-0.07	2.12	4.37	0.07	7.78†	4.34	0.25
Indirect (a*b)	5.38†	3.11	0.18	3.08	2.78	0.10	11.10†	6.66	0.36	6.30*	2.63	0.21	0.80	1.82	0.03
M on Fringe	0.38	0.24	0.68	0.42†	0.23	0.84	0.32	0.26	0.57	0.39	0.34	0.61	0.69**	0.22	1.01
M on Level	0.24	0.19	0.43	0.24	0.17	0.47	0.33	0.21	0.60	0.05	0.22	0.07	0.09	0.30	0.13
TFI on Baseline	0.08	0.17	0.06	0.09	0.18	0.07	0.04	0.17	0.03	0.11	0.17	0.09	0.09	0.18	0.07
TFI on Fringe	-5.64	5.05	-0.37	-6.70	5.22	-0.44	-6.62	5.90	-0.43	-5.55	5.25	-0.36	-4.51	5.66	-0.29
TFI on Level	9.36*	4.34	0.61	9.10*	4.43	0.59	6.00	4.99	0.39	11.92**	4.23	0.78	12.06**	4.43	0.78
M Intercept	3.25***	0.18	5.82	3.37***	0.15	6.78	3.17***	0.23	5.71	3.40***	0.19	5.29	3.58***	0.30	5.25
TFI Intercept	14.57	14.94	0.95	8.84	12.62	0.58	-5.31	25.53	-0.34	16.27	13.95	1.06	37.80**	13.01	2.46
Residual variances															
TFI	133.27***	32.33	0.56	133.93**	39.14	0.57	97.93**	36.11	0.41	127.64**	0.12	0.54	163.60***	38.59	0.69
M	0.24**	0.08	0.76	.20**	0.07	0.80	0.19**	0.07	0.62	0.32**	0.12	0.79	0.39	0.28	0.84
Within-level															
M on Role	0.13	0.15	0.20	0.10	0.13	0.17	0.22†	0.13	0.25	0.24	0.15	0.31	-0.01	0.27	-0.01
Residual variances															
M	0.43***	0.07	0.99	0.39***	0.06	1.00	0.74***	0.13	0.99	0.59***	0.10	0.98	1.66***	0.30	1.00
χ^2 (df)	3.88(4)			3.70(4)			4.19(4)			3.56(4)			4.39(4)		
SRMR within	0.002			0.001			0.004			0.000			0.004		
SRMR between	0.086			0.079			0.102			0.079			0.086		

Abbreviations: M Mediator, TFI TFI Total Percentage at 2020, SRMR Standardized Root Mean Squared Residual

*** $p < .001$ ** $p < .01$ * $p < .05$ † $p < .10$; *b* = unstandardized coefficient, β = standardized coefficient

These findings highlight how specific elements of team functioning, including productive work sessions, team unity, and goal setting, are targetable mechanisms that can aid in the successful implementation of universal prevention programming in schools. The implementation strategies employed in the present study provided both content expertise and skill-building for team members, which likely helped team members to identify more efficiently the specific tasks and goals necessary to improve implementation. Importantly, the collaborative relationship between the implementation support specialists and team members also likely played a strong role in improving team functioning [13] by helping to build a positive culture of support within the team itself. Although team efficacy and tension had relationships with implementation fidelity, neither were improved by the intervention. This could relate to the self-selection of team members, who approached PBIS implementation with high motivation and low potential for tension with other team members.

Our results confirm that external supports can improve organizational readiness and change commitment, and that these associate with improved Tier 1 implementation

fidelity. This is an important finding given that PBIS developers note that high staff commitment is required to effect positive changes in student behavior [33], yet few strategies for obtaining this buy-in have been tested [52]. Trainings and assistance that improve school-wide capacities, particularly during early adoption of evidence-based programming, may be one such strategy. Organizational readiness is critical to the successful adoption and sustainment of evidence-based programming [3]. More research is needed to examine whether the RS3 supports that were effective in the initial stages of Tier 1 adoption are similarly effective in sustaining implementation. Furthermore, while the supports examined here focused on universal implementation (Tier 1), additional technical assistance may be needed to improve fidelity for targeted and intensive supports (Tiers 2 and 3).

These results have meaningful implications for scale-up of schoolwide (i.e., universal) prevention initiatives. Although many initiatives are designed to be self-sustaining within schools following limited initial trainings, school teams can benefit from additional trainings and ongoing assistance from experts. The direct improvements to implementation fidelity likely extend beyond

the scope of this study, as improved fidelity in the universal tier of PBIS has been associated with greater improvement in fidelity of targeted and intensive tiers [53]. Importantly, the training and technical assistance package that we tested included supports with relatively minimal personnel and time requirements, as each implementation support specialist oversaw technical assistance for ten schools. This suggests that efficient investment in external supports provided by a small number of content experts—particularly those that focus on improving school team functioning and building school-wide capacity—can lead to positive gains for districts and states.

Strengths and limitations

A notable strength of the present study is its multi-site, longitudinal research design that allowed for investigation of the effects of the implementation supports at both the school and team levels, including a-priori hypothesized mediational mechanisms. Despite the substantial benefits afforded by having 40 schools in a randomized trial, teams were limited in size, typically to about five members. The nature of this sample inherently limits statistical power, thus we were unable to test multiple mediators simultaneously and had reduced capacity to include additional school- and team-level covariates, or potential substantive confounds, such as innate team-oriented qualities among members, administrative leadership style, and resource allocation, which may moderate or otherwise contribute to the relationship between the intervention and both team functioning and implementation fidelity. Likewise, conducting multiple tests of mediational pathways may have increased the chance of Type 1 errors. Despite these limitations, we were able to use a multilevel mediation design offering greater specificity of the intervention effects beyond what could have been tested with an aggregated data approach, and we strengthened the estimates through simulation of the indirect effects. Importantly, for several outcomes, the Monte Carlo-simulated confidence intervals differed from the models' *p*-values. Although the simulated confidence intervals are expected to be more robust estimates, further evidence is needed to confirm these indirect paths.

The present study focused on rural schools, which could limit generalizability. Likewise, schools were limited to those that agreed to participate in a randomized trial, which may differentiate them from other schools in the state. Some schools were grouped by district, which may have increased similarity among schools within condition. Because participating schools had a variety of grade levels, we had limited capacity to examine school-type more precisely and could only differentiate primary grades (i.e., elementary levels) from adolescent-focused

schools (i.e., secondary levels). Another limitation is the lack of baseline measures for team functioning measures, but because teams were all new, functioning levels did not exist at baseline. Although prior research has noted the contribution of technical assistance to team functioning [13], we cannot infer that the intervention was solely responsible for observed differences. Lastly, the TFI relies on self-reports of team members, and thus may be impacted by reporting biases, particularly in the intervention condition. Replication with assessments of implementation fidelity by external observers who are masked to treatment condition would increase rigor.

Conclusion

Despite the increasing use of implementation teams, little research has examined team functioning as a potential target for improving fidelity of interventions. Findings from this study show that implementation strategies—including trainings, technical assistance and a virtual learning collaborative—that focus on teaming, can improve the fidelity of schoolwide universal prevention initiatives in rural schools, and this appears to operate through enhanced team functioning and improved commitment among school staff.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s43058-024-00691-9>.

- Supplementary Material 1.
- Supplementary Material 2.
- Supplementary Material 3.

Acknowledgements

We thank each of the schools and all team members for their participation.

Authors' contributions

All authors contributed to conceptualization and design of the analyses; CF conducted analyses and drafted the manuscript; LT and HC designed and implemented the study protocol and reviewed and edited the manuscript; all authors read and approved the final manuscript.

Funding

This study is funded by the National Institute of Justice, #2017-CK-BX-0021.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to security provisions of the protocol approved by the institutional review board, but de-identified data may be available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This research was approved by the Institutional Review Board at Boise State University (protocol number 101-SB17-207). All participants provided informed consent prior to each survey.

Consent for publication

Not applicable.

Competing interests

We have no known competing interests to disclose.

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Received: 17 April 2024 Accepted: 26 December 2024

Published online: 06 January 2025

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