The Effects of Adaptive Eating Behaviors on Weight Loss of Physically Disabled Children and Adolescents: A Cluster-Randomized Controlled Trial

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Obesity is rapidly growing in both developed and developing countries (Arroyo-Johnson & Mincey, 2016) which boosts the risk of developing severe physical health problems (e.g., cancer, Calle & Kaaks, 2004; type 2 diabetes, Stein & Colditz, 2004; cardiovascular disease, Field et al., 2001), mental health problems (e.g., depression, Stunkard et al., 2003; low self-esteem, Franklin et al., 2006; body dissatisfaction and eating disorders, Brownell & Walsh, 2017; He et al., 2017), and decreasing quality of life (He et al., 2016). Thirty-nine million children younger than five years old were overweight or obese in 2020, and more than 340 million children and adolescents aged 5-19 were overweight or obese in 2016 (WHO, 2021). The prevalence of obesity doubled in over 70 countries from 1980 to 2015 and has continuously increased in most countries (The GBD 2015 Obesity Collaborators, 2017). In China, the prevalence of obesity among adults increased dramatically from 1991 to 2011, particularly among men (Mi et al., 2015). 24.35 billion RMB annual cost accounting for 2.46% of the nation's health care expenditure was generated due to the increasing obesity rate in China (Qin & Pan, 2016).

Among obesity populations, physically disabled children and adolescents are about twice compared with non-disabled peers (Neter et al., 2011). According to previous studies, several reasons account for the higher obesity rate in physically disabled children and adolescents. First, it's difficult for physically disabled children and adolescents to complete enough physical activities against obesity (Rimmer &

Rowland, 2008). Besides, many physically disabled children are raised in poor families; therefore, a healthy diet may not be affordable for these children, and facilities for exercise are less accessible for them (Emerson et al., 2010). Moreover, disabled people frequently lack participation in social activities, which usually causes feelings of isolation, resulting in a risk of binge eating or other maladaptive eating behaviors to compensate for loneliness (Reinehr et al., 2010). However, problematic eating behaviors may trigger obesity (Warren et al., 2017).

Interventions that focus on developing adaptive eating behaviors (e.g., mindful eating and intuitive eating) were proved to show positive outcomes to tackle obesity-related behaviors, including binge eating and emotional eating (Warren et al., 2017). Mindful eating and intuitive eating are similar concepts that emphasize being aware of food choice, hunger and fullness and developing good relationship with foods instead of focusing on diets (Warren et al., 2017). Mindful eating can help individuals slow down consumption of a meal and recognize feelings of fullness to better control overeating (Lofgren, 2015). Besides, a slower pace of eating lessens overall energy consumption as individuals feel full before eating too much (Monroe, 2015).

As physically disabled individuals have more difficulties doing exercises to lose weight compare to non-disabled peers (Rimmer & Rowland, 2008) and may suffer distressing emotions such as sense of isolation (Reinehr et al., 2010) that may lead to disordered eating behaviors (Warren et al., 2017), adaptive eating behaviors focusing on awareness of internal feelings and sensations might be feasible for them to reduce obesity. However, to our best knowledge, previous treatments concerning obesity

reduction on physically disabled people didn't involve these interventions (Matizanadzo & Paudyal, 2021; McPherson et al., 2014).

In previous interventions, physical training, exercises, and diet education were adopted to lose weight, whereas the reductions in BMI or weight were not significant (Matizanadzo & Paudyal, 2021; McPherson et al., 2014) as physical activities and dietary intervention, which are closely related to obesity, might fail to be optimally combined in past interventions (Matizanadzo & Paudyal, 2021). Shortcomings of previous interventions were summarized in systematic reviews. It's common to see small to medium sample sizes in previous studies (Matizanadzo & Paudyal, 2021; McPherson et al., 2014), and few set a control group (McPherson et al., 2014). Furthermore, previous research lacks long-term interventions in which most evaluated outcomes less than three months after interventions (McPherson et al., 2014). Additionally, the effect of parents who play a crucial role in children's obesity intervention (Golan & Weizman, 2001) was underestimated.

Given the positive effect of eating behavior interventions and flaws of previous studies, which mainly focused on physical activities, we aim to adopt eating behavior treatment to explore its outcomes in physically disabled children.

We have several objects in the present study: a) Integrate the theories of mindful eating and intuitive eating, and localize the integrated theories in physically disabled adolescents in China as the theoretical basis for our intervention; b) The intervention scheme and the manual for intervention will be designed according to the theoretical basis, then the feasibility of the intervention scheme will be verified and revised through

pretesting, from which the final scheme will be determined; c) Cluster randomized control study will be used to test the effect of the scheme in different intervention modes; d) The short- and long-term effects of the scheme will be evaluated; e) A guide to the obesity intervention for physically disabled adolescents will be developed based on all the results. We hypothesize that the intervention scheme will show positive effect on children and adolescents with physical disabilities.

Methods

Participants

The sample size will be calculated using G*Power software (version 3.1.9.4). Previous research has shown that a medium effect size of 0.21 is appropriate (Salkind, 2010). Setting a significance level of $p < .05$, a power level of 80%, number of groups of 4, number of measurements of 4 (disordered eating, mindful eating, intuitive eating, and waist circumference) and a constant correlation of 0.5, a total sample size of 160 participants (40 participants in each group) will be needed.

160 Junior high school students aged 12-15 from rehabilitation centers or schools in Shenzhen will be recruited randomly. Their parents will also be involved in the intervention sessions as parents with increased nutrition/health skills and increased parenting skills can create a more desirable environment (e.g., regular mealtimes, optimally allocated food portions, and less stimulus for overeating) for adolescents' weight loss (Golan & Weizman, 2001). Families will be excluded if the child has an intellectual disability, comorbidities, cardiovascular, respiratory, or renal disease, or is currently involved in other interventions. Medical records will be examined to confirm

their physical disability status. Waist circumferences will be measured to determine whether a participant is obese or not (boys: over 83cm; girls: over 78cm; Wingo et al., 2015). All participants will be provided written informed consent to participate, and all study procedures will be conducted after being approved by the university's review board.

Study Design

Preparations

Prior to conducting the experiment, I will use systematic review to integrate theories about intuitive eating and mindful eating to form a comprehensive theoretical model, then revise the model using in-depth interviews and by contacting experts via emails or seminars. Besides, the localized model will be confirmed or revised using questionnaires. Moreover, the intervention scheme and the manual for intervention will be designed according to the integrated articles.

Pilot study

The pilot study will be conducted in a rehabilitation center or school in Shenzhen not included in the formal intervention. 20 students will be randomly selected, and the content of the course according to the intervention program will be completed at a frequency of once a week for 6-8 weeks. Details of the intervention program will be further refined through weekly classroom observations, and feedback from students, parents, and teachers, and investigators and interventionists will be trained. The participants in the pilot study will not be involved in the formal intervention.

Formal intervention

The participants will be randomly divided into four samples and will be randomly divided into three intervention groups and one control group. Considering the existence of health education curriculum in the schools or rehabilitation centers, and the potential influence of parents' behaviors, the three intervention groups will use different intervention modes: mode 1 "regular intervention" (in addition to the health education curriculum and physical activity, intervention scheme will be given), mode 2 "integrated intervention" (integrate the intervention scheme into the health education curriculum and physical activity), and mode 3 "indirect intervention" (adolescents will be given health education curriculum and physical activity only but parents will be given lessons). In all intervention groups, parents will be given regular lessons on how to assist their children in losing weight and reducing incentives that can potentially lead to weight gain. The control group will be assigned a health education curriculum only. At the end of the intervention, differences in the effects of the intervention modes will be compared. The project's short- (after 3 months) and long-term (after 1 year) results will be evaluated. Thus, participants in intervention groups will fill out the questionnaires after three months and after one year, respectively. Additionally, control variables including sociodemographic factors, gender, and stage of puberty development will be collected using a questionnaire before the intervention. The detailed contents of the intervention program and questionnaires will be determined after preparations mentioned above.

Parents might refuse to participate if their children do not receive the interventions. To address this issue, participants in the control group will receive the

intervention after the whole study. The parent of each participant will be rewarded 100 Chinese Yuan, and rewards (e.g., notebooks) will be given to participants who complete each intervention session. Stationery (e.g., pens, erasers) will be rewarded to participants who achieve an attendance rate of at least 85%. Besides, only participants who complete the entire study will receive the 100 Chinese Yuan reward, which will help to reduce withdrawals and increase participations.

Measures

Eating Disorder Symptomatology.

The 12-item Eating Disorder Examination Questionnaire (EDE-QS) examines eating disorder symptomatology (Gideon et al., 2016). The response scale ranges from 0 to 3, assessing anorexia nervosa, bulimia nervosa, and binge-eating disorder symptoms. Scores of items are summed, and higher scores indicate a higher level of symptomatology. Recent findings suggested that the Chinese version of EDE-QS showed strong reliability and validity (He et al., 2021).

Intuitive eating

The Intuitive Eating Scale-2 (IES-2; Tylka & Kroon Van Diest, 2013) is a 23 items scale containing four subscales measuring eating for physical rather than emotional reasons, unconditional permission to eat, reliance on hunger and satiety cues, and body–good choice congruence. The response scale ranges from 1 (“strongly disagree”) to 5 (“strongly agree”). Higher total scores indicate higher levels of intuitive eating. A recent study suggested that the Chinese version of IES-2 showed adequate reliability and validity (Ma et al., 2019).

Mindful eating

The 17-item Mindful Eating Questionnaire adapted for Children (MEQ-C; Hart et al., 2018) is a tool to measure mindful eating rating on a 4-point Likert scale from 1 to 4, with higher scores indicating more mindfulness. The Chinese version of this scale will be translated and validated before using it for measurement.

Waist circumference

Waist circumference will be measured at the uppermost lateral border of the iliac crest with a non-elastic tape measure using procedures from the National Health and Nutrition Examination Survey (National Center for Health Statistics, 1994). Optimal cut points for waist circumference (boys: 83 cm; girls: 78 cm) was proved to be the best predictor of obesity for physically disabled children and adolescents (Wingo et al., 2015).

The development stage of puberty

As the participants will be adolescents, the puberty development will be considered as a confounding factor to be measured and controlled for. The Chinese version of the self-reported Pubertal Development Scale (Chan et al., 2010) will be adopted to evaluate the development stage of puberty. This scale consists of five items: age at menarche (girls only), breast growth (girls only), deepening-voice (boys only) and facial hair growth (boys only), body hair growth (both genders), growth spurt (both genders) and skin changes (both genders), especially pimples. The response scale ranges from 1 (“not yet started”) to 4 (“seems completed”). Menarche will be coded dichotomously as no (0 point) or yes (1 point). Menarche, breast and body hair growth

in girls, and deepening-voice, body hair and facial hair growth in boys will be computed (Petersen et al., 1988) to categorize the children into one of the five pubertal development stages (prepubertal, early pubertal, mid-pubertal, late pubertal, and post-pubertal).

Data analysis

The statistical analysis will be carried out by R 4.0.0 software (Team, 2020) and *psych* package version 2.1.9 (Revelle & Revelle, 2015). Correlation matrix of measured variables will be carried out. All of the variables measured before the formal intervention will be tested for between-group differences using one-way analysis of variance. A repeated measures multivariate analysis of variance will be used to test for significant differences in the changes in the outcome variables between each intervention group and the control group. Intention-to-treat analysis will be adopted and performed to avoid bias from withdrawals or protocol deviations.

Time Table for Completing the Thesis

See appendix.

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Appendix

	2022		2023				2024				2025	
	Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Literature review, integration of theories and application for approval of the university's review board												
Localization of integrated theories												
Design of the intervention scheme and the manual for intervention; recruiting participants for different groups												
Pilot study, revision of intervention manual based on results, and training of investigators												
Base line survey, intervention and post-test												
Complete short-term intervention												
Complete long-term interventions and thesis												