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Effectiveness of a school-based universal prevention program on self-efficacy and mental health problems in Japanese children: differences between universal- and indicated-level effects

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Abstract

Background Mental health problems among children and adolescents have been increasing worldwide, highlighting the need for preventive interventions in schools. This study examined the effectiveness of a school-based universal prevention program on self-efficacy and mental health problems in Japanese children using a quasi-experimental design with intervention and control groups.

Methods A total of 1,281 third- and fourth-grade students participated, with 264 assigned to the intervention group and 1,017 to the control group. The intervention group received the Universal Unified Prevention Program for Diverse Disorders (Up2-D2), a 12-session program based on cognitive-behavioral and positive psychological interventions.

Results A significant universal-level effect was found for positive attitude (a self-efficacy subscale), which improved over time in the intervention group but not in the control group. At the indicated level, a Time × Group interaction was observed for depressive symptoms among children with elevated baseline depression; however, the group effect at Time 4 did not reach statistical significance after covariate adjustment. Effect sizes at Time 4 were small for positive attitude at the universal level ($g = 0.19$) and small-to-moderate for depressive symptoms at the indicated level ($g = 0.36$).

Conclusions These findings suggest that Up2-D2 may promote positive attitude at the universal level, while potential indicated-level benefits for depressive symptoms may warrant further confirmation. Evaluating outcomes in both general and at-risk subgroups may help clarify for whom and on which outcomes universal school-based prevention programs are most beneficial.

Keywords School-based, Children, Mental health, Self-efficacy, Universal prevention

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Background

Mental health problems among children and adolescents have been increasing worldwide [1]. Mental health problems affect 10–20% of children and adolescents [1, 2]. In Japan, mental health problems among children and adolescents have emerged as a critical public health concern. For instance, school absenteeism and violent behavior have become increasingly problematic in Japanese schools. According to the latest Japanese National Survey [3], 346,482 elementary and junior high school students were absent from school for more than 30 days during the last fiscal year, representing approximately 3.7% of all students. In addition, 108,987 cases of violent behavior were reported across elementary, junior high, and high schools, corresponding to an incidence rate of 8.7 cases per 1,000 students [3]. Both school absenteeism and violent behavior have reached the highest levels since data collection began in Japan [3]. Moreover, the number of suicides among children and adolescents in Japan has reached a record high, with 527 reported cases, marking the highest number ever recorded [4]. Depression, a major underlying factor, has been reported in a substantial proportion of students. The point prevalence of depression among junior high school students is reported to be 4.9% [5], and 10–20% of children and adolescents in Japan exhibit elevated depressive symptoms [6, 7]. These findings highlight the urgent need for preventive interventions in schools.

Given that schools play a pivotal role in fostering students' social and emotional development [8], school-based prevention is a desirable approach to addressing mental health problems in children and adolescents. School-based preventive interventions are categorized into two approaches: universal (implemented for all students) and selective/indicated prevention (for students at risk or those with some symptoms) [9]. Many meta-analyses revealed the effectiveness of preventive interventions in schools for various outcomes as universal level effects [10–17]. These meta-analyses have demonstrated preventive effects across multiple domains, including general difficulties [10], depressive/anxiety symptoms and other internalizing symptoms [10–14], aggressive and other externalizing behaviors [10, 15], stress [16] as well as more recent evidence supporting universal transdiagnostic school-based programs that target shared emotional and behavioral processes across disorders [17]. In particular, school-based universal prevention interventions have several advantages: (i) they do not require unnecessary screening to detect at-risk children, (ii) minimized stigma from the screening procedure, and (iii) include children and adolescents who may develop mental health problems and disorders [11, 14]. Although the importance of investing in early prevention interventions has been emphasized [18], small effect sizes are often found in universal prevention interventions [10–17]. This is because most students participating in universal prevention programs do not have moderate or severe mental health problems. Therefore, the effectiveness of universal prevention should be examined not only for negative variables such as mental health problems, but also positive variables which have room for improvement.

Self-efficacy is one of positive variables that can be improved via universal prevention programs. Self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to achieve desired outcomes [19, 20]. Self-efficacy is based on four main sources of information: performance accomplishment, vicarious experience (modeling), verbal persuasion, and emotional arousal [19]. One of school-based prevention programs that may be effective for self-efficacy is the Universal Unified Prevention Program for Diverse Disorders (Up2-D2: [21, 22]). The Up2-D2 is a 12-session classroom-based universal prevention program for elementary to junior high school students, with each session lasting 45 min, designed so that regular teachers can deliver it for their students. Each lesson follows a consistent structure of introduction, skill presentation, practice (often in pairs or groups), and conclusion, and incorporates cognitive-behavioral components such as psychoeducation, behavioral activation, social skills training, relaxation, cognitive restructuring, exposure, and problem-solving. To enhance engagement and comprehension, the program uses a cartoon-story format with original characters representing typical emotional difficulties, along with visual metaphors ("gadgets") for psychological skills. Activities emphasize interpersonal practice and peer support, reflecting classroom culture and promoting self-efficacy through modeling, verbal persuasion, and emotional experience. The program also includes "strength-work," encouraging students to recognize personal and peer strengths, thus fostering resilience and positive mental health. The previous study [21] implemented the Up2-D2 for 213 children (grades 4 to 6) to examine its acceptability and fidelity. As a result, high acceptability reported by children (enjoyment, comprehensibility, and self-efficacy of each skill) and acceptable fidelity (76.2%) were demonstrated.

Several studies were implemented to examine effectiveness of the Up2-D2 on both self-efficacy and mental health problems in Japanese children and adolescents. An open trial [23] implemented the Up2-D2 with 396 children (grades 4 to 6) to examine the effectiveness of self-efficacy and general difficulties in an open trial. Self-efficacy (positive attitude) and general difficulties improved immediately after implementation and three months later. Another study [24] also implemented the Up2-D2 with 131 children (grades 4 and 5) to examine the effectiveness of teacher training and on-going

supervision as well as its implementation. The study showed that general difficulties among children with higher scores improved to a greater extent in the school that participated in on-site teacher training and received continuous supervision compared to the school that did not. Moreover, other preliminary trials of the Up2-D2 were conducted with junior high school students during the COVID-19 pandemic [25], and the study indicated that the Up2-D2 could be effective for reducing anxiety in students. In addition, the Up2-D2 was effective in children at risk, such as those with higher difficulties [24], those with higher anxiety [25], and those with moderate autism traits [23]. However, no quasi-experimental study with both intervention and control groups has examined the effectiveness of the Up2-D2 on self-efficacy and mental health problems. Furthermore, it remains necessary to investigate whether the program's effects differ between the universal level (all children) and the indicated level (children with elevated baseline mental health problems).

This study addressed this gap by evaluating the effectiveness of the school-based universal prevention program Up2-D2 on self-efficacy and mental health problems in Japanese children using a quasi-experimental design with intervention and control groups.

Methods

Recruitment and implementation process

First, a collaborative research agreement was established between Doshisha University and a board of education to implement a mental health prevention program in all elementary schools in the city, specifically targeting third- and fourth-grade students. In total, seven schools participated in the project. All participating schools were public schools. Detailed demographic data such as socioeconomic status or ethnicity were not collected. The study was conducted in a rural prefecture of Japan, where nearly all students are Japanese. The sample, drawn from all students in the participating schools, represents a broad socioeconomic range rather than a specific subgroup. In Japan, schools follow a three-semester system per fiscal year: the school year begins in April, with the first semester from April to July, summer holidays in August, and the second and third semesters from September to December and January to March, respectively. The board of education selected four schools to implement the program, taking into account factors such as district, school characteristics, number of students, and the relationship between teachers and the board of education. Of these, three schools implemented the program in the first semester, and one school in the second semester. The timing of program implementation was determined through discussions between school teachers and board of education staff. Among the seven schools, fourth-grade students from the three schools that did not implement the program were assigned to the control group. Additionally, third-grade students from all seven schools were included in the control group. This study targeted third- and fourth-grade elementary school students in consultation with the local Board of Education. First- and second-grade students were not included due to insufficient language development, while fifth- and sixth-grade students were excluded because of higher demands from school events and the academic curriculum. Additionally, based on previous evidence and trials using the program, the research team recommended its use for students in Grade 4 and above. Considering these factors, third- and fourth-grade students were judged to be the most appropriate population for this study. The control group was a non-intervention group in which children did not receive the Up2-D2 program. It was not a waiting-list or active control condition. For children identified as having elevated symptom levels, feedback on questionnaire results was provided to school administrators and homeroom teachers after study completion, allowing schools to independently implement support as needed. Furthermore, the city has established a collaborative system with the medical institution affiliated with the fifth and sixth authors, allowing for consultation in cases involving high-risk students or the occurrence of adverse events. Thus, this study employed a quasi-experimental design. The study was approved by the Institutional Review Board of Doshisha University (No. 202102). This study was not registered in a clinical trial registry. Written informed consent was obtained from the parents and school principals. Assent was obtained from all participating children at the beginning of the study (Time 1). The assent statement was displayed on tablet screens provided to each child, and classroom teachers read it aloud. For children who had difficulty understanding the content due to literacy level or age, teachers provided additional explanations to ensure comprehension and the ability to participate in the research activity. Data for which parental informed consent or child assent could not be obtained were excluded. These procedures were approved by both the participating schools and the institutional ethics committee.

School-based universal prevention

This study used the Universal Unified Prevention Program for Diverse Disorders (Up2-D2; [21]), which was developed based on cognitive-behavioral and positive psychological interventions delivered by teachers. It serves as a school-based mental health prevention program. The program consists of 12 sessions, each lasting 45 min, covering psychoeducation, behavioral activation, social skills training, relaxation, strength work, cognitive restructuring, exposure, problem-solving skills, and a final summary, delivered sequentially. Classroom

teachers implemented each lesson according to teaching plans, and worksheets were provided to students. Previous studies employing Up2-D2 in elementary schools reported high levels of child satisfaction and acceptable adherence by providers [21], while another study reported adequate usability, as assessed by teachers [22].

In this study, after the 12 sessions, three additional interventions were conducted to review the program content and promote its use in daily life. First, each student who participated in the program received an original pencil board listing the skills learned, allowing them to review these skills at any time. Second, newsletters were distributed to parents, including photos of program lessons, key points from each session, and prompts to encourage discussion about their child's learning. Finally, short videos were shared with teachers via a video streaming platform to help them encourage students to apply the skills in school. A total of 12 videos, each lasting 2–3 min, were created.

Teacher training and supervision

For the three schools that implemented the program in the first semester, the research team held a teacher training workshop three months prior to implementation. The workshop lasted two days, totaling six hours, and covered the program's theoretical background, results from effectiveness trials, and session-specific implementation. The school that implemented the program in the second semester received a one-day workshop (six hours) with similar content one month before the program began. Additionally, the researchers held a one-hour meeting with all participating teachers before implementation to review the program, highlight key points from the first session, show a video of the lesson, and address any questions raised by the teachers.

During implementation, members of the research team visited each school at least once to observe the lessons. They also reviewed video recordings of the sessions and provided supervision to classroom teachers. To further support program delivery, supervisors from the city board of education observed the classrooms at least twice during the program, providing guidance on classroom management, lesson development, and tutoring. Thus, each teacher received a total of three sessions of external supervision from the research team and board of education staff during program implementation.

Assessments

Assessments were conducted at four time points: Time 1 (May, beginning of the first semester), Time 2 (July, end of the first semester), Time 3 (September, beginning of the second semester), and Time 4 (December, end of the second semester). Data collection was integrated into regular school educational activities. Students were assessed on scheduled assessment days; those absent at a given time point were reassessed if they returned to school in subsequent sessions. Participants who returned continued to be included in analyses, and were therefore not considered dropouts. This school-based implementation contributed to the high retention rate.

General self-efficacy scale for children-revised (GSESC-R)

Children's self-efficacy was measured using the GSESC-R [26], comprising 18 items across two subscales: sense of security and positive attitude. Each item is rated on a 5-point Likert scale, with higher scores indicating greater self-efficacy. Both subscale scores and the total score were used to assess self-efficacy. The internal consistencies (Cronbach's α) of the total scale, sense of security, and positive attitude were 0.85, 0.90, and 0.79, respectively. The scale has been validated in Japanese elementary and junior high school students, capturing emotional, cognitive and behavioral aspects of self-efficacy.

Strength and difficulties questionnaire (SDQ)

The self-report version of the SDQ [27] was used, and the Japanese version has demonstrated acceptable reliability and validity [28]. In the present study, we used the SDQ General Difficulties score, given its frequent use as a screening index in school settings and its comparatively more stable reliability than some SDQ subscales. The internal consistency (Cronbach's α) of the General Difficulties score was 0.75.

Short version of the spence children's anxiety scale (Short CAS)

The Short CAS [29] was used to assess anxiety symptoms in children and adolescents. This scale was developed as a short version of the Spence Children's Anxiety Scale. The reliability and validity of the Japanese version have been confirmed by a previous study [30]. Each item is rated on a 4-point scale, with higher scores indicating greater anxiety. The internal consistency (Cronbach's α) of the scale was 0.83. This scale allows efficient assessment of anxiety symptoms across a range of contexts in school-aged children.

Depression self-rating scale for children (DSRS-C)

The DSRS-C [31] was used to assess depressive symptoms in children and adolescents. The reliability and validity of a short Japanese version have been confirmed by a previous study [9]. Items are rated on a 3-point scale, with higher scores indicating higher depressive symptoms. The internal consistency (Cronbach's α) of the scale was 0.71. This scale has been widely used for screening depressive symptoms in Japanese children.

Anger scale for children and adolescents (ASCA)

The ASCA [32] was used to assess anger in children and adolescents. The ASCA was originally developed for Japanese children and adolescents, and the reliability and validity of the scale have been confirmed for Japanese sample. Each item is rated on a 4-point Likert scale, with higher scores indicating higher anger. The internal consistency (Cronbach's α) of the scale was 0.95. The ASCA allows assessment of angry emotion rather than anger-related cognitions and behaviors in Japanese children.

Fidelity assessment

The Up2-D2 Fidelity Checklist [21] was used to evaluate adherence to the program. The checklist was developed to assess the quality of program sessions and consists of approximately 30 items rated on a yes/no scale, indicating whether each recommended or prohibited action was performed. Previous research reported a fidelity of 76.2% when implementing this program in elementary schools [21]. In the present study, 12 sessions were conducted in seven classes across four schools, totaling 84 sessions. From these, 1–2 sessions per class were randomly selected and recorded, resulting in nine sessions (10.7% of all sessions) for evaluation. Fidelity ratings were conducted by research team members, who had not participated in teacher training or supervision, using the checklist and the recorded videos.

Usability assessment by teachers

A feedback survey on the program's usability was conducted after the final assessment at Time 4. Teachers rated their satisfaction with the program and their understanding of its content on a 5-point scale. They also completed the Up2-D2 Usability Scale [22] to assess program usability, with higher scores indicating greater satisfaction, understanding, and usability. Of the nine teachers who implemented the program, seven responded to the usability survey (five men, two women), aged 20–50 years (two in their 20s, four in their 30s, and one in their 50s). The average teaching experience was 9.43 years (SD = 10.92).

Statistical plan

To examine the effectiveness of the school-based mental health prevention program, analyses were conducted for all children as well as for at-risk children. Baseline equivalence between the intervention and control groups was examined using chi-squared tests and t-tests for grade, age, gender, and each outcome measure.

Given the unbalanced sample sizes and the longitudinal structure of the data, primary analyses were conducted using linear mixed-effects models (LMMs) with Restricted Maximum Likelihood (REML) estimation and Satterthwaite's approximation for degrees of freedom. Time, group, and their interaction (Time × Group) were specified as fixed effects, and a random intercept for participants (ID) was included to account for within-individual correlations across repeated measurements. The primary parameter of interest was the Time × Group interaction, indicating differential change over time between the intervention and control groups.

Secondary analyses were conducted for at-risk children identified based on baseline symptom levels at Time 1. At-risk status was defined using the following criteria: higher difficulties (SDQ-C ≥ 18), elevated anxiety (+1 SD or more; Short CAS ≥ 12), elevated depressive symptoms (DSRS-C ≥ 7), and elevated anger (+1 SD or more; ASCA ≥ 8). Children with higher difficulties were analyzed for general difficulties using the same LMM framework, whereas children with elevated symptom scores were further examined for each corresponding symptom outcome.

Sensitivity analyses were conducted only when a statistically significant Time × Group interaction was observed in the primary or secondary analyses. In such cases, robustness was examined using analysis of covariance (ANCOVA) focusing on the post-intervention assessment. Specifically, the Time 4 outcome was specified as the dependent variable, group was included as the fixed effect, and the corresponding baseline (Time 1) value (i.e., positive attitude for all children and depressive symptoms for depressive children) was entered as a covariate. Grade, age, and gender (boys = 1, girls/others = 0) were additionally included as covariates.

Effect sizes (Hedges' g) were calculated based on descriptive statistics (means and standard deviations) for each group. Within- and between-group effect sizes were interpreted using conventional thresholds, with values of 0.20, 0.50, and 0.80 representing small, moderate, and large effects, respectively. For sensitivity analyses, effect sizes at Time 4 were calculated to compare outcomes between the intervention and control groups. All analyses were conducted using JASP (version 0.95.4).

Results

Participants

The study included 1,344 participants from seven elementary schools. At Time 1, 63 students with missing responses were excluded, resulting in a final sample of 1,281 children (613 third graders and 668 fourth graders). Of these, 264 children were allocated to the intervention group and 1,017 to the control group. Figure 1 presents the flow of participants.

Characteristics of each group

Baseline equivalence between the intervention and control groups was examined using χ^2 and t-tests for grade, age, gender, and each measure at Time 1. Significant

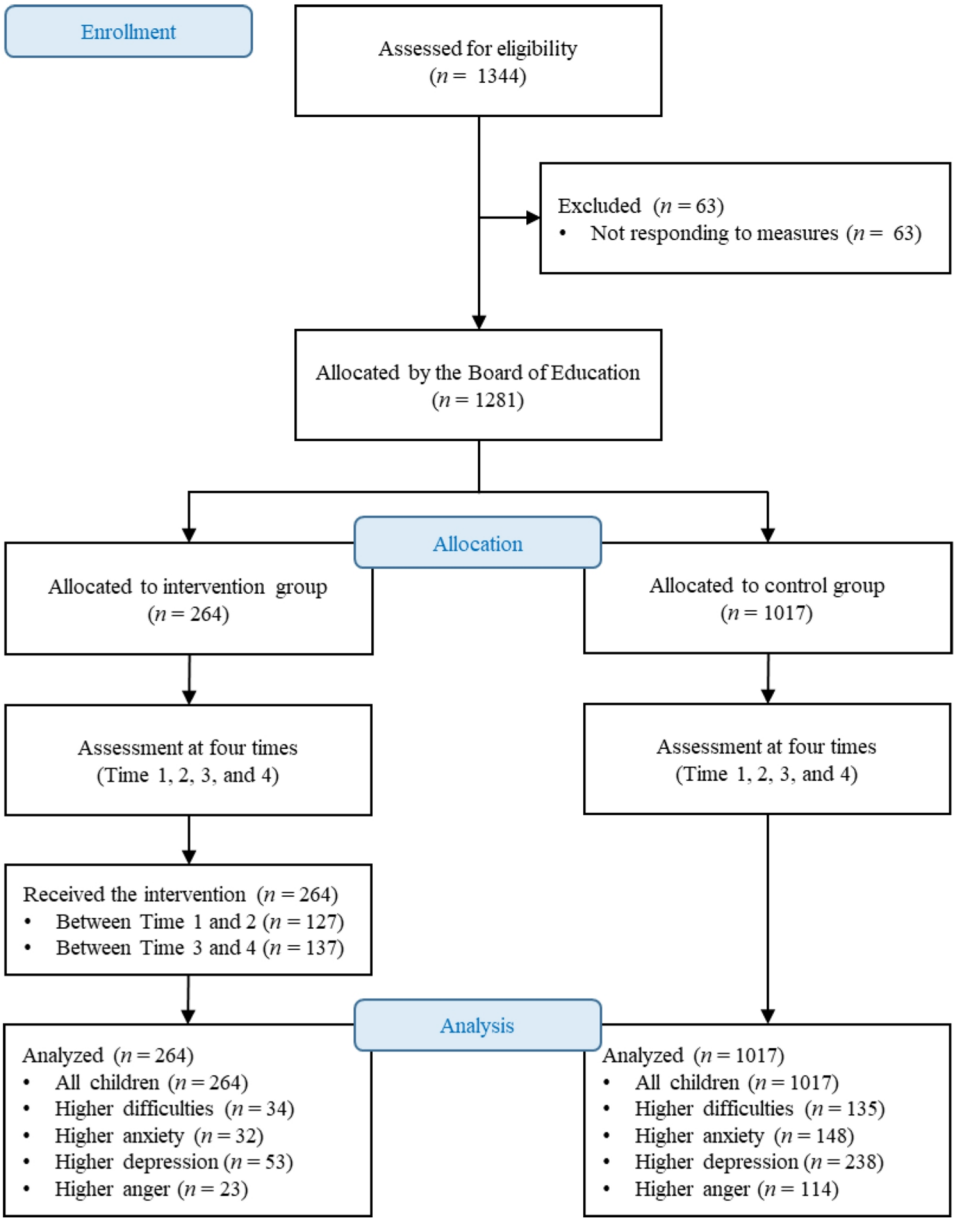

Fig. 1 Participant flow diagram

differences were observed for grade ($p < 0.001$), age ($p < 0.001$), and positive attitude ($p < 0.05$), but not for other measures. Specifically, the intervention group had a lower positive attitude score than the control group, whereas no significant differences were found for the remaining measures. Table 1 presents the baseline characteristics of the participants and comparisons between the intervention and control groups.

Fidelity and usability assessment

Program fidelity and teacher-rated usability were examined in the four schools where the program was implemented. Fidelity, assessed from nine lessons, was 67.05% ($SD = 11.25$). Teacher-rated satisfaction and understanding were 2.86 ($SD = 0.90$, range 1–5) and 3.14 ($SD = 1.07$), respectively. The usability score on the Up2-D2 Usability Scale was 19.43 ($SD = 5.59$, range 6–30).

Results for all children as universal-level effects

Table 1 presents descriptive data for all variables across Times 1 to 4 for all children. LMMs revealed no significant interaction for self-efficacy (F (3, 2772.53) = 1.11, $p = 0.35$). In contrast, a significant interaction was observed for positive attitude (F (3, 2974.18) = 6.54, $p < 0.001$), but not for sense of security (F (3, 3093.66) = 1.58, $p = 0.19$). Post-hoc tests showed that, for

Table 1 Baseline characteristics of the participants and comparisons between the intervention and control groups

	range	Intervention group (n =264)			Control group (n = 1017)			χ^2/t	p	α
		Time 1			Time 1					
		M	SD	n	M	SD	n			
grade								305.15	***	
3rd				0			613			
4th				264			404			
age	(8-10)	9.09	0.31	264	8.52	0.60	1017	223.51	***	
gender								0.98		
Boys				131			513			
Girls				132			501			
Others				1			3			
Self-Efficacy	(18-72)	50.89	9.63	203	51.03	10.59	825	0.17		0.85
Sense of security	(9-36)	27.22	6.64	220	26.62	7.60	887	1.08		0.90
Positive attitude	(9-36)	23.42	5.71	219	24.39	5.80	865	2.22	*	0.79
General difficulties	(0-40)	12.43	5.51	199	12.48	5.66	774	0.11		0.75
Anxiety	(0-24)	5.52	5.01	224	6.10	5.37	867	1.46		0.83
Depression	(0-18)	4.45	2.99	229	4.65	3.17	892	0.87		0.71
Anger	(0-21)	2.09	4.29	248	2.58	4.71	951	1.48		0.95

*** = $p < 0.001$, * = $p < 0.05$

positive attitude in the intervention group, a significant time effect was observed and scores at Times 2, 3, and 4 were higher than those at Time 1 (all $p < 0.01$), whereas no significant time effect was observed in the control group. Similarly, no significant interactions were identified for general difficulties (F (3, 2562.49) = 1.77, $p = 0.15$). No significant interactions were found for anxiety (F (3, 3085.34) = 1.83, $p = 0.14$), depression (F (3, 3117.74) = 0.27, $p = 0.85$), or anger (F (3, 3341.15) = 0.36, $p = 0.78$).

As a sensitivity analysis, an ANCOVA was conducted for positive attitude at Time 4, with group as the fixed factor and baseline (Time 1) positive attitude, grade, age, and gender entered as covariates. After adjustment for baseline and demographic variables, the intervention group continued to show higher positive attitude scores than the control group, consistent with the pattern observed in the primary analyses ($F = 3.85$, $p < 0.05$).

Effect sizes at Time 4 indicated a small between-group effect for positive attitude ($g = 0.19$). Within-group effect size for positive attitude from Time 1 to 4 in the intervention group was small-to-moderate ($g = 0.42$), whereas no effect was observed in the control group ($g = 0.04$). Table 2 presents the descriptive statistics for each variable at each time point for the intervention and control groups in all children. Table 3 summarizes the results of the LMMs, the ANCOVA, and the corresponding effect sizes for all children.

Results for at-risk children as indicated-level effects

Children with higher difficulties were identified for the analysis. A total of 34 children in the intervention group and 135 in the control group were included. LMMs revealed no significant interactions for general difficulties (F (3, 378.98) = 0.94, $p = 0.42$). Next, children with higher anxiety, depression, or anger were identified for the analyses. For anxiety, depression, and anger, 32, 53, and 23 children in the intervention group and 148, 238, and 114 children in the control group were included, respectively. LMMs revealed a significant interaction for depression in children with elevated depression (F (3, 741.11) = 4.02, $p < 0.01$), whereas no significant interactions were found for anxiety (F (3, 455.93) = 0.36, $p = 0.78$) or anger (F (3, 358.98) = 0.48, $p = 0.69$). Post-hoc tests indicated that significant effects of time were observed in both the intervention and control groups, with depression scores at Times 2, 3, and 4 were significantly lower than at Time 1 in both groups (all $p < 0.05$).

As a sensitivity analysis, an ANCOVA was conducted for depressive symptoms at Time 4 among children with elevated depression, with group specified as the fixed

Table 2 Descriptive statistics for each outcome variable at each time point in the intervention and control groups for all children

Intervention group (n=264)	Time 1			Time 2			Time 3			Time 4		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Self-Efficacy	50.89	9.63	203	51.95	10.77	200	52.10	10.55	195	52.93	10.61	205
Sense of security	27.22	6.64	220	26.54	6.97	223	27.35	6.80	220	27.23	7.32	220
Positive attitude	23.42	5.71	219	25.25	6.00	215	24.99	5.66	204	25.80	5.61	219
General difficulties	12.43	5.51	199	12.70	5.89	181	11.15	4.83	181	11.22	5.54	187
Anxiety	5.52	5.01	224	5.96	5.00	223	5.26	4.99	215	5.45	4.91	223
Depression	4.45	2.99	229	4.37	3.02	220	3.88	2.77	216	3.98	3.15	215
Anger	2.09	4.29	248	2.41	4.09	232	1.54	3.46	232	2.06	4.44	232
Control group (n = 1017)	Time 1			Time 2			Time 3			Time 4		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Self-Efficacy	51.03	10.59	825	52.01	10.80	729	52.23	11.06	724	51.68	10.79	746
Sense of security	26.62	7.60	887	27.06	7.35	794	27.78	7.20	826	27.11	7.25	822
Positive attitude	24.39	5.80	865	24.91	5.81	783	24.49	5.90	764	24.65	5.98	801
General difficulties	12.48	5.66	774	11.95	5.14	652	11.32	5.29	684	11.55	5.28	692
Anxiety	6.10	5.37	867	5.83	5.20	803	5.20	4.87	827	5.60	5.17	832
Depression	4.65	3.17	892	4.48	3.08	816	4.24	2.95	835	4.29	3.08	820
Anger	2.58	4.71	951	2.57	4.60	856	1.91	4.14	903	2.18	4.20	909

Table 3 Results of the linear mixed-effects models, ANCOVA, and effect sizes for all children

	LMMs	ANCOVA	Effect size from Time 1 to Time 4 in intervntion group		Effect size fromTime 1 to Time 4 in control group		Effect size at Time 4 between two groups	
	Intraction (F)	Group (F)	*g*	95%CI	*g*	95%CI	*g*	95%CI
Self-Efficacy	1.11		0.20	[0.01 , 0.40]	0.06	[-0.04 , 0.16]	0.12	[-0.04 , 0.27]
Sense of security	1.58		0.00	[-0.19 , 0.19]	0.07	[-0.03 , 0.16]	0.02	[-0.13 , 0.17]
Positive attitude	6.54 ***	3.85 *	0.42	[0.23 , 0.61]	0.04	[-0.05 , 0.14]	0.19	[0.05 , 0.34]
General difficulties	1.77		-0.22	[-0.42 , -0.02]	-0.17	[-0.27 , -0.07]	-0.06	[-0.22 , 0.10]
Anxiety	1.83		-0.01	[-0.20 , 0.17]	-0.09	[-0.19 , 0.00]	-0.03	[-0.18 , 0.12]
Depression	0.27		-0.15	[-0.34 , 0.03]	-0.12	[-0.21 , -0.02]	-0.10	[-0.25 , 0.05]
Anger	0.36		-0.01	[-0.19 , 0.17]	-0.09	[-0.18 , 0.00]	-0.03	[-0.17 , 0.12]

*** = p < 0.001, * = p < 0.05. As primary analyses, linear mixed-effects models (LMMS) were conducted for all variables with Restricted Maximum Likelihood (REML) estimation and Satterthwaite's approximation for degrees of freedom. As a sensitivity analysis, an analysis of covariance (ANCOVA) was performed for positive attitude at Time 4, with group as the fixed factor and baseline (Time 1) positive attitude, grade, age, and gender entered as covariates

factor and baseline (Time 1) depression, grade, age, and gender entered as covariates. After adjustment for these variables, the group effect did not reach statistical significance (F = 2.52, p = 0.11), suggesting that the between-group difference in depressive symptom reduction was attenuated when baseline and demographic factors were taken into account.

Although the Time × Group interaction was not significant for general difficulties, the descriptive between-group difference at Time 4 corresponded to a small-to-moderate effect size (g = 0.40), which should be interpreted cautiously given the small indicated sample. Between-group effect sizes at Time 4 showed small-to-moderate efficacy for depression (g = 0.36) relative to the control group, whereas no effects larger than small were

Table 4 Descriptive statistics for each outcome variable at each time point in the intervention and control groups for at-risk children

Intervention group	Time 1			Time 2			Time 3			Time 4		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
General difficulties[a]	21.53	3.07	34	13.16	5.51	25	10.77	3.69	22	10.77	3.69	22
Anxiety[b]	14.94	2.66	32	5.84	5.52	25	5.63	5.10	24	5.73	4.90	26
Depression[c]	9.00	1.89	53	4.14	2.98	42	3.42	2.46	43	3.67	3.16	42
Anger[d]	13.87	4.16	23	2.47	3.64	19	0.75	1.48	20	1.95	3.78	20
Control group	Time 1			Time 2			Time 3			Time 4		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
General difficulties[a]	21.86	3.46	135	13.13	5.39	90	13.01	5.84	89	13.01	5.84	89
Anxiety[b]	15.40	3.20	148	6.61	5.61	114	5.77	5.76	124	6.01	5.85	127
Dcepression[c]	8.92	1.92	238	5.24	3.13	193	5.06	3.22	201	4.84	3.27	189
Anger[d]	13.69	4.15	114	2.92	4.75	92	2.32	4.12	102	2.57	4.63	103

A = Children with higher difficulties at time 1, b = Children with higher anxiety at time 1, c = children with higher depression at time 1, d = Children with higher anger at time 1

Table 5 Results of the linear mixed-effects models, ANCOVA, and effect sizes for at-risk children

	LMMs	ANCOVA	Effect size from Time 1 to Time 4 in intervntion group			Effect size fromTime 1 to Time 4 in control group			Effect size at Time 4 between two groups		
	Intraction (*F*)	Group (*F*)	*g*	95%CI		*g*	95%CI		*g*	95%CI	
General difficulties[a]	0.94		3.19	[2.39 ,	3.99]	1.94	[1.61 ,	2.26]	0.40	[-0.06 ,	0.87]
Anxiety[b]	0.36		2.38	[1.70 ,	3.05]	2.03	[1.74 ,	2.32]	0.05	[-0.37 ,	0.47]
Depression[c]	4.02 **	2.52	2.09	[1.59 ,	2.59]	1.57	[1.35 ,	1.78]	0.36	[0.02 ,	0.69]
Anger[d]	0.48		2.94	[2.07 ,	3.80]	2.52	[2.17 ,	2.88]	0.14	[-0.34 ,	0.62]

** = $p < 0.01$. a = Children with higher difficulties at time 1, b = Children with higher anxiety at time 1, c = Children with higher depression at time 1, d = Children with higher anger at time 1. As primary analyses, linear mixed-effects models (LMMs) were conducted for all variables with Restricted Maximum Likelihood (REML) estimation and Satterthwaite's approximation for degrees of freedom. As a sensitivity analysis, an analysis of covariance (ANCOVA) was performed for depression at Time 4, with group as the fixed factor and baseline (Time 1) depression, grade, age, and fender entered as covariates

observed for anxiety ($g = 0.05$) or anger ($g = 0.14$). Table 4 presents the descriptive statistics for each variable at each time point for the intervention and control groups in the at-risk children. Table 5 summarizes the results of the LMMs, the ANCOVA, and the corresponding effect sizes for the at-risk children.

Discussion

This study examined the effectiveness of the school-based universal prevention program Up2-D2 on self-efficacy and mental health problems in children using a quasi-experimental design with intervention and control groups. Overall, the findings suggest a universal-level benefit for positive attitude, a subscale of self-efficacy, whereas effects on mental health symptom outcomes were not observed at the universal level. At the indicated level, depressive symptoms among children with elevated baseline depression showed a modest differential change between groups, although the robustness of this finding was limited in sensitivity analyses. Together, these results highlight that program effects may vary depending on whether outcomes are evaluated at the universal versus indicated level, and they underscore the value of examining both positive outcomes (e.g., self-efficacy) and symptom/negative outcomes when assessing school-based prevention programs.

A previous study using Up2-D2 [22] also demonstrated its effectiveness in improving positive attitude. In that study, fidelity was 76.2%, whereas in the present study it was 67.05%. These results suggest that positive attitude at the universal level can be maintained even when fidelity decreases to around 70%. However, no universal-level effects on mental health problems were observed in this study. Previous studies reported effects

on general difficulties [22], suggesting that higher fidelity may be particularly important for achieving universal-level effects on mental health outcomes. Meta-analyses indicate that only about half of school-based prevention programs report fidelity [11, 12]. Future research should investigate the relationship between program fidelity and effectiveness for various outcomes, and explore strategies to enhance fidelity in pragmatic trials.

At the indicated level, children with elevated depressive symptoms showed a small-to-moderate between-group difference at Time 4 (g = 0.36); however, this effect was attenuated and did not reach statistical significance after adjustment for baseline symptoms and demographic covariates. This finding suggests that, while a universal classroom-based program such as Up2-D2 may provide some benefit for children with elevated depressive symptoms, its impact on symptom reduction among higher-risk children may be limited. Previous Japanese studies of school-based cognitive-behavioral interventions for depression have indicated that more intensive or focused programs, often involving stronger emphasis on cognitive restructuring, repeated practice, and closer support, are required to achieve clearer symptom reduction among children and adolescents with elevated depressive symptoms [33, 34]. In this context, Up2-D2 may function more effectively as a foundational, universal intervention that promotes positive functioning and provides early support, whereas children with more pronounced or persistent depressive symptoms may require indicated or selective interventions with greater intensity. From a tiered prevention perspective, integrating universal programs with more rigorous, targeted interventions may be essential to adequately address the needs of children at higher risk.

Teacher-rated usability, satisfaction, and understanding scores in this study were lower than those reported in a previous study using Up2-D2 with junior high school students [22]. These differences may be attributed, aside from age, to variations in the recruitment process. In this study, the program was implemented using a top-down approach: the local board of education decided on program introduction, selected the initial schools, conducted on-site visits, and provided guidance to classroom teachers. In contrast, the previous study [22] employed a bottom-up approach, in which schools voluntarily opted to implement Up2-D2. This difference may have influenced teachers' motivation and understanding at program introduction. As suggested previously [24], recruitment processes could potentially affect the program's effectiveness. Future research should investigate how outcome measures relate to social validity indicators, including usability, satisfaction, and understanding among both students and teachers.

From a public health perspective, even small effects observed in universal school-based prevention programs should not be underestimated. Meta-analyses consistently indicate that universal interventions tend to yield small effect sizes on symptom outcomes [10–17], which is expected given that most participating children do not present with elevated clinical symptoms at baseline. However, such programs offer important advantages, including broad reach, low stigma, and the potential to shift the overall distribution of risk when implemented at scale. In this context, promotive effects on positive functioning, such as self-efficacy, represent a particularly relevant target for universal prevention, as these outcomes may enhance children's coping capacity and resilience in the face of developmental challenges. Sustained investment in early, school-based universal prevention may therefore play a complementary role within a tiered mental health system, alongside more intensive and targeted interventions for children with elevated needs.

This study has several limitations. First, the sample sizes were highly unbalanced across conditions, and baseline differences were observed for grade, age, and positive attitude. Although LMMs and sensitivity analyses were used to address baseline and demographic differences, the unequal design may reduce the precision and robustness of estimates and increase reliance on model assumptions. Second, although a quasi-experimental design with intervention and control groups was employed, a randomized controlled trial was not conducted. Third, outcomes were assessed solely using child-reported measures; future research should evaluate program effectiveness from multiple perspectives, including teachers and parents. Fourth, the intervention was implemented only for fourth-grade students, and future studies should examine its effectiveness in other age groups. Fifth, although the SDQ is widely used internationally for screening, the internal consistency of the SDQ General Difficulties score and the short version of the DSRS-C was modest in the present sample (α = 0.75 and 0.71, respectively), which may have limited sensitivity to detect change [35]. Finally, fidelity and usability were assessed in a small number of classes and teachers, and these implementation indices should be interpreted as preliminary.

Conclusion

Despite these limitations, this study provides initial evidence from a quasi-experimental design that Up2-D2 may promote positive attitude, a self-efficacy subscale, at the universal level in Japanese elementary school students. The findings further suggest that potential benefits for depressive symptoms in children with elevated baseline depression warrant confirmation in future trials with more balanced group sizes, stronger control conditions,

and longer follow-up periods. More broadly, evaluating both universal- and indicated-level outcomes may help clarify the conditions under which universal school-based prevention programs yield promotive and symptom-reduction benefits.

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Data availability
The datasets used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted with the approval of the Institutional Review Board of the authors' university (202102). Written informed consent was obtained from the parents and school principals, and assent was obtained from the children.

Competing interests
The authors declare no competing interests.

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