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Original article

A cluster-randomized trial comparing two SWITCH implementation support strategies for school wellness intervention effectiveness

Richard R. Rosenkranz [a,*], Philip M. Dixon [b], David A. Dzewaltowski [c], Gabriella M. McLoughlin [d,e], Joey A. Lee [f], Senlin Chen [g], Spyridoula Vazou [g], Lorraine M. Lanningham-Foster [h], Doug A. Gentile [i], Gregory J. Welk [g]

[a] *Department of Food, Nutrition, Dietetics & Health, Kansas State University, Manhattan, KS 66506, USA*
[b] *Department of Statistics, Snedecor Hall, Iowa State University, Ames, IA 50011-1210, USA*
[c] *Department of Health Promotion, University of Nebraska, Omaha, NE 68198-4365, USA*
[d] *Implementation Science Center for Cancer Control and Prevention Research Center, Brown School, Washington University in St. Louis, St. Louis, MO 63130, USA*
[e] *Division of Public Health Sciences (Department of Surgery), Washington University School of Medicine, Washington University in St. Louis, St. Louis, MO 63130, USA*
[f] *Department of Health Sciences, University of Colorado Colorado Springs, Colorado Springs, CO 80918, USA*
[g] *Department of Kinesiology, Iowa State University, Ames, IA 50011-4008, USA*
[h] *Department of Food Science & Human Nutrition, Iowa State University, Ames, IA 50011, USA*
[i] *Department of Psychology, Iowa State University, Ames, IA 50011-1041, USA*

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Abstract

Background: The School Wellness Integration Targeting Child Health (SWITCH) intervention has demonstrated feasibility as an implementation approach to help schools facilitate changes in students' physical activity (PA), sedentary screen time (SST), and dietary intake (DI). This study evaluated the comparative effectiveness of enhanced (individualized) implementation and standard (group-based) implementation.

Methods: Twenty-two Iowa elementary schools participated, with each receiving standardized training (wellness conference and webinars). Schools were matched within region and randomized to receive either individualized or group implementation support. The PA, SST, and DI outcomes of 1097 students were assessed at pre- and post-intervention periods using the Youth Activity Profile. Linear mixed models evaluated differential change in outcomes by condition, for comparative effectiveness, and by gender.

Results: Both implementation conditions led to significant improvements in PA and SST over time ($p < 0.01$), but DI did not improve commensurately (p value range: 0.02–0.05). There were no differential changes between the group and individualized conditions for PA ($p = 0.51$), SST ($p = 0.19$), or DI ($p = 0.73$). There were no differential effects by gender (i.e., non-significant condition-by-gender interactions) for PA ($p_{\text{for interaction}} = 0.86$), SST ($p_{\text{for interaction}} = 0.46$), or DI ($p_{\text{for interaction}} = 0.15$). Effect sizes for both conditions equated to approximately 6 min more PA per day and approximately 3 min less sedentary time.

Conclusion: The observed lack of difference in outcomes suggests that group implementation of SWITCH is equally effective as individualized implementation for building capacity in school wellness programming. Similarly, the lack of interaction by gender suggests that SWITCH can be beneficial for both boys and girls. Additional research is needed to understand the school-level factors that influence implementation (and outcomes) of SWITCH.

Keywords: Children; Implementation science; Obesity prevention; Physical activity; School health

1. Introduction

Schools provide an ideal setting for coordinated youth obesity prevention and health promotion, but challenges persist in disseminating evidence-based programs in a cost-effective

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* Corresponding author.
E-mail address: ricardo@ksu.edu (R.R. Rosenkranz).

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way.[1] Multi-component interventions that target multiple obesity-prevention behaviors and reach multiple settings have been widely recommended in the scientific literature,[2,3] but there are few examples of integrated social-ecological approaches that offer potential for broad dissemination. The School Wellness Integration Targeting Child Health (SWITCH) is a promising multi-component intervention designed to support school wellness programming and contribute to youth obesity prevention.[4–7]

The SWITCH intervention encourages schools to target multiple settings and to prioritize 3 distinct obesity-prevention and health promotion behaviors: physical activity (PA), sedentary screen time (SST), and dietary intake (DI) focused on fruit and vegetable consumption. In a controlled efficacy study, children attending intervention schools had significantly larger gains in both SST and DI than children in control schools, and these effects were generally sustained for 6 months following the intervention.[5] A limitation of the original intervention model was its print-based materials, which limited broader dissemination among schools. The focus of subsequent work was on converting SWITCH to an online intervention, thereby facilitating dissemination. In a controlled effectiveness study, the web-based form of SWITCH showed similar utility and outcomes as the print-based version, but effects were directly related to the degree of engagement within the school.[6] Through a project funded by the United States Department of Agriculture, a novel school wellness team training and implementation model was designed to facilitate greater adoption and more effective implementation of SWITCH in schools. The revised SWITCH implementation model offers potential for broader dissemination, but research is needed to determine the most effective ways to deliver the training.

Recent school-based health promotion efforts have focused on individualized training and coaching of school personnel to improve student outcomes.[8] Currently, it is unclear whether individualized approaches to evidence-based practice implementation are more effective—or worth the extra time needed—compared to group approaches. During the 2016–2017 iteration of SWITCH, an individualized implementation support strategy using one-on-one webinar sessions was investigated in a sample of 8 schools.[4] This implementation support strategy employed the principles of motivational interviewing[9] to promote engagement and motivation for implementing wellness programming activities and evidence-based practices within schools. Such an individualized implementation support strategy may be helpful to schools but presents challenges for broader dissemination. Therefore, the focus of the 2017–2018 iteration of SWITCH was on evaluating the comparative effectiveness of the more intensive (individualized) implementation support strategy against a more efficient (group-based) implementation support strategy in efforts to increase health-promoting behaviors among school-aged boys and girls. The direct comparison of implementation strategies is a recommended procedure in implementation science research because it helps to determine the most effective and sustainable way to achieve broader dissemination.[10] Additional aims of this study were to determine whether there were interactions between implementation support condition and gender for PA, SST, and DI, and whether school-level participation in tracking of PA, SST, and DI was related to behavior change over time. We hypothesized that: (a) the individualized implementation support condition would be more effective than the standard group support condition; (b) there would be no interactions between condition and gender; and (c) higher tracking participation would be associated with more favorable changes in PA, SST, and DI.

2. Materials and methods

2.1. Design and recruitment of schools

This study used a cluster-randomized trial design to compare 2 distinct implementation support strategies in a geographically widespread sample of Iowa elementary schools.[11] The phased dissemination of SWITCH is conducted in partnership with the Iowa 4-H Extension and Outreach program, so recruitment of schools was handled exclusively by regional and county Extension leaders across the state. The original goal was to have 4 schools from each of 6 state 4-H regions participate, with an aim to build capacity and to facilitate coordination and evaluation of county youth coordinators who worked collaboratively with the regional youth specialists. A requirement was that schools needed to identify intact the 4th- and 5th-grade classrooms to participate as a unit. Schools were also required to establish a team of 3 lead staff members and to have formal administrative approval (signature from the principal) to ensure organizational commitment to the capacity-building process. Schools that formally enrolled received free programming, paid travel to the annual SWITCH training conference, and USD 1000 to support local coordination efforts and purchasing of necessary supplies.

Fig. 1 shows the flow of schools and students through the trial. The recruited sample included 25 schools from all 6 regions and from 18 different counties. The sample consisted of 22 public schools and 3 private schools in the state of Iowa, USA. Three of the public schools were experienced schools that had participated in the program during the previous year and so were excluded from the trial. The new schools ($n = 22$; with 19 public and 3 private) were included in the trial and categorized into 8 regional groups that were defined first by county, second by Extension region, and third by proximity to other SWITCH schools. The matching process emphasized county over socio-economic status or school characteristics, since schools had wide variability in enrollment size and rurality, and it was deemed most important to ensure balanced exposure and involvement of Extension and 4-H leaders who provided support to the schools. The matching process led to 11 pairs of matching schools (1:1). One school within each of the 11 pairs was then randomly selected for allocation to the individualized implementation condition; the other school within each of the 11 pairs was consequently allocated to the standard group implementation condition.

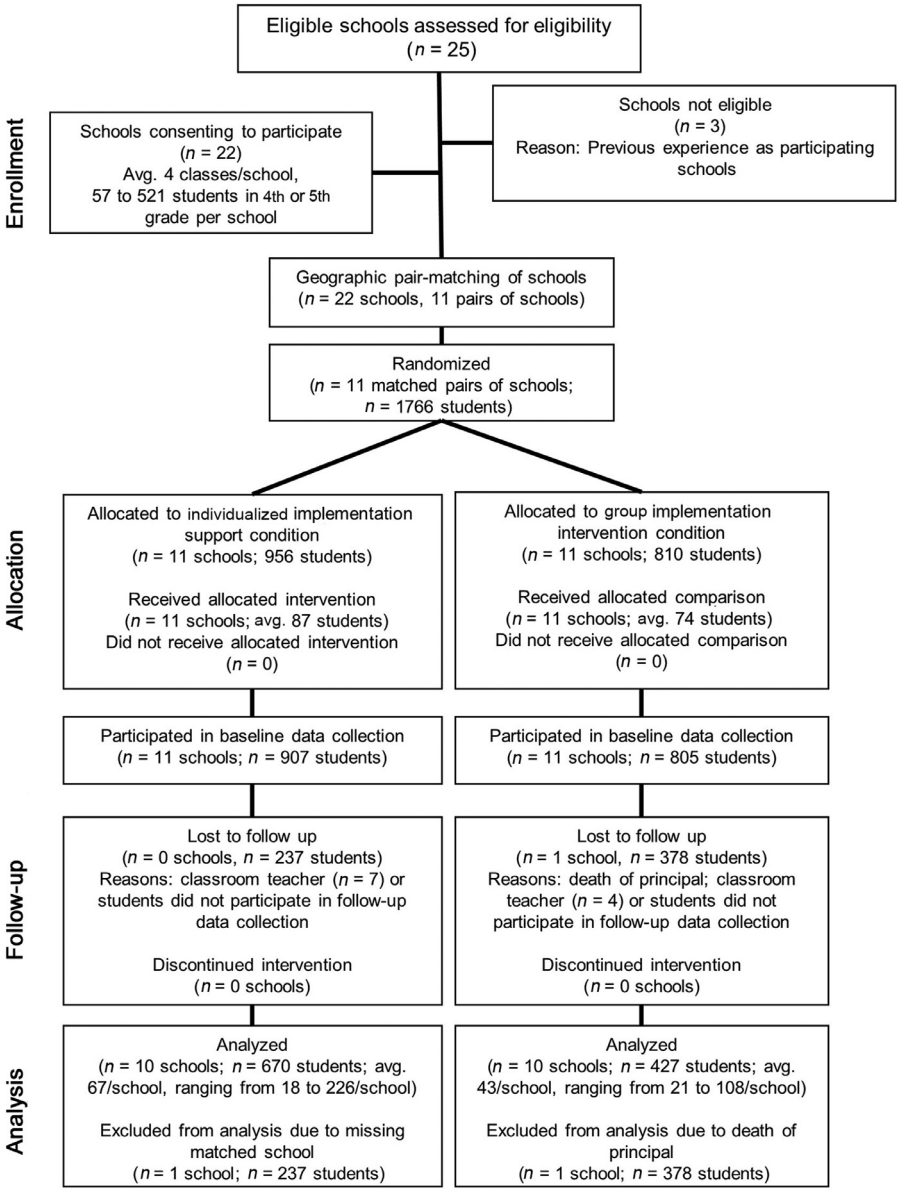

Fig. 1. Consolidated Standards of Reporting Trials diagram showing the flow of participants through stages of cluster-randomized trial. avg. = average.

2.2. Participants

Fig. 1 and Table 1 provide information on the number and characteristics of the participating schools and students across the phases of this cluster-randomized trial. The Iowa State University Institutional Review Board (IRB) approved the study and made an exempt determination for the school-based components of the project since they were minimal risk and consistent with normal educational activities in schools. Within the fully approved IRB protocol (#14-651), informed consent from participants was not required for the use of the de-identified data collected in the project. The school components met the IRB criteria for exemption as the programming was led by schools, and students were involved in normal educational practices.

Data on school enrollment and percentage of low-income households, race, and ethnicity were obtained from publicly available records, while grade and gender were self-reported by students. The 22 elementary schools represented 16 counties across all 6 Extension regions in the state. Schools were predominantly rural with heterogeneous enrollments ($n = 57–521$) and low-income households (8.5%–59.4%). Consistent with overall demographics in the state, the large majority of students were non-Hispanic white (84.3%). There was nearly equal representation of girls (47.8%) and boys (52.2%) in the participating schools. The final sample included 20 schools with complete data from 605 students in Grade 4 (aged 9−10 years) and 492 students in Grade 5 (aged 10−11 years).

2.3. Intervention

The SWITCH training process is based on an established training and implementation model developed through the Healthy Youth Places project[12] and later refined in the HOP'N

Table 1
Characteristics of participating schools and students by SWITCH implementation condition.

	Individualized	Standard group
School		
Enrolled schools	11	11
Completing schools	10	10
Total school enrollment	330 ± 99	348 ± 148
Free/reduced lunch (%)	48.4 ± 18.7	35.7 ± 7.1
Non-Hispanic (%)	84.3 ± 11.2	83.5 ± 16.9
Student		
Baseline	956	810
Complete cases	670	427
Grade 4 (9−10 years)	346	259
Grade 5 (10−11years)	324	168
Girls	320	204
Boys	350	223
Multiple imputation	837	732

Note: Data are shown as *n* or mean ± SD.
Abbreviation: SWITCH = School Wellness Integration Targeting Child Health intervention.

After School project.[13] As applied to school wellness programming, it was designed to build the capacity of school personnel to establish and sustain healthier school environments. Full details on the intervention can be accessed in our previously published feasibility trial[4,14] and through the clinical trial registry.[11] Through the sequential phases of training, school personnel are provided with guidelines for effective use of SWITCH "quality elements" components, but they are provided ample flexibility regarding how to coordinate and deliver the programming in their own school. Three settings within the school are targeted (i.e., classroom, lunchroom, and physical education), and setting-specific "best practices" are provided to help facilitate programming consistent with SWITCH priority behaviors and themes. The standardized training process ensures that the approach can be systematically evaluated, while the flexible implementation enables the programming to be tailored and customized to fit local needs and interests. Consistent with self-determination theory, schools are more likely to be motivated to create and sustain local change when they have autonomy for local decision-making (as well as competence and relatedness).

School capacity (i.e., competence) is built through an annual school wellness conference, a sequential set of preparatory webinars, and an online community of practice network that allows school personnel to share strategies with their peers from other participating schools. Each school forms a school wellness team of 3 who are provided with resources and base program materials, including setting-specific resource modules and posters, but the wellness team is given autonomy regarding how those resources are used within their school. School programming is most directly supported through the use of a customized, online content-management system that allows school wellness teams to coordinate local SWITCH programming. The web platform provides wellness team leaders with the ability to enroll classes and provide individual students with access to a simple online tracking system designed to promote self-monitoring skills. Teachers in both implementation support conditions were asked to promote use of the online self-regulation platform by students to track PA, SST, and DI behaviors. The behavioral focus cycled through a set of SWITCH standardized and targeted goals related to "do" (PA), "view" (SST), and "chew" (DI) each week (standardized as ≥60 min of PA, ≤2 h of SST, ≥5 servings of fruits and vegetables). Once students completed their online tracking, they were given immediate visual feedback on whether they met daily PA, SST, and DI goals in green (met), orange, or red (not met). After receiving feedback, students were directed to their dashboard, where they could see the full week of feedback. This self-regulation platform enabled students to see the number of days that they tracked and whether or not they met PA, SST, and DI recommendations. Classroom teachers were also able to receive feedback on class-level tracking, and they were encouraged to use SWITCH trinkets as an incentive for self-regulation behaviors. A previous study on the 2017−2018 iteration of SWITCH[14] documented the positive impact of regular tracking on promoting behavior change through SWITCH, so the regular use of the tracker was emphasized as a particularly useful component for promoting positive health behavior outcomes.

Schools in the group implementation support condition received weekly updates through the online content-management system, the community of practice, and via direct email correspondence. These communications provided reminders about the rotating weekly themes ("do", "view", and "chew"), links to related module activities, and other strategies to maintain engagement in the school. Schools in the individualized SWITCH implementation support condition schools received the same training, access, and resources as the group SWITCH implementation condition along with individualized monthly training webinars throughout the intervention. Building on the previous feasibility study,[4,14] the individualized webinars were based on motivational interviewing principles meant to promote autonomy and motivation for school change through the process.[9] This supplemental support was provided through participation in 2 online "checkpoint sessions" that helped schools self-assess their use of the recommended quality elements and setting-specific best practices. Consistent with motivational interviewing principles, they were encouraged to develop and implement strategies to address limitations in their programming.

2.4. Data collection

Outcome measures of student behavior change were obtained using the Youth Activity Profile (YAP), an online, self-report instrument designed to specifically facilitate evaluation of youth PA, SST, and DI behaviors in school settings.[15] The YAP includes 5 items on PA at school, 5 items on PA out of school, 5 items on SST, and 5 items on DI. It was completed by students at all schools during baseline (Time 1) assessment in January, 2018 and again at the end of intervention in April or early May, 2018 (Time 2). Calibration estimates are not yet available for estimating DI, so raw YAP scores were used in the mixed-model analyses to ensure that PA, SST, and DI

outcomes could be evaluated in a consistent way. The algorithms used to estimate daily minutes of moderate-to-vigorous PA (MVPA) and sedentary behavior have been refined recently for the online version of the tool used in the present study,[15] so the refined versions were used to estimate effect sizes for both intervention conditions over time.

The extent of student self-monitoring with the SWITCH tracker was computed to evaluate the potential moderating influence from this component of the intervention. Tracking was calculated as an overall percentage for each school using the number of weeks that their students entered data into the web-based platform, divided by the number of weeks of the intervention. Depending on the degree of each school's overall implementation of the self-monitoring platform, students could have had up to 11 weekly opportunities to track the 3 behaviors related to the SWITCH goals, followed by the post-test assessment of YAP.

2.5. Statistical analysis

Statistical analyses of the main YAP outcome variables of PA, SST, and DI behaviors were performed using a series of linear mixed models (PROC MIXED) on complete cases of students and schools in SAS (Version 9.3; SAS Inc. Cary, NC, USA). The potential impact of missing individual data (i.e., for before or after the intervention) was evaluated using multiple imputation. Missing PA values (e.g., after the intervention) were randomly sampled from the joint distribution of pre- and post-intervention PA values. Missing SST values were imputed from the observed SST values. The same linear mixed models were then fit to the observed and imputed values. The process of imputation and fitting a mixed model was then repeated 20 times. The reported estimates are the average of the 20 estimates from different imputations; standard errors were calculated using Rubin's estimator.[16]

All linear mixed models accounted for the hierarchical structure and clustering of the data. Multiple comparisons were accounted for by setting α at 0.0025 to guard against type I error. The SAS proc mixed analysis uses a full-rank representation of the design matrix. All reported effects were estimable functions of the model parameters, so the choice of centered coefficients or indicator coefficients has no effect on the reported results. The study design matched schools by similar school economic status (based on the percentage of students receiving free and reduced school lunch) and geographic location. Primary analyses included economic status as a linear covariate, both in addition to the blocking variable (matching) and instead of the blocking variable. Adding economic status, in either manner, increased the estimated variance between school averages. Because economic status was already included in the school matching and the data suggested no need to include it specifically in the analysis model, we found no justification for including it.

The YAP scores for PA were converted to mean minutes of MVPA and sedentary behavior using published algorithms[15] and were compared by condition at both time points to evaluate the degree of behavior change through SWITCH implementation. Validated algorithms are not currently available to estimate DI from the YAP, but the estimates of PA and sedentary behavior provide insights about the magnitude of change in these 2 behaviors. To test additional aims of investigating interactions, the within-group changes were statistically adjusted for school region and gender (for non-stratified analysis of all participants). Interaction terms were statistically adjusted for school region and gender (for non-stratified analysis of all participants). A spearman correlation coefficient was computed to examine the association between school-level tracking and overall behavior change using a composite indicator of PA, SST, and DI change. For all YAP data, estimated variance components for 4 levels of random variation were calculated to determine contributions from school, time, student, and observation; these were used to intra-cluster correlation coefficients (ICCs) associated with schools (ICC = 0.0694 for PA, ICC = 0.0058 for SST, and ICC = 0.0650 for DI).

3. Results

3.1. Participant retention

Fig. 1 illustrates how data from 10 of 11 schools in each implementation support condition were used in statistical analysis. In the group implementation condition, data from 427 of the 810 students who began the trial were used as complete cases, while data from 732 were available for multiple imputation statistical analysis. In the individualized implementation condition, data from 670 of the 956 students who began the trial were used as complete cases, while data from 837 were available for multiple imputation statistical analysis. Table 1 provides additional details on the number of boys and girls from the 4th and 5th grades who provided complete data for analysis.

3.2. Outcomes of PA, SST, and DI

Main outcomes relevant to whether the enhanced individualized implementation support condition was more effective than standard group implementation support condition are presented in Table 2. For the PA outcome, Type 3 tests of fixed effects (using multiple imputation) showed that there was no significant difference by implementation condition ($\beta = 0.013$, 95%CI: −0.130 to 0.156; $p = 0.860$). Similarly, there were no differences by condition for SST ($\beta = -0.024$, 95%CI: −0.148 to 0.100; $p = 0.703$), or DI ($\beta = 0.037$, 95%CI: −0.121 to 0.195; $p = 0.645$). There were no significant interactions for condition by time by gender for outcomes of PA ($\beta = 0.047$, 95%CI: −0.220 to 0.314; $p = 0.729$), SST ($\beta = 0.80$, 95%CI: −0.161 to 0.322; $p = 0.514$), or DI ($\beta = 0.074$, 95%CI: −0.197 to 0.345; $p = 0.592$). In addition to condition by time analyses for outcomes of PA, SST, and DI, Table 2 displays results for change over time within each condition and change by condition by gender. The following results are for multiple imputation (see lower half of Table 2), unless otherwise noted. For PA, both the individualized condition ($M = 0.31$; $p < 0.001$) and group condition ($M = 0.27$; $p < 0.001$) showed significant

Table 2
Tests of comparative effectiveness between enhanced individualized implementation and standard group implementation, and whether effectiveness differed by student gender.

	Time 1 (mean ± SE)	Time 2 (mean ± SE)	Within-group (mean ± SE)	Within-group change p value[#]	Condition by time p value[†]	Condition by time by gender p value[‡]
Complete cases (n = 1097)						
PA: YAP Do [a]					0.507	0.861
SWITCH individualized	3.18 ± 0.05	3.50 ± 0.04	0.30 ± 0.04	<0.001*		
SWITCH group	2.97 ± 0.07	3.28 ± 0.07	0.33 ± 0.04	<0.001*		
SST: YAP View [b]					0.190	0.455
SWITCH individualized	3.51 ± 0.04	3.70 ± 0.06	0.19 ± 0.03	<0.001*		
SWITCH group	3.60 ± 0.05	3.74 ± 0.06	0.12 ± 0.03	0.006		
DI: YAP Chew[c]					0.725	0.150
SWITCH individualized	3.51 ± 0.05	3.63 ± 0.08	0.12 ± 0.05	0.054		
SWITCH group	3.46 ± 0.10	3.60 ± 0.05	0.14 ± 0.05	0.023		
Multiple imputation (n = 1569)						
YAP Do[a]					0.860	0.729
SWITCH individualized	3.17 ± 0.03	3.47 ± 0.03	0.31 ± 0.03	<0.001*		
SWITCH group	3.01 ± 0.03	3.27 ± 0.05	0.27 ± 0.04	<0.001*		
YAP View[b]					0.703	0.514
SWITCH individualized	3.43 ± 0.03	3.60 ± 0.03	0.17 ± 0.03	<0.001*		
SWITCH group	3.59 ± 0.03	3.71 ± 0.05	0.12 ± 0.05	0.022		
YAP Chew[c]					0.645	0.592
SWITCH individualized	3.42 ± 0.03	3.51 ± 0.03	0.09 ± 0.03	0.002*		
SWITCH group	3.49 ± 0.03	3.61 ± 0.05	0.12 ± 0.05	0.013		

[a] ICC = 0.0694.
[b] ICC = 0.0058.
[c] ICC = 0.0650.
* Statistical significance at $p < 0.0025$; [#] Within-group change statistically adjusted for school region and gender; [†] Interaction statistically adjusted for school region and gender; [‡] Interaction statistically adjusted for school region.
Abbreviations: DI = dietary intake; ICC = intra-cluster correlation coefficient; PA = physical activity; SE = standard error; SST = sedentary screen time; SWITCH = School Wellness Integration Targeting Child Health intervention; YAP = Youth Activity Profile.

increases from baseline (Time 1) to post-test (Time 2). For SST, the individualized condition resulted in significant changes (for YAP View, higher scores indicate less SST; $p < 0.001$), while the group condition change was not significant ($p = 0.022$; $\alpha = 0.0025$). From Time 1 to Time 2 for DI, the individualized condition showed a significant increase ($M = 0.09$; $p = 0.002$), while the group condition did not significantly change ($M = 0.12$; $p = 0.013$). As seen in the Table 3 complete case analyses, these patterns for PA, SST, and DI were similar between boys and girls.

Fig. 2 displays the YAP calibration estimate of MVPA from Time 1 (baseline) to Time 2 (post-test) for each condition. The individualized condition increased ($p < 0.001$) from Time 1 ($M = 75.6$; 95%CI: 74.3−76.9 min) to Time 2 ($M = 82.2$; 95%CI: 80.8−83.6 min). Similarly, The group condition increased ($p < 0.001$) from Time 1 ($M = 73.7$; 95%CI: 72.3−75.1 min) to Time 2 ($M = 79.1$; 95%CI: 77.3−80.9 min). Thus, both conditions increased by approximately 6 min per day over the course of the intervention.

Fig. 3 displays the YAP calibration estimate of sedentary behavior from Time 1 to Time 2 for each condition. The individualized condition decreased ($p < 0.001$) from Time 1 ($M = 216.1$; 95%CI: 214.5−217.7 min) to Time 2 ($M = 212.1$; 95%CI: 210.3−214.0 min). The group condition showed a non-significant decrease ($p = 0.007$) from Time 1 ($M = 214.2$; 95%CI: 212.6−215.8 min) to Time 2 ($M = 212.0$; 95%CI: 209.9−214.1 min). Across conditions, sedentary time decreased approximately 3 min per day.

In Fig. 4, a scatter-plot of the association between school-level tracking and behavior change is portrayed. The correlation was statistically significant ($r_s = 0.315$; $p = 0.012$). This represents a small correlation whereby behavioral tracking explained approximately 10% of the variance in the students' changes in PA, SST, and DI.

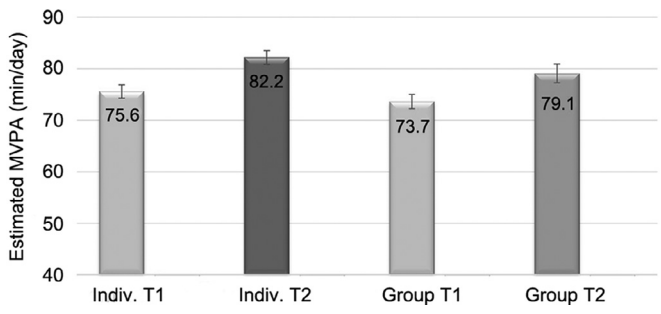

Fig. 2. YAP-estimated daily MVPA across 2 time points by condition (using multiple imputation analysis). Data are shown as mean ± SE. Indiv. = individualized; MVPA = moderate-to-vigorous physical activity; T1 = Time 1, baseline assessment; T2 = Time 2, post-test assessment.

Table 3
Gender-stratified tests of comparative effectiveness between enhanced individualized implementation and standard group implementation (complete cases).

	Time 1 (mean ± SE)	Time 2 (mean ± SE)	Within-group (mean ± SE)	Within-group change p value[#]	Condition by time p value[†]
Girl complete cases only (n = 524)					
PA: YAP Do					0.685
SWITCH individualized	3.13 ± 0.06	3.45 ± 0.04	0.30 ± 0.05	<0.001*	
SWITCH group	2.96 ± 0.06	3.28 ± 0.07	0.33 ± 0.05	<0.001*	
SST: YAP View					0.070
SWITCH individualized	3.59 ± 0.06	3.79 ± 0.07	0.21 ± 0.03	<0.001*	
SWITCH group	3.77 ± 0.06	3.88 ± 0.07	0.12 ± 0.03	0.006	
DI: YAP Chew					0.542
SWITCH individualized	3.55 ± 0.06	3.67 ± 0.09	0.13 ± 0.04	0.010	
SWITCH group	3.55 ± 0.11	3.68 ± 0.07	0.09 ± 0.04	0.064	
Boy complete cases only (n = 573)					
PA: YAP Do					0.627
SWITCH individualized	3.23 ± 0.07	3.55 ± 0.06	0.28 ± 0.06	0.002*	
SWITCH group	2.97 ± 0.07	3.29 ± 0.09	0.32 ± 0.07	0.001*	
SST: YAP View					0.474
SWITCH individualized	3.42 ± 0.06	3.61 ± 0.04	0.17 ± 0.04	0.002*	
SWITCH group	3.43 ± 0.04	3.59 ± 0.07	0.12 ± 0.04	0.020	
DI: YAP Chew					0.414
SWITCH individualized	3.47 ± 0.05	3.59 ± 0.08	0.07 ± 0.07	0.343	
SWITCH group	3.37 ± 0.09	3.52 ± 0.08	0.16 ± 0.08	0.068	

* Statistically significant at $p < 0.0025$; [#] Within-group change statistically adjusted for school region and gender; [†] Interaction statistically adjusted for school region and gender.
Abbreviations: DI = dietary intake; PA = physical activity; SST = sedentary screen time; SWITCH = School Wellness Integration Targeting Child Health intervention; YAP = Youth Activity Profile.

4. Discussion

The primary aim of this study was to determine whether the enhanced (individualized) support was more effective than standard (group-based) support for implementation of SWITCH. We also sought to determine whether there were interactions between implementation support conditions and gender for those outcomes and whether school-level behavioral tracking was related to behavior change over time.

4.1. Study findings

Contrary to our *a priori* hypothesis, the enhanced condition was not more effective than the standard condition for PA, SST, or DI. Further statistical examination of these 2 intervention conditions showed not only the lack of superiority for the individualized condition, but that the conditions were statistically equivalent to one another. This indicates that the lack of evidence for superiority was not due to large standard errors or insufficient sample size. For both conditions, PA increased to a statistically significant degree during the trial, while SST declined for both conditions over time but decreased significantly only in the individualized condition. DI improved slightly during the trial, and that change was statistically significant for the individualized condition within the multiple imputation analysis. Overall, considering that the change outcomes were statistically equivalent between conditions, one may infer that the one-on-one webinar sessions based on principles of motivational interviewing did not provide an advantage over the group implementation support strategy. It is possible that the individualized implementation support could promote engagement and motivation for implementing wellness programming activities and evidence-based practices; however, the intended improvement to effectiveness outcomes is clearly absent within our analyses.

We also hypothesized that interactions between condition and gender would be non-significant and that higher levels of participation in behavioral tracking at the school level would be associated with increases in PA, SST, and DI (suggesting a potential pathway for intervention effectiveness). For the gender-related hypothesis, the results indicated no significant interactions. Thus, there was not a statistically significant interaction between the implementation conditions and gender in terms of who could experience benefit from SWITCH between the 2 conditions. Such gender differences can be

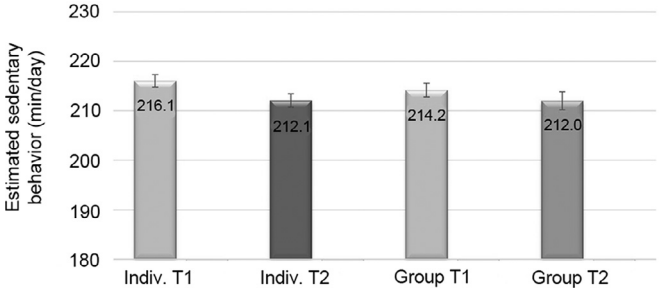

Fig. 3. YAP-estimated daily sedentary behavior across 2 time points by condition (using multiple imputation analysis). Data are shown as mean ± SE. Indiv. = individualized; T1 = Time 1, baseline assessment; T2 = Time 2, post-test assessment; YAP = Youth Activity Profile.

particularly concerning as boys (on average) are more physically active than girls[17] and because girls sometimes respond differently than boys to PA interventions.[18] The behavioral tracking hypothesis was also supported in the form of a small correlation, which suggests that the schools that did a better job of helping students to track their PA, SST, and dietary behavior showed somewhat better improvements in those health-related behaviors. This supports an earlier study from the previous version of SWITCH that looked at the individual level of association between student tracking and changes to behavior.[14]

4.2. Context of wider literature

Among school-based obesity prevention and health promotion interventions, trials that test implementation strategies and gather data on effectiveness are still relatively rare. In a somewhat similar educational context, Swindle and colleagues[19] tested a basic versus enhanced strategy to implement 4 evidence-based practices within early care and education settings. Their enhanced strategy included training, reminders, and strategies tailored to individual contexts and educators, while the basic strategy was merely training and reminders. Similar to the present study, Swindle and colleagues[19] found no significant differences in effectiveness (child outcome measures), although the fidelity outcomes of adoption and implementation did show favorability for the enhanced strategy.

In general, findings have been equivocal on the effectiveness of interventions delivered within schools for increasing children's PA.[18] In an umbrella review of extant evidence, multi-component interventions in the school setting appeared most likely to be effective.[20] The present results showed an increase of approximately 6 min of MVPA across the entire day for both trial conditions, which is a larger amount of increase than is found in most trials.[18,21] Another umbrella review concluded that interventions for sedentary behavior were usually effective in reducing screen time among children and adolescents, but the effect size is typically small.[22] Although findings of a third umbrella review suggest that intervention strategies implemented within schools to increase fruit and vegetable consumption can be effective,[23] our observed effects for DI (including fruit and vegetable consumption) showed smaller changes than those seen for PA and SST.

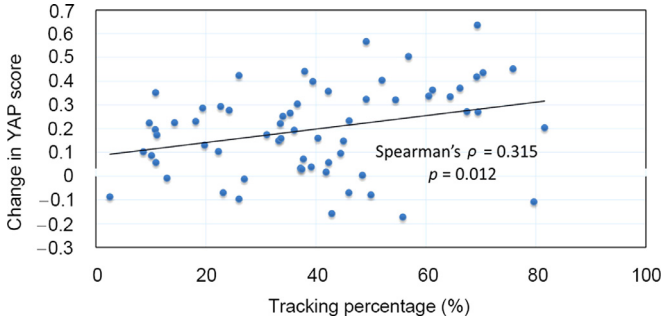

Fig. 4. School-level association between tracking and behavior change (comprising physical activity, sedentary screen time, and dietary intake). YAP = Youth Activity Profile.

4.3. SWITCH and school wellness directions

Over the past decade, researchers and public health practitioners have emphasized the use of "whole-of-school" and related comprehensive school PA programs intervention strategies. These approaches encourage coordinated and integrated programming, rather than isolated programming in specific settings.[24] SWITCH focuses on PA and fosters a coordinated effort to increase opportunities for students to adopt healthier behaviors (including DI and limited SST) in classrooms, lunchrooms, physical education, and at home. The findings from the present study provide insights about the degree of support needed to help schools take coordinated action. SWITCH straddles a line between standardization and customization by providing training for implementation of a core set of quality elements and best practices yet allowing each school wellness team flexibility to adapt that core set and implement SWITCH in accordance with how it best fits the school. This model is beneficial because it preserves the evidence-based elements shown to be effective as well as meets school staff needs for autonomy as they essentially co-create the custom version of SWITCH that is implemented within their school.

4.4. Strengths and limitations

One key strength of this study was its ecological and external validity. This cluster-randomized controlled trial involved students learning and playing in schools that expressed interest in receiving assistance to meet their needs for the wellness policy programming required by law. The study did not have strict inclusion or exclusion criteria and was therefore able to obtain data on a large number and wide variety of schools and students in rural and urban areas across the state of Iowa. The study prioritized external validity by relying on county Extension leaders to facilitate recruitment and engagement of schools. This participatory/community-engagement approach was critical for promoting the broader engagement and capacity within the state Extension network needed to facilitate the long-term sustainability of SWITCH.[25]

A limitation of the study is that our effectiveness data were based on a self-report instrument (YAP) and may be subject to information bias. Such bias could include demand characteristics stemming from the behavioral tracking activities, social desirability bias, or variability in PA due to warming weather across springtime. The YAP, however, has been carefully calibrated with accelerometer data and has been shown to have relatively low levels of mean absolute percent error (21%−23% for PA; 8%−10% for SST), indicating sound measurement validity for MVPA and sedentary behavior among groups of children and adolescents.[15] Although 2 schools were lost during the course of the study, and we were not able to get complete data from all students who began the trial, our data analyses did not reveal differential attrition (data not shown), so missingness was deemed to be at random and unlikely to affect study conclusions. The relatively short duration of SWITCH may not be sufficient to create large changes in individual behaviors, but the focus is on building schools' capacity

for planning and delivering SWITCH over time. Schools engage in the capacity-building process over a full school year, but longitudinal studies may be needed to evaluate long term changes in school-level outcomes.

A final limitation is that the current study was not designed *a priori* as a fully powered superiority trial. Thus, it is possible that there was insufficient power to detect small differences between implementation conditions. However, the general insights from the ongoing work with SWITCH point to the fact that other school-level factors may have a greater influence on implementation and outcomes at a local level. For example, support from administrators and the overall engagement of the core teams appear to be bigger drivers of school success with SWITCH (unpublished observations). Future work is aimed at evaluating these school-level factors that may explain implementation and outcomes associated with SWITCH. As it gradually increases in scale, the SWITCH project's ongoing quality improvement model continues to focus on what works best for the population of schools in Iowa and strives for continual refinement of the intervention in light of the available resources, stakeholder needs, and evaluation data analyzed.

5. Conclusion

Within this cluster-randomized controlled trial, we found that the individualized implementation support was not more effective and was statistically equivalent to the standard group implementation support. The observed lack of difference suggests that group implementation is sufficient to support schools in building capacity for school wellness programming. Similarly, the lack of interaction by gender suggests that the SWITCH intervention can be beneficial for both boys and girls. Additional research is needed to understand the factors that influence implementation and effectiveness outcomes following SWITCH implementation. Multi-component interventions that operate across the entirety of schools and connect to the home setting appear promising in efforts that aim to improve children's health behavior, promote health, and prevent obesity.

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Authors' contributions

RRR helped to conceive the study, led writing of first manuscript draft, contributed to data analysis, and composed tables and figures; PMD led data analysis and revised the manuscript for important intellectual content; DAD helped to conceive the study, contributed to data analysis, and revised the manuscript for important intellectual content; GMM contributed to data collection activities and revised the manuscript for important intellectual content; JAL, SC, SV, LMLF, and DAG helped to conceive the study and revised the manuscript for important intellectual content; GJW led conception of the study, contributed to data analysis, and revised the manuscript for important intellectual content. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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