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Impact of Sources of Strength on adolescent suicide deaths across three randomized trials

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ABSTRACT

Universal interventions are key to reducing youth suicide rates, yet no universal intervention has demonstrated reduction in suicide mortality through an RCT. This study pooled three cluster-RCTs of *Sources of Strength* (n=78 high schools), a universal social network-informed intervention. In each trial, matched pairs of schools were assigned to immediate intervention or wait-list. Six schools were assigned without a pair due to logistical constraints. During the study period, no suicides occurred in intervention schools vs four in control schools, that is, suicide rates of 0 vs. 20.86/100,000, respectively. Results varied across statistical tests of impact. A state-level exact test pooling all available schools showed fewer suicides in intervention vs. control schools (p=0.047); whereas a stricter test involving only schools with a randomised pair found no difference (p=0.150). Results suggest that identifying mortality-reducing interventions will require commitment to new public-health designs optimised for population-level interventions, including adaptive roll-out trials.

Youth suicide is a leading cause of death and years of life lost world wide.¹ In the United States in 2020, for example, suicide was the second leading cause of death for people ages 10–14 and third leading cause for ages 15–24.²

Universal interventions targeting broad youth populations are likely essential to achieve significant population reductions in suicide rates for at least two reasons.^{3–4} First, strategies limited to already identified high-risk individuals will not capture most youth who will die by suicide, the majority of whom are not seen by a mental health professional in the months prior to death.⁵ A second reason is the limited availability and accessibility to effective clinical services for many populations with high suicide rates (eg, Indigenous, rural and other underserved communities). Despite emerging consensus on the need for population strategies, no universal intervention has yet demonstrated a reduction in youth suicide mortality through a randomised controlled trial (RCT).

Among the class of universal interventions, those that strengthen relationship structures and social norms around youth and emerging adults are uniquely promising for suicide prevention.^{6–7} For youth who are already at elevated risk or suicidal, natural social networks are often the only pathway to formal clinical services (ie, based on their status as minors, they typically cannot navigate these systems independently and require supportive

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ No universal suicide prevention programme has previously demonstrated reduction in youth suicide deaths through an RCT.

WHAT THIS STUDY ADDS

⇒ Analysis combining three cluster randomised trials (n=78 schools) suggested that the *Sources of Strength* programme may reduce suicide mortality in schools.

⇒ Results varied across statistical models, with the intervention condition showing a reduction in suicides in a state-level test including all schools versus no significant reduction in a test involving only schools with a randomised pair.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ *Sources of Strength* and other network-based interventions are a uniquely promising strategy for reducing youth suicide mortality and worthy of broader population roll-out studies.

⇒ Larger state-wide roll-out trials are needed to confirm these promising results.

encouragement).⁸ For youth who are currently healthy (but a portion of whom will become suicidal), stronger social integration and healthy peer norms can prevent future vulnerability to becoming suicidal.^{6,7} Taken together, social network interventions thus build proactive suicide protection into the social environment,^{9,10} and address both the multifaceted drivers of youth suicide and extended time scales in which suicide can emerge.

Sources of Strength is a social network-informed intervention that trains diverse youth key opinion leaders to disseminate a multidimensional coping framework through their friendship groups by conducting school-wide prevention campaigns. The objective is reducing suicide risk across a school's full school student population. Three cluster (school) RCTs have been conducted. In an initial efficacy trial testing target engagement of programme mediators, *Sources of Strength* improved school-wide protective norms (eg, help seeking acceptability) and student help-seeking behaviours (eg, referral of suicidal friends to adults).¹¹ A second hybrid effectiveness-implementation trial showed *Sources of Strength* increased student help-seeking behaviours over one school year that were subsequently lost when implementation fidelity declined, and no overall beneficial effects on student suicide



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Table 1 Trials of *Sources of Strength*, suicide deaths and rates per 100 000 student years

Trial	State (Time Frame)	Condition	No. schools	Student Population*	Student yrs. Exposed†	No. suicides	Suicide rate per 100,00
Wyman <i>et al.</i> ¹¹ 2010	GA (2007–09)	Wait-list	3	6059	1845.6	0	
		Intervention	3	6088	2159.1	0	
	ND (2008–09)	Wait-list	2	128	62.4	0	
		Intervention	2	180	87.9	0	
	NY (2008–09)	Wait-list	4	1357	855.2	0	
		Intervention	4	2524	1586.7	0	
Wyman <i>et al.</i> 2023 ¹²	ND (2010–13)	Wait-list	5	848	926.3	0	
		Intervention	4	550	568.4	0	
	NY (2010–15)	Wait-list	15	9870	10 858.4	1	10.13
		Intervention	16	9569	11 063.5	0	
Espelage <i>et al.</i> ¹³ 2023	CO (2017–19)	Wait-list	9	3470	4624.0	3‡	86.46
		Intervention	11	4189	6110.2	0	
Cumulative		Wait-list	38	19 098	19 171.9	4	20.86
		Intervention	40	20 862	21 575.8	0	
		Total	78	39 960	40 747.7	4	9.82

*Total students on school rosters.

†School population X duration. 0.9% occurred outside of assigned condition due to 2 control schools withdrawing prior to study completion.

‡Two student suicides occurred in one control school eight months apart.

attempts.¹² A third trial that tested for cross-over effects on sexual violence¹³ showed significant reductions in suicide attempt rates (student self-report) over a 2 year school period.¹⁴

Taken together, prior findings suggest at least the potential for this social network intervention to reduce adolescent suicide mortality. However, no prior trial examined *Sources of Strength* impact on student suicide mortality. To evaluate its effectiveness for reducing suicide fatalities, this investigation pooled these three group-randomised controlled trials spanning 78 high schools.

METHODS

In each of these RCTs, high schools were stratified (location, size, timing) to form matched pairs and randomly assigned to either immediate *Sources of Strength* (intervention) or to the wait-list condition. Six schools were assigned without a pair due to logistical constraints. In the first trial,¹¹ intervention schools implemented *Sources of Strength* for one school semester and control schools began implementing in the second semester (see table 1). In the second¹² and third trials,¹³ intervention schools implemented the programme for two school years, with control schools starting in year three.

Counts of suicide deaths across all trials came from mandatory school reports to the Data Safety Monitoring Committees/IRBs detailing any suicides among each school's student population during the study period when intervention schools were implementing and control schools had not yet started. This active study period for counting suicide deaths ended once control schools began implementing *Sources of Strength*, since any deaths after that point could not be attributed to difference in intervention exposure across the two randomised conditions.

To determine if the suicide rate differed by randomised condition across the three aggregated trials, student years of exposure to condition (intervention or control) was calculated. For each school, this was calculated as the total student population X duration of the exposure period. The exposure start-date was date of training for student peer leaders in the intervention condition (same start-date in matched control school). The exposure period lasted through first semester in trial #1 and end of the second school year in trials #2 and #3. Condition was

based on a school's assigned condition (ITT). Because suicide deaths are relatively rare occurrences, an exact conditional test of a common OR of 1 between condition and suicide was used to determine if the association between suicide rates and condition was non-random. We conducted two exact tests: (a) one including all 78 schools (trial X state=6 strata), and (b) the other with only the matched pairs of 72 schools (36 pairs=36 strata). The first model is thus a state-level analysis and also includes more schools; whereas the second includes a smaller sample, but is a stricter statistical control for baseline characteristics.

RESULTS

The three cluster RCTs with 78 schools accounted for 40 747 student years of exposure: 21 576 to intervention and 19 172 to control conditions. Across all three trials, no suicides occurred in the intervention schools (point estimate of 0). Four suicides occurred in control schools that had not yet implemented *Sources of Strength*, representing an aggregated suicide rate of 20.86 per 100 000 person years (table 1).

The first exact test that pooled the 78 schools by state and trial showed the suicide event rate was lower in intervention compared with control schools ($p=0.047$). In the second test comparing the 72 schools randomised in pairs, no significant difference was observed ($p=0.150$).

DISCUSSION

Sources of Strength is a universal school-based social network intervention with a growing evidence base. To extend knowledge about this intervention, this study examined impact on student suicide mortality. This study's results combining three prior trials ($n=78$ high schools) suggest *Sources of Strength* reduced student suicides, but also that broader state-wide roll out trials are needed to confirm this initially promising signal. Specifically, if the current results are replicated, scaling up the programme across a moderate-sized state could translate to more than 100 saved lives over a decade. However, this study also underscores limitations of traditional RCT designs – that enroll and follow individual people – to identify population level suicide impacts, even when combining multiple large trials as in

this study. Identifying mortality-reducing interventions instead demands commitment to new public-health designs.

We specifically recommend “adaptive roll out” trials that sequentially randomise blocks of communities or regions in a state to receive an intervention such as *Sources of Strength* at different phases.¹⁵ Such an approach can leverage ongoing surveillance of suicides in a larger number of new intervention sites (ie, not requiring new data collection for deaths), dramatically increasing power to detect impact on mortality. In addition to sequential roll-out and comparison of sites randomised to different implementation timing, these trial designs build in the expectation of an iterative implementation refinement based on what is learnt in early cohorts, along with systematic tracking of implementation practices.

The observed modifications to *Sources of Strength* over 15 years in which these three trials were conducted demonstrates this point regarding refinement in implementation over time. Trial one was focused on efficacy for target engagement of key intervention mediators, although suicide deaths were also collected as part of the safety monitoring in this trial. During this initial phase *Sources of Strength* focused on training student peer leaders. With that sole focus, *Sources of Strength* was then tested in an implementation-effectiveness hybrid trial (trial 2), which showed short term benefits on targeted mediators (ie, more students school-wide engaged adults for support) and findings supported an indirect effect of increased adult support in the first school year on reduced suicide attempts; however, those benefits were lost in the second school year as implementation fidelity waned, and *Sources of Strength* showed no overall benefit on reduced suicide attempts by the end of the second school year and became potentially iatrogenic for ninth grade students when implemented in schools with low fidelity (ie, non-adherence to recommended peer-led messaging campaigns).¹² In a more recent trial (trial 3) testing *Sources of Strength* after significant expansion in training and implementation resources provided to adults who mentor student peer leaders, the programme showed more consistent, beneficial effects on reducing suicidal behaviours.¹⁴

This study has several strengths. A key strength is this study evaluated intervention efficacy for an outcome of high public health significance that is seldom possible to evaluate in a clinical trials framework. Suicide deaths among high school students are a major source of years of life lost both in the US and worldwide¹ and few interventions have been shown under conditions of randomization to reduce it. Second, the very same outcome measure was used across the three trials in the same age-group, unlike many other RCT synthesis analyses that combine heterogeneous measures and population groups.¹⁶ And across these three trials, suicide deaths were collected in the same manner. However, although there were these key areas of standardisation across trials (measure, population), this study is still affected by known variability in implementation – a common methodological challenge in trial synthesis studies. Third, these trials strategically sampled a large diverse cross-section of high school students from a range of socioeconomic backgrounds and social contexts (eg, urban and rural, ethnicity, geographic region, school size).

This study also has some limitations. First is the variability across trials in the duration of the active trial period during which deaths were tracked (ie, trial one was one school semester vs two school years in trials 2 and 3). Because there were no student suicide deaths in trial 1, no adjustments were made to account for variability in study duration across trials. Moreover, with only three trials it is difficult to meaningfully disentangle the effect of trial length on suicide deaths. A second limitation

is that, although the base rate of suicide mortality across these trials was comparable to the general youth population in the U.S., the outcome is still sufficiently rare that it may have suppressed statistical power for one or both models tested. Simply put, an exact test with a low number of events has low statistical power. A third and possibly related limitation is that study results were variable across statistical tests. Specifically, the test with the smaller number of paired schools (stricter control for baseline differences) did not detect an intervention effect on mortality, whereas a more inclusive test with a greater number of schools did find an intervention effect. On the basis of this inconsistency, it is still plausible that there is a promising signal that *Sources of Strength* may reduce suicide deaths of students in future larger trials. However, we reiterate that larger scale public health-oriented designs (state-wide rollouts) are likely required before definitive claims can be made about this intervention’s efficacy for reducing mortality.

An additional caveat is that trial 2 (ie, implementation-effectiveness RCT) suggested that *Sources of Strength* delivered with low implementation fidelity may have limited or even adverse impact on suicidal behaviour among younger cohorts. It is therefore possible that this programme delivered with low implementation fidelity could produce similar problems for suicide deaths. With this caveat in mind, future roll-out trials should carefully consider behavioural outcomes including suicide deaths and their ongoing relationship to implementation fidelity.

Across multiple populations, suicide decedents are known to be systematically different from individuals who seriously consider or make non-lethal suicide attempts,^{17 18} therefore identifying interventions that reduce youth suicide mortality is an important independent priority. Prior to this study, no universal intervention has shown reduction in youth suicide mortality through an RCT. The present findings add to evidence that *Sources of Strength* and other network-based interventions that modify peer and adult relationship systems are a uniquely promising strategy and now worthy of even broader population roll-out studies.

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REFERENCES

- 1 Glenn CR, Kleiman EM, Kellerman J, et al. Annual research review: a meta-analytic review of worldwide suicide rates in adolescents. *J Child Psychol Psychiatry* 2020;61:294–308.
- 2 CDC. *Suicide Prevention Resource for Action: A Compilation of the Best Available Evidence*. Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, 2022.
- 3 Rose G. Sick individuals and sick populations. *Int J Epidemiol* 2001;30:427–32.
- 4 Wyman PA. Developmental approach to prevent adolescent suicides: research pathways to effective upstream preventive interventions. *Am J Prev Med* 2014;47(3 Suppl 2):S251–6.
- 5 Luoma JB, Martin CE, Pearson JL. Contact with mental health and primary care providers before suicide: a review of the evidence. *Am J Psychiatry* 2002;159:909–16.
- 6 Wilcox HC, Kellam SG, Brown CH, et al. The impact of two universal randomized first- and second-grade classroom interventions on young adult suicide ideation and attempts. *Drug Alcohol Depend* 2008;95 Suppl 1:S60–73.
- 7 Wyman PA, Pisani AR, Brown CH, et al. Effect of Wingman-Connect upstream suicide prevention for air force personnel in training: a cluster randomized controlled trial. *JAMA Netw Open* 2020;3:e2022532.
- 8 Pescosolido B, Boyer CA. Understanding the context and dynamic social processes of mental health treatment. In: Schneid TL, ed. *A handbook for the study of mental health: Social contexts, theories, and systems*. 2. Cambridge University Press, 2010: 420–38.
- 9 Wyman PA, Pickering TA, Pisani AR, et al. Wingman-Connect program increases social integration for Air Force personnel at elevated suicide risk: social network analysis of a cluster RCT. *Soc Sci Med* 2022;296:114737.
- 10 Wyman PA, Pickering TA, Pisani AR, et al. Peer-adult network structure and suicide attempts in 38 high schools: implications for network-informed suicide prevention. *J Child Psychol Psychiatry* 2019;60:1065–75.
- 11 Wyman PA, Brown CH, LoMurray M, et al. An outcome evaluation of the Sources of Strength suicide prevention program delivered by adolescent peer leaders in high schools. *Am J Public Health* 2010;100:1653–61.
- 12 Wyman PA, Cero I, Brown CH, et al. 2023 Impact of the Sources of Strength peer-leader program on suicide attempt rates in 40 high schools: A cluster randomized controlled trial [in review].
- 13 Espelage DL, Kuehl T, Wyman PA, et al. An RCT of Sources of Strength high school primary prevention program on sexual violence perpetration and associated gender-based attitudes & behaviors. *School Psych Rev* 2023.
- 14 Wyman PA, Cerol, Espelage D, et al. 2023 Impact of Sources of Strength on self-report suicide attempts and tests of moderation by sexual violence victimization and perpetration [under review].
- 15 Brown CH, Ten Have TR, Jo B, et al. Adaptive designs for randomized trials in public health. *Annu Rev Public Health* 2009;30:1–25.
- 16 NIMH Collaborative Data Synthesis for Adolescent Depression Trials Study Team including, Perrino T, Howe G, et al. Advancing science through collaborative data sharing and synthesis. *Perspect Psychol Sci* 2013;8:433–44.
- 17 Beautrais AL. Suicides and serious suicide attempts: two populations or one? *Psychol Med* 2001;31:837–45.
- 18 Britton PC, Crasta D, Bohnert KM, et al. Shorter and longer-term risk for non-fatal suicide attempts among male U.S. military veterans after discharge from psychiatric hospitalization. *J Psychiatr Res* 2021;143:9–15.