Story Immersion May Be Effective in Promoting Diet and Physical Activity in Chinese Children

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AUTHOR DISCLOSURE STATEMENT

R.B. is the President of Archimage, Inc., the company that created Diab. No competing financial interests exist for other authors.

Abstract

Objective: Evaluate the effect of playing a health videogame embedded with story immersion, "Escape from Diab" (Diab), on children's diet and physical activity (PA) and explored whether children immersed in Diab had greater positive outcomes.

Design: Two-group, non-randomized design; three outcome assessments at baseline, immediately postgame (post 1), and 8-10 weeks postgame (post 2)

Participants: 179 Chinese children aged 8-12-year-old

Intervention: Treatment group played Diab. Control group received no intervention.

Main outcome measures: Motivation, self-efficacy, preference for fruit, vegetables, water and PA as well as PA behavior.

Analysis: Adjusted changes to post 1 and post 2 by analysis of covariance controlling for demographic and baseline variables.

Results: Children played Diab increased intrinsic motivation for fruit and water, self-efficacy for PA, and self-reported PA score at post 1($p_s < 0.05$). Children with higher immersion score (above the median) had increased intrinsic motivation for fruit and water, autonomous and controlled motivation for PA at post 1 ($p_s < 0.05$). However, these were not significant at post 2.

Conclusion and implications: Diab provides a promising innovative medium for promoting Chinese children's psychological correlates of diet and PA and PA behavior. However, its maintenance of effectiveness needs to be enhanced and mechanisms of change need to be investigated more thoroughly.

Key Words: Videogame, story immersion, fruit, vegetable, water, physical activity, motivation

INTRODUCTION

Obesity tracks from childhood into adulthood[1] which shortens the lifespan, impairs functional ability and diminishes quality of life.[2] Innovative technologies may provide alternative methods to encourage healthy behaviors for childhood obesity prevention.[3] Recently, with a growing interest in video games, not only as an entertainment, but also an educational medium,[4] a steadily increasing number of video games have been developed for serious purposes, called "serious games", which are characterized by both "fun-ness" (i.e. components that entertain players through animation, storyline, sound effects, etc.) and "serious-ness" (i.e., components that promote behavior modification through tailoring, problem solving, goal setting, etc.). "Games for Health" (G4H), one type of serious game, have been designed to encourage players to modify their health-related attitudes and behaviors.[5] G4Hs are interactive and could influence player's cognitions and affect, generate positive emotions, and effect health behaviors.[6]

A narrative is defined as "*the framework for the sequence of events that make up the plot we see, and the story we imagine*".[7] Narrative is considered a basic game feature that could universally attract players and create playing enjoyment.[8] Immersion in the story can

be described as a state of mental absorption, where the player is consumed by the narrative.[8,9] Story immersion refers to the process that a player experiences from active engagement with the narrative. A G4H embedded with well-crafted narratives may offer an especially suitable alternative for behavior modification, since players may experience psychological absorption whilst fully immersed in games. The immersion could draw their close attention to the provided game context and behavior change components, and subsequently, engender a greater health outcome.[10]

"Escape from Diab" (Diab, by Archimage Inc, Houston, TX, USA) is a G4H designed with story immersion to lower the risk of obesity and type 2 diabetes by changing attitudes and behaviors related to diet and physical activity (PA). In American children, positive changes in psychological correlates were observed in a one-arm trial[11] and improvements in behavioral indicators of diet and PA were observed in another study.[12] An individual interview study has confirmed the acceptability and applicability of Diab among Hong Kong Chinese children,[13] however, no study comprehensively explored its intervention effect on both psychological correlates of diet & PA and PA behavior in Chinese children.

Thus, the current study conducted the intervention using Diab and examined its effect on improving the psychological and behavioral indicators of diet and physical activity in Chinese Children. We hypothesized that: 1) Playing Diab would improve Chinses children's self-efficacy, motivation and preferences for diet and PA; and 2) Story immersion in Diab would induce a more beneficial effect.

METHODS

Study Design

This study was a non-randomized trial. Participants in the intervention group played

Diab in the school setting. The control group received no intervention. Outcome assessments were conducted at baseline; immediately postgame (post 1: about 8-10 weeks after baseline); and 8-10 weeks postgame (post 2: 8-10 weeks after completion of game playing, the follow-up time were kept the same as the intervention duration for each participating school). Written informed consent was obtained from each participant and their parents or guardians. The study was approved by the institutional ethic committee and was registered with Centre for Clinical Research and Biostatistics (Identifier: CUHK_CCT00434).

Participants

Setting a significance level of $p < 0.05$, power of 80%, a constant correlation of 0.3 for 3 repeated measures, and taking 20% drop out rate into account, 176 participants (two groups, n = 88 each group) was required to detect a small-to-moderate overall effect (Cohen's d = 0.25).[14] Students with physical diseases and psychological illnesses that may have prevented their participating in PA and eating a normal diet were excluded. A total of 179 students aged 8~12 years (mean = 10.2 years; 103 males) from four primary schools with English as the medium of instruction were included. Four schools had a similar size and were located in different Hong Kong districts which varied in student social-economic status (SES) (one from high SES, one from medium SES, and two from low SES according to local statistics.[15] Participants in the same school were allocated into either the intervention group or control group to minimize potential moderating effects of socio-economic status.

Intervention: Game for Health: "Escape from Diab"

Diab was designed based on social cognitive[16] (e.g., functional knowledge on how to

122 select appropriate portion sizes, self-efficacy to eat another 3 fruit next week), self-
123 determination[17] (e.g., autonomy to choose 20 kinds of healthy food independently,
124 competence to successfully do the physical activity) and the elaboration-likelihood model[18]
125 (e.g., identifying the problem in goal setting for vegetable intake, and finding the
126 solutions).[5] Diab, using three dimensional scenes and animated characters, tells the story
127 of DeeJay, an athletic and healthy, modern-day youth. He accidentally falls through the
128 floor of an abandoned building into a world, Diab, where fruit, vegetables, and PA are
129 forbidden by the evil King Etes. DeeJay is befriended by a group of youth who begin to
130 plot their escape from Diab by adopting a healthier lifestyle under DeeJay's guidance. The
131 video game comprised nine episodes. Within each episode there were three to four action-
132 adventure mini games. The session-by-session mini games in each episode have been
133 described elsewhere.[12] Behavior change components, mini-games with tailoring
134 knowledge, motivational statements, goal setting and review, feedback, problem solving,
135 and behavioral inoculation were integrated into Diab.[5] Children were required to set goals
136 at the end of each episode (diet goals in episodes 1 to 4 and physical activity goals in
137 episodes 5 to 8). Goal setting in the game included action goals (i.e., select specific foods
138 and number of days to attempt goals) and coping goals (i.e., identify the most likely barrier
139 to achieving the goal and choose an effective solution for overcoming the barrier).

140 Procedure

141 Participants who had schedule conflicts with play sessions were assigned to the
142 control group. The remaining participants who were available for playing schedule were
143 randomly assigned into the intervention or control groups. The participants in the
144 intervention group (n = 95) were arranged to play Diab in the school's multi-media

classroom on single consoles at the scheduled sessions (play session: two 40-minute morning sessions before classes in two schools, or one 90-minute afternoon session after school in the other two schools). During each session, participants were asked to play one episode. The players could return to the current or previous episode and replay the mini-games if they had time remaining in the session, but could not move to the following episode until the next game session. A translation of food and PA vocabulary were provided on the multimedia screen during play. Children in the control group (n = 84) received no intervention. The intervention lasted between 8-10 weeks depending on the completion of game play. During the session, one to two researchers were present to monitor children's progress and provide assistance on possible hardware or software problems. After playing, game controller that costs HK$50 and game CD were offered to participants in the treatment group as incentives. The no-treatment concurrent control was set. Children in the control group adopted the general diet and PA information and behaviors as usual during the program. After completing the final test at post 2, a game controller and Diab game CD with activation code were provided to participants in the control group to encourage to play Diab by themselves at home.

Measures

The translation of the questionnaires used in this study was followed the standard procedure with translation and back translation by three bilanguage speakers (i.e., English and Cantonese). Five primary students were invited to an individual interview to test the questionnaires and minor wording revisions were made according to their feedback.

Demographics. Children's height and weight were measured and body mass index (BMI) was calculated at baseline.

Immersion. Immersion was assessed immediately after playing all Diab episodes using an 18-item immersion scale adapted from the narrative transportation scale to be specific to Diab (Cronbach's alpha (α) = 0.91).[19] Participants were required to rate their levels of agreement with statements (e.g., ''At least one of the Diab characters reminds me of myself,'') (1 = do not agree; 2 = somewhat agree; 3 = agree a lot, score range: 18 to 54).

Intrinsic motivation for fruit, vegetable and water. Intrinsic motivation for fruit, vegetable and water were assessed with 12 items for fruit (α = 0.73), 9 items for vegetables (α = 0.72), and 9 items for water (α = 0.73).[11] Children indicated whether reasons as to why they ate or drank it originated from their inherent satisfaction, for example, "I usually drink water because drinking water makes me happy" (1 = I am not sure; 2 = I am a little bit sure; 3 = I am very sure).

PA motivation. PA motivation was assessed with a validated 16-item scale[20] with three items for intrinsic motivation (i.e., inherent satisfaction in doing the behaviors), five items for identified regulation (i.e., recognizing the value of behavior and accepting the regulatory process), three items for introjected regulation (i.e., involving internalized rules or demands), and five items for external regulation (i.e., from external locus of initiation of behaviors, for example, for avoiding punishment or gaining reward). Each item used a 7-point Likert scale (e.g., 1 = not at all true; 4 = somewhat true; 7 = very true). Sample item included: I am active regularly "Because I enjoy being active". A score for autonomous motivation (α = 0.88) was created by summing the items in the intrinsic motivation and identified regulation subscales indicating a sense of personal volition that originates from an internal perceived locus of causality for the behavior, whereas the introjected and external regulations items were summed to form a controlled motivation

score that originates from an external perceived locus of causality (α = 0.79).

Self-efficacy for fruit, vegetable, and water. Self-efficacy for fruit, vegetable, and water were assessed using validated 12-item (α = 0.86), 8-item (α = 0.85), and 5-item scales (α = 0.79).[21] Each item asked about fruit, vegetable or water intake behavior (e.g. "How sure are you that you can eat 1 portion of fruit/vegetable for a snack at home at least four days a week") (1 = I am not sure; 2 = I am a little bit sure; 3 = I am very sure).

PA self-efficacy. PA self-efficacy was assessed using a 12-item scale (α = 0.91).[22] Sample item included "How sure are you that you can be physically active more than 30 minutes for one day, even when you have lots of homework" (1 = I am not sure; 2 = I am a little bit sure; 3 = I am very sure).

Fruit, vegetables and water (FVW) preferences. FVW preferences were measured using a validated 37-item scale (α = 0.90).[23] Items asked how much children liked different types of food (e.g., plums, oranges) (1 = I have never tasted it; 2 = I do not like it; 3 = I like it a little; and 4 = I like it a lot).

PA preference. PA preference was assessed using a validated 28-item scale (α = 0.84).[24] In a similar way to the FVW preference scale, each item asked about a form of PA (e.g., bicycling, swimming).

Self-reported physical activity. Physical Activity Questionnaire for Older Children (PAQ-C)[25] was used to measure self-reported PA (α = 0.79). The PAQ-C items were used to compute moderate-to-vigorous PA (MVPA) for the day as a whole and for segments during the day using a 5-point Likert scale (e.g., 1 = none; 3 = 2-3 days; 5 = 5 days for evening, or weekend).

Objective physical activity. ActiGraph GT3X (ActiGraph, Pensacola, USA)[26] were

used to measure objective PA. Children were asked to wear the ActiGraph for 7 consecutive days. Cut-off points developed by Evenson et al.[27] were used to determine the levels of PA intensity (sedentary ≤ 100 counts per min; light PA (LPA) > 100 counts per min; MVPA ≥ 2296 counts per min). Of the 179 participants, 82.1% provided ≥ 3 valid days of accelerometer data (including 1 weekend day) at baseline and 60.3% at post 1. Due to conflict of time and resources for schools, objective PA assessment was not conducted at post 2.

Social desirability (SocD). SocD describes a type of response bias and reflects the desire to give answers that met the expectations of others, but not the true response. SocD is the tendency of overestimating desirable behaviors and underestimating undesirable ones.[28] To control for this type of bias, SocD was measured by 9-item "Lie Scale" from the revised children's manifest anxiety scale[29] (α = 0.87) and was adjusted in the analysis.

Statistical Analyses

Baseline characteristics and measures for the treatment and control groups were compared using a Pearson's chi-square test of homogeneity for categorical variables and independent *t*-test for continuous variables (a two-sided p value < 0.05 in SPSS). Participants in the treatment group were divided into high and low immersion subgroups according to whether their immersion scores were above or below the median scores (36.0). For the treatment vs. control groups, and high vs. low immersion groups, changes to post 1 and post 2 (minus baseline) were examined using analysis of covariance (ANCOVA), controlling for age, gender, BMI, SocD and baseline variable. The adjusted means and 95% confidence interval (CI) were reported as effect sizes. To further examine the contribution of immersion to the treatment effect, partial correlations controlling for age, gender, and

BMI were performed between the immersion scale and change scores. According to the intention-to-treat principle, the similar analyses were performed in all the participants as well. Children who did not provide the complete data were imputed using Last Observation Carried Forward method.

RESULTS

Of 179 participants, 166 (92.7%) provided completed data at post 1 and 163 did (91.1%) at post 2. The retention rate was 92.6% in the treatment group and 89.3% in the control group (Figure 1). There were no significant differences in gender and BMI between the treatment and control groups. Compared to the control group, the treatment group had more children aged 11~12 years (χ^2 (1) = 5.60, p = 0.018) (Table 1). No differences existed in demographics or anthropometrics between those retained and eliminated from the sample.

The measures were normally distributed and no suspicious outliers were detected. Table 2 presents the results for all measures, stratified by group using ANCOVAs at each time point. At post 1, there were significant adjusted changes between the treatment and control groups in intrinsic motivation for fruit (adjusted change (95% CI): 1.6 (0.1, 3.1)), intrinsic motivation for water (adjusted change (95% CI): 1.2 (0.2, 2.3)), self-efficacy for PA (adjusted change (95% CI): 2.4 (0.5, 4.4)), and PAQ-C (adjusted change (95% CI): 1.9 (0.3, 3.4)), which all increased in the treatment group but decreased in the control group. However, these significant adjusted changes were not detected at post 2.

Upon the completion of all Diab episodes, 88 children in the treatment group reported a complete immersion score using the 18-item scale. The immersion score ranged from 20.0 to 52.0 with the average value at 37.8 (SD: 9.2), close to the center score at 36.0.

Partial correlation between the immersion scale with change score was significant for autonomous motivation for PA at post 1 ($r = 0.27$, $p = 0.041$), but not in changes of other measures at either time point ($p_s > 0.05$).Table 3 presents high- and low- immersion level means for the treatment group children at three time points. At post 1, there were significant adjusted changes between the two groups in intrinsic motivation for fruit (adjusted change (95% CI): 2.2 (0.3, 4.2)), water (adjusted change (95% CI): 2.2 (0.7, 3.7)), autonomous motivation for PA (adjusted change (95% CI): 3.9 (0.3, 8.1)), and controlled motivation for PA (adjusted change (95% CI): 4.6 (0.3, 8.9)), which all increased in the high immersion group but decreased in the low immersion group. However, these significant adjusted changes were not detected at post 2.

The results on the outcomes with imputed data using Last Observation Carried Forward method were in line with those reported above among the participants who provided complete data (data not shown).

DISCUSSION

We hypothesized that playing Diab, a health videogame with an immersive story, could improve children's motivation, self-efficacy, and preference for diet and PA and subsequent health behaviors. Improvements in intrinsic motivation for water, self-efficacy for PA, PA preference and PAQ-C score were observed immediately after playing the game in the treatment group, while these measures decreased in the control group. Thus, Diab motivated children partially with short-term beneficial effects on diet and PA outcomes.

Video games employing immersive virtual realities hold promise of being effective because they create a virtual environment and provide an engaging experience through interaction with the characteristics that make the narrative personally relevant.[30,31] A higher

level of immersion may produce a greater sense of presence, which refers to a user's subjective experience of "being there". Higher immersion could produce a greater psychological impact and experience a higher degree of stimulation.[32] In the present study, immersion scores were positively related to changes in autonomous motivation for PA at post 1 in the treatment group (r = 0.27). Several psychological correlates for diet and PA improved in the high immersion groups, and reduced in the low immersion group at post 1, suggesting more immersion in G4H would be more effective to improve player's health attitudes. This finding indicates the importance of developing G4H with more immersive narrative to enhance videogame's influence. A notable result showed that improvements in PA motivation after game playing in higher immersion group when compared to lower immersion group, but the effect of the game on motivation overall in the intervention group was not detected. This finding suggests the potential mediation effect of story immersion in the game. As a first step to establish mediation, association between immersion score and change of health outcomes were examined to inform the identification of mediator, however, because of insufficient statistical power, the subgroup analysis rather than mediation analysis was performed in this study. Future studies by enrolling more participants are recommended to examine the potential mediating mechanisms underlying story immersion in Diab and to further understand the process between health video game and health outcomes.

Characters in the video games are important to make the players perceive similarity and competence.[33] Children tend to be more receptive to a storyline and thereby, could be more influenced by media context if they perceive similarity to the characters.[34] After playing Diab, Hong Kong children achieved average immersion with mean scores of 37.8

306 (SD: 9.2), which was lower than a prior Diab study of US children (mean (SD): 40.8
307 (8.2)).[11] Diab was created to have diverse characters with different genders, racial origins,
308 body sizes, appearance and personalities. However, the characters featured African-
309 American, Native American, and Hispanic, not Asian children. Even though the game
310 demonstrated acceptability and applicability among Chinese children, the dynamic
311 processes of character identification and situation reproduction might be affected by the
312 cultural adoption. The possible lack of cultural identity between Asians and African-
313 American and Hispanics could have lowered the immersion level and limited the
314 intervention effect.

315 Self-determination theory posits that motivation helps individuals initiate and
316 maintain behavior and more self-determined forms of motivation lead to optimal
317 functioning and well-being.[35] Bandura[36] outlined the role of self-efficacy in a model where
318 the individual engages in a behavior outcome. As such, perceived motivation and self-
319 efficacy could influence aspects of behavior. In the current study, despite the fact that some
320 psychological correlates improved at post 1, the objective PA level did not demonstrate a
321 positive change in the study. It is possible that increasing the magnitude of these
322 psychological correlates were not powerful enough to engender a behavior outcome as
323 expected. Kelly and colleagues[37] found that behavior change was poorly predicted by self-
324 efficacy for some lifestyle areas. As health-compromising behaviors, poor dietary habits
325 and PA are difficult to change.[38] Even though an individual's intention is assumed to be
326 the best predictor of actual change, people often do not behave in accordance with their
327 intentions.[39] This discrepancy may be due to several factors, for example, unforeseen
328 barriers and environmental influences.[40]

In the current study, the maintenance of improvements in the psychological correlates in the treatment group were non-existent at follow up which was 8-10 weeks without exposure to the game. This finding poses a question regarding the sustained effect of the health video game and suggests a need for an increased focus to support behavior change maintenance.[41,42] This lack of sustained effect may be due to the short-term improvements on indicators being insufficient to encourage the children to maintain beneficial effects after disconnecting from Diab. Previous reviews of prevention programs have indicated that, compared to brief interventions, longer duration, multi-session interventions produced superior effects since longer intervention afford a greater opportunity for presenting the information and enhancing behavioral change skills.[43] In the development of video games, the concept of energy balance was divided into 18 component skills to be learned sequentially, with the first nine inserted into the Diab and the other nine inserted into the "Nanoswarm: Invasion from Inner Space" (Nano). Playing Diab and Nano has led to an increase in fruit and vegetable consumption by about 0.67 servings per day among American children.[12] However, due to the limitation of the schools' schedules, only Diab was completed in this study. More episodes and longer duration should be considered in the future to enhance the dosage of the treatment.

The limitations of this study include the nonrandomized design which may threaten internal validity and affect generalizability. The further study recruiting participants with equal age distribution in the intervention and control groups is also encouraged to enhance the comparability of two groups. Although the existing and previously validated questionnaires were used and demonstrated the adequate to excellent internal consistency in this sample, the test-retest reliability and criterion validity were not available in target

children. More study is needed to further test the advanced psychometric properties of these questionnaires. Additionally, dietary behaviors were not measured due to operational issues (e.g., difficulty in data collection on recall diet diary among children without parental support, and unavailability of software for the diet components analysis). Thus, the treatment effect on dietary behavior aspect was not examined, which limits the overall evaluation of the Diab intervention using Diab.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study found that Diab could help Hong Kong Chinese children partially to improve their motivation, self-efficacy and preference for diet and PA behaviors immediately after completing nine episodes of the game. However, the effect was not maintained 8-10 weeks later. The improvements in psychological influence and behaviors after playing suggest that health videogames with appealing characters and immersive stories may have the potential to promote child diet and PA as innovative mediums. However, the lasting effectiveness should be examined with more episodes and longer play duration. Further studies by enrolling more participants are recommended to thoroughly investigate the mediating mechanisms of story immersion in health videogame.

Video game entertainment is prevalent in contemporary culture and society and fully integrated into the everyday lives of many of our young people. Published studies have gradually started to focus on the more interesting alternative aspect of video games, that of their educational potential as teaching and learning tools.[44] Videogames have been used in schools to teach education content,[45] convey nutrition information,[46] for alcohol and drug awareness,[47,48] and education about hygiene.[49] The present research using Diab contributes to childhood obesity prevention, in the school setting, specifically targeting diet and PA.

Video games used in education are labeled “Parallel Schooling”, and offer an uninterrupted flow of miscellaneous signs and symbols transmitted via specific stories and activities within the game.[44] As a result of the current findings, Diab have the potential to be applied in a school education program as an innovative and attractive medium through which to deliver diet and PA knowledge and behavioral modification components.

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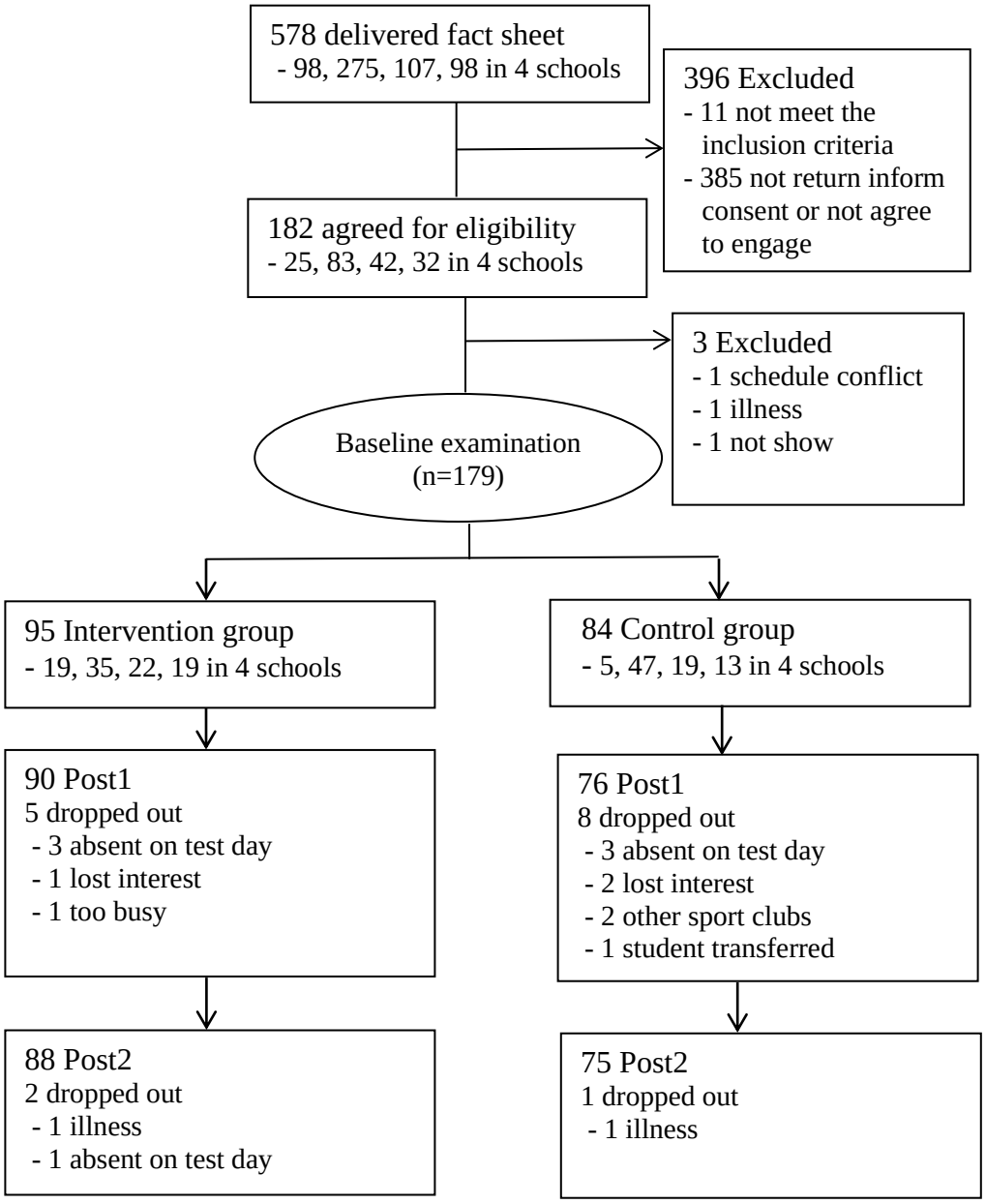

Figure 1. A CONSORT statement of participants flow

Table 1. Children's demographic characteristics at baseline

	Overall (n = 179)	Treatment (n = 95)	Control (n = 84)	Statistics (χ^2/ t)	p value
Gender, n (%)				0.50	0.545
Boys	103 (57.5)	57 (60.0)	46 (54.8)		
Girls	76 (42.5)	38 (40.0)	38 (45.2)		
Age (year), n (%)				5.60	0.018
8~10	94 (52.5)	42 (44.2)	52 (61.9)		
11~12	85 (47.5)	53 (55.8)	32 (38.1)		
Body mass index (kg/m2), mean[SD]	18.93 [3.72]	19.16 [3.76]	18.67 [3.69]	0.88	0.381

Notes: SD, standard deviation. Pearson's chi-square tests of homogeneity were performed for gender and age groups as well as an independent t-test for body mass index.

Table 2. Means (SD) for measures at three time points stratified by group and time using ANCOVAs

Dependent variables	Baseline		Post 1			Post 2		
	Treatment group (n = 95)	Control group (n = 84)	Treatment group (n = 90)	Control group (n = 76)	Adjusted change [a] Mean (95%CI)	Treatment group (n = 88)	Control group (n = 75)	Adjusted change [a] Mean (95%CI)
Intrinsic motivation								
Fruit	24.0 (5.1)	24.7 (4.0)	24.0 (5.7)	23.2 (4.4)	1.6 (0.1, 3.1)*	23.4 (5.2)	23.4 (5.1)	0.9 (-0.5, 2.4)
Vegetable	17.4 (4.1)	18.5 (3.6)	17.5 (4.9)	17.4 (3.9)	1.1 (-0.1, 2.4)	17.1 (4.4)	17.0 (4.1)	1.1 (-0.1, 2.2)
Water	19.9 (4.6)	20.0 (3.4)	20.3 (4.3)	19.6 (3.7)	1.2 (0.2, 2.3)*	19.3 (4.2)	19.0 (4.1)	0.7 (-0.5, 1.9)
PA motivation								
Autonomous	40.1 (12.7)	43.3 (9.9)	40.7 (13.4)	42.2 (12.0)	0.3 (-2.9, 3.6)	39.3 (13.2)	41.0 (12.7)	-0.3 (-3.4, 2.8)
Controlled	22.7 (12.3)	19.7 (8.5)	22.4 (12.1)	19.0 (10.9)	2.1 (-1.2, 5.5)	20.8 (11.8)	18.0 (9.6)	1.2 (-1.9, 4.3)
Self-efficacy								
Fruit	25.3 (6.7)	24.1 (6.6)	26.5 (6.7)	24.7 (7.1)	1.3 (-0.5, 3.1)	24.7 (7.6)	24.3 (6.8)	0.3 (-1.7, 2.3)
Vegetable	16.2 (4.7)	16.6 (4.9)	17.1 (5.5)	16.9 (5.2)	0.3 (-1.0, 1.6)	16.7 (5.3)	16.4 (4.8)	0.4 (-0.9, 1.8)
Water	11.7 (3.1)	11.7 (3.0)	12.1 (3.0)	11.5 (3.3)	0.5 (-0.4, 1.4)	11.8 (2.9)	11.3 (3.0)	0.6 (-0.2, 1.4)
PA	25.2 (7.6)	26.4 (6.9)	26.5 (7.4)	24.7 (7.6)	2.4 (0.5, 4.4)**	25.9 (7.5)	25.1 (6.8)	0.9 (-1.1, 2.9)
Preferences								
FVW	112.9 (16.8)	113.4 (16.5)	114.1 (19.3)	114.6 (15.3)	0.1 (-3.9, 4.1)	116.5 (16.7)	117.0 (15.0)	0.6 (-3.1, 4.3)
PA	78.5 (12.6)	80.2 (10.7)	81.6 (13.7)	79.9 (11.9)	3.1 (-0.2, 6.3)	80.2 (13.5)	80.3 (12.7)	1.4 (-2.1, 4.9)
PAQ-C	23.5 (6.5)	25.1 (5.4)	24.9 (6.8)	24.2 (5.6)	1.9 (0.3, 3.4)*	24.7 (6.6)	23.8 (6.2)	1.5 (-0.1, 3.1)
Objective PA (minute)	(n = 85)	(n = 62)	(n = 62)	(n = 46)				
Sedentary [b]	627.8 (78.1)	579.9 (73.5)	610.4 (90.9)	556.4 (70.4)	21.4 (-8.6, 51.4)	-	-	-
LPA	158.7 (30.8)	166.0 (34.8)	152.7 (30.1)	162.2 (30.9)	-1.9 (12.8, 9.0)	-	-	-
MVPA	40.6 (10.8)	44.2 (15.4)	42.2 (13.3)	43.1 (17.3)	0.7 (-4.0, 5.5)	-	-	-

Notes: [a] Adjusted change means and 95% confidence intervals (CIs) are the differences of the treatment group relative to control group by ANCOVA adjusted for age, gender, body mass index, social desirability, and baseline assessment of the variable.

[b] Indicates variables for which there were baseline differences.

* $p < 0.05$, ** $p < 0.01$

PA, physical activity; FVW, fruit, vegetables and water; PAQ-C, physical activity questionnaire for older children; LPA, light PA; MVPA, moderate-to-vigorous PA.

Table 3. Means (SD) for measures at three time points stratified by immersion score within treatment group using ANCOVAs

Dependent variables	Baseline		Post 1			Post 2		
	High immersion (n = 45)	Low immersion (n = 43)	High immersion (n = 45)	Low immersion (n = 42)	Adjusted change [a] Mean (95%CI)	High immersion (n = 41)	Low immersion (n = 41)	Adjusted change [a] Mean (95%CI)
Intrinsic motivation								
Fruit	24.7 (4.9)	23.0 (5.2)	25.7 (4.6)	22.3 (6.0)	2.2 (0.3, 4.2)*	24.5 (4.1)	21.9 (6.0)	1.7 (-0.3, 3.7)
Vegetable	17.8 (4.1)	16.6 (3.9)	18.4 (4.5)	16.7 (5.1)	0.8 (-0.9, 2.5)	17.6 (4.5)	16.2 (4.3)	0.7 (-0.9, 2.3)
Water	20.0 (4.7)	19.5 (4.5)	21.4 (3.6)	18.9 (4.6)	2.2 (0.7, 3.7)**	19.8 (3.9)	18.2 (4.2)	1.4 (-0.1, 2.9)
PA motivation								
Autonomous	40.2 (12.8)	40.1 (12.8)	42.4 (13.9)	38.9 (12.6)	3.9 (0.3, 8.1)**	38.7 (13.7)	39.6 (13.3)	-0.3 (-4.2, 3.6)
Controlled	24.8 (13.0)	20.2 (11.3)	25.0 (12.6)	18.9 (9.5)	4.6 (0.3, 8.9)**	19.6 (10.4)	19.9 (12.3)	-2.4 (-6.9, 2.1)
Self-efficacy								
Fruit	25.4 (6.6)	24.7 (6.7)	27.8 (6.4)	25.3 (6.9)	2.4 (-0.1, 4.9)	25.2 (7.9)	23.3 (7.0)	1.9 (-1.0, 4.8)
Vegetable	16.3 (4.6)	15.8 (4.8)	17.3 (5.5)	17.1 (5.6)	0.1 (-1.7, 1.9)	17.0 (5.7)	16.0 (5.0)	0.9 (-0.8, 2.6)
Water	11.4 (3.4)	11.9 (2.9)	12.1 (3.1)	12.2 (2.9)	0.2 (-0.9, 1.3)	12.0 (2.9)	11.4 (2.9)	1.1 (0.1, 2.1)*
PA	25.7 (8.0)	24.3 (7.1)	26.8 (7.8)	26.3 (7.1)	0.0 (-2.2, 2.3)	25.0 (8.2)	25.8 (6.8)	-0.8 (-3.8, 2.2)
Preferences								
FVW	113.6 (15.3)	112.5 (18.2)	115.4 (20.8)	113.8 (17.0)	1.5 (-4.4, 7.4)	116.3 (17.5)	116.4 (16.4)	-0.1 (-5.4, 5.1)
PA	78.4 (13.8)	78.3 (11.4)	81. 24 (15.2)	81.6 (12.4)	0.1 (-4.3, 4.5)	79.2 (14.1)	79.8 (12.6)	0.2 (-4.6, 5.0)
PAQ-C	24.0 (7.1)	23.3 (5.6)	25.3 (7.5)	24.7 (5.9)	0.2 (-1.9, 2.4)	24.5 (7.2)	23.9 (5.6)	0.4 (-1.6, 2.4)
Objective PA (minute)	(n = 40)	(n = 38)	(n = 34)	(n = 28)				
Sedentary [b]	635.4 (68.0)	595.3 (92.6)	608.8 (102.5)	614.1 (74.8)	-17.9 (-56.6, 20.8)	-	-	-
LPA	163.2 (32.4)	152.6 (31.4)	158.6 (29.5)	146.5 (31.3)	0.2 (-14.6, 14.9)	-	-	-
MVPA	42.0 (11.6)	39.5 (10.9)	41.2 (10.4)	43.6 (16.0)	-2.5 (-9.2, 4.1)	-	-	-

Notes: [a] Adjusted change means and 95% confidence intervals (CIs) are the differences of the high immersion group relative to low immersion group by ANCOVA adjusted for age, gender, body mass index, social desirability, and baseline assessment of the variable.

[b] Indicates variables for which there were baseline differences.

* $p < 0.05$, ** $p < 0.01$

PA, physical activity; FVW, fruit, vegetables and water; PAQ-C, physical activity questionnaire for older children; LPA, light PA; MVPA, moderate-to-vigorous PA