The Effects of Family-Based Mindfulness Intervention on ADHD symptomology in young children and their parents: A randomized control trial

Abstract

Objective: To investigate the feasibility of a Family-Based Mindfulness Intervention in improving children with inattention and hyperactivity symptoms. **Method:** One hundred children aged 5 to 7 with ADHD symptoms and their parents were randomly assigned to a family-based mindfulness intervention (n = 50) or a waitlist control group (n = 50). **Results:** Families from intervention group had greater improvements in children's Attention Deficit Hyperactivity Disorder symptoms, with medium effect sizes of -.60 for inattention and -.59 for hyperactivity, overall behaviors, and in parenting stress and well-being than those in waitlist control group. **Conclusion:** The positive results on the child primary outcome measures have provided initial evidence of the family-based mindfulness intervention as a treatment option to ADHD. The reduction of parental stress and increase in psychological well-being has demonstrated the value of mindfulness in enhancing parent's self-management.

Keywords

ADHD, children, family, mindfulness, randomized controlled trial

Introduction

Attention-deficit hyperactivity disorder (ADHD) is a common childhood psychiatric disorders. It is characterized by the core symptoms of inattention, hyperactivity and impulsivity with an early onset (American Psychiatric Association, 2013). The prevalence of ADHD is between 1.5% and 8%, depending on the diagnostic criteria used (Taylor et al., 2004). A study in Hong Kong estimated that 3.9% of the adolescents were diagnosed as having ADHD (Leung et al., 2008).

Most children with ADHD have significant impairments in executive functions (EFs), which include cognitive flexibility, inhibition, self-control, self-regulation, working memory; problem-solving, reasoning and planning (Barkley, 2015). EFs are very important for school readiness. A study found that children with poorer self-control at age 3–11 tend to have worse health, earn less, and commit more crimes 30 years later, comparing with those having better self-control as children, after controlling for intelligence quotient, gender, social class, and other factors (Moffitt et al., 2011). ADHD is also associated with disturbances in family and poorer parenting practices.

ADHD is also associated with disturbances in the family and poorer parenting practices (DuPaul, McGoey, Eckert, & VanBrakle, 2011; Harpin, 2005). Challenging child behavior evokes harsh parenting, which is defined by intense hostility and negative emotionality and is hypothesized to influence the development of oppositional and conduct problems via a process of mutual reinforcement (Johnston & Jassy, 2007). The parents of children with ADHD report higher levels of stress, lower levels of social support and quality of life, and less parenting satisfaction than parents of children without ADHD (Lange et al., 2005). In view of the reciprocal and dynamic interactions between children with ADHD and their parents, the treatment of ADHD should consider the promotion of calm and consistent discipline and emotional responsiveness in parenting (Johnston & Chronis-Tuscano, 2014).

Evidence-based treatment for ADHD has focused on the use of medication, behaviour therapy and parent training (Cairness & Millner, in press). Psychostimulant medications were

popular and over 70% of children with ADHD experience improved improvements in attention and learning after medication (Biederman et al., 2008; Multimodal Treatment Study of Children with ADHD Cooperative Group, 1999). However, stimulants were also found to produce side effects, such as sleep problems and loss of appetite and thus it is not preferred for very young children (Corcoran, 2011; Faraone, Biederman, Morley, & Spencer, 2008). Behavioural interventions, including antecedent-based strategies, contingency management techniques and self-management skills, are also found to be effective in enhancing the motivations and decreasing the disruptive behaviours of children with ADHD (Fabiano et al., 2009; Roman, 2010). However, when parents are under stress or experiencing their own mental health issues, they may not be able to properly implement the skills which are learned from behaviour training, and may feel frustrated and negatively reinforce parent-child conflicts (Bögels, Hellemans, van Deursen, Römer, & van der Meulen, 2014). Therefore, it is imperative to investigate more options in psychosocial interventions that can be targeted toward the well-being of the entire family system.

Mindfulness and Its Potential Application in Children and in a Familial Context

Mindfulness is defined as paying attention non-judgmentally, to the present moment (Kabat-Zinn, 2013). Mindfulness training can improve attention regulation, that can not only promote the EFs of children with ADHD, but also promote parents' self-regulation in response to their child's challenging behavior and alters the dysfunctional patterns in parenting behavior (Bögels, Lehtonen, & Restifo, 2010; Shaprio, Carlson, Astin, & Freeman, 2006). Instead of having preoccupied in the difficulties in behaviors of child and parenting, mindfulness may benefit children and parents through building or improving on strengths of family members, and enhancing nurturing family environment.

Evidences of mindfulness training specifically for families with ADHD children are emerging (Cassone, 2016). In an evaluation of an 8-week mindfulness training course, 22 children between 8 and 12 years of age with ADHD and their parents indicated significant reductions in the children's ADHD symptoms and in their parents' inattention and hyperactivity symptoms, by comparing the families from treatment group and waitlist control group (van der Oord, Bögels, & Peijnenburg, 2012). There were improvements in parental stress and over-reactivity. In a study of the same program in 10 adolescents aged 11 to 15 with ADHD and their parents, the adolescents, parents, and tutors all reported improvements in attention and behavioral problems (van de Weijer-Bergsma, Formsma, Bruin, & Bögels, 2012). A study evaluated 18 adolescents aged 13 to 18 with ADHD and their parents and reported significant improvements in ADHD symptoms, internalizing and externalizing problems, functional impairment, family functioning, parenting stress and mindfulness (Haydicky, Shecter, Wiener, & Ducharme, 2015). The above studies reported positive findings but they have limitations such as small samples, and two of them did not have control group. Although some studies have reported positive benefits of young children after completing mindfulness training, none of the studies are based on young children below age of 8.

This project applies mindfulness training in family-based intervention. It is one of the earliest attempts to apply mindfulness training in young children and families, and to the best of our knowledge, no studies of mindfulness training has been conducted and published in this age group at the time of preparing this manuscript. The objectives of the project are: (1) To reduce ADHD symptoms of children; (2) to reduce the stress of parents of children with ADHD and to promote their well-being; and (3) to examine the feasibility of family-based mindfulness intervention (FBMI) in Chinese families with children of ADHD. The following hypotheses were tested: (1) We hypothesized that children randomized to the FBMI would have more improvements in the symptoms of inattention and hyperactivity relative to those in a wait-list control group. (2) We

hypothesized children randomized to the FBMI would have more improvements in their internalizing and externalizing symptoms relative to those in a wait-list control group. (3) We hypothesized parents randomized to the FBMI have improvements in parental stress, well-being, and parent mindfulness relative to those in a wait-list control group. (4) We hypothesized attention of children mediated the changes in children's behavior problem, parental stress and parent well-being.

Methods

Participants

One hundred and twenty-three families with children between 5 and 7 years applied for the FBMI program, after attending a briefing seminar. Screening interviews were arranged for assessing the eligibility. The inclusion criteria included (1) children aged between 5 and 7 years, (2) a score that meets or exceeds the borderline cutoff of the Strengths and Weaknesses of ADHD Symptoms and Normal Behaviors Rating Scale (SWAN) (Swanson et al., 2012), and (3) both parent and children were committed to join the FBMI program. The exclusion criteria included (1) children with another developmental disability, such as an intellectual disability or autism spectrum disorder, as reported by parents if children had received formal diagnoses before in the screening interviews, and (2) the inability of either the parent or the child to attend 80% of the program sessions due to other commitments in training programs or social and leisure activities. Twenty-three of the families were excluded from the study, because of not meeting the cut-off score of SWAN (n = 12), not interested in the program (n = 4), and loss of contact (n = 7). All participants gave full written consent. Among the 100 children, 74 of them had diagnoses of ADHD before they applied for the program. The rest of them had been waitlisted for the assessment. Since the project was promoted within the school counsellors and school social workers, parents who applied for the program were either with confirmed child ADHD diagnoses, or facing difficulties in managing

their children's issues at study. Only 17% of the children in the program were female. Implications of these sample characteristics to findings were addressed in the discussion section.

Study Design and Procedures

The study protocol was published and all procedures followed the study protocol (Lo, Wong, Wong, Wong & Yeung, 2016). One hundred families were randomized into intervention group and wait-list control group. The randomization procedure was as follows. A 10 × 10 table was created by randomly assigning digits 0 to 9. One row of the table was randomly selected, and the sequence of digits in that row was observed. A participant list was prepared, and the sequence of participants was observed. The first digit would determine the first participant's group, and so on. Participants with an even digit were assigned to the intervention group, and those with an odd digit were assigned to the control group. After the families were assigned to groups, another research team member contacts the parents by phone, to inform the parent about the results of randomization and to confirm that both the parent and the child would participate in the study. The team member who interviewed the families was blinded in the assignment process.

A flowchart of the recruitment and implementation of this waitlist randomized controlled trial is illustrated in Figure 1. All eligible families were randomized into a treatment group or a wait-list control group. The FBMI was delivered in a group format. All families in the waitlist control groups underwent the same program after the post-test of the treatment groups. Three local non-government organizations (NGOs) in Hong Kong participated in the study. The programs are conducted in the NGOs' integrated family service centers.

The parent program of the FBMI was designed by the first author by means of some adaptations to two overseas mindful parenting programs (Bögels & Restifo, 2014 and Coatsworth, Duncan, Greenberg, & Nix, 2010). The program lasts for 6 weeks, and each session lasts 1.5 hours. A protocol was prepared by the first author, and the session themes and key contents are

summarized in Table 1. The parent programs were implemented by instructors employed by the research team or social workers from the three NGOs who have completed training organized by the first author. All parent group instructors completed an 8-week mindfulness-based stress reduction program or mindfulness-based cognitive therapy program. A two-day training was provided by Dr. Larissa Duncan, the trainer of another mindful parenting program (Coatsworth et al., 2010), to all parent group instructors.

For the child program, FBMI followed the child mindfulness program "Mindfulness Matters" (the green book for children 5 to 8 years of age) (Snel, 2014). The program includes four to six children, and each session lasts 1 hour. All child group instructors possess a professional degree in social work, education, or clinical psychology and have been certified as instructors by completing the 6-day "Mindfulness Matters" professional training program.

During the fourth and sixth sessions of the parent program, 30-minute joint activities were incorporated. This design helps the family members to practice mindfulness together and to review their learning and progress in each other's presence. The session themes of the child program are shown in Table 2. Participants in the wait-list group received the same intervention after the families from intervention group completed FBMI.

All parent and child groups were audio recorded. Among all FBMI group sessions, 10% of the sessions were randomly selected for evaluating the teaching integrity and performance. Parent group instructors were evaluated using Mindfulness-Based Intervention – Teaching Assessment Criteria (Crane et al., 2013). The child group instructors were evaluated by an evaluation form constructed by the research team, focusing on two areas, adherence to session protocol, and competence in program delivery. Assessor gave a rating from 1 to 5, in terms of the levels of adherence and competence, in each item of the scale.

All parents attended a screening interview. A research team member explained the procedure and research design to them in group format. Once the parents agreed to participate in the study

with their children, both parent and children were interviewed by assessing their motivation to participate and their eligibility. Pre-test was conducted after they signed the consent form.

The study protocol has been reviewed by the funder of this study, the Health Care and Promotion Fund from the Food and Health Bureau, the Government of the Hong Kong Special Administrative Region. The ethical approval was granted from the research office of the corresponding author's university (ref. 3-3-201504_03) and is registered under the Chinese Clinical Trial Registry (ref. ChiCTR-IOR-15007292).

Measures

Three measures were used to assess child functioning:

Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Rating Scales (SWAN): The scale was developed based on 9 symptoms of inattention and 9 symptoms of hyperactivity/impulsivity in the DSM-5 diagnostic criteria for ADHD, and is completed by parents to assess their child's attention and hyperactivity symptoms (Swanson et al., 2012). The borderline and cutoff scores were validated and defined in a study of Chinese ADHD children (Lai et al., 2013).

Child Behavior Checklist (CBCL): The Chinese version of CBCL was used to assess behavioral problems in children by parent's ratings (Achenbach & Rescorla, 2000). There is a total score, internalizing problems, and externalizing problems, and sub-factors on anxiety problems, withdrawal depressed problems, somatic complaint problems, attention problems, and aggression problems. The first four subscales are classified as internalizing problems, and the following two are classified as externalizing problems, and this factor structure was confirmed in a Mainland China's study, which reported correlations from 0.38 to 0.71 among the seven subscales and a correlation of 0.75 between internalizing and externalizing problems (Liu, Cheng, & Leung, 2011).

Child Attention Network Test (ANT): The test was administered by a research team member and in a computer program (Posner & Petersen, 1990). Five fishes were presented in a horizontal row above or below the fixation point. The children were instructed to press a key to indicate in which direction the central fish was pointing and to ignore the flanking fishes. Completion of the task allowed the calculation of three scores related to the efficiency of attention networks. Alerting was measured by the additional time required to respond with no cue, compared to the response time to a cue that informed the child that a target will occur shortly. Orienting was measured by the time taken to respond to a cue at the target location minus the reaction time to a central cue. Executive attention was measured as the interference effect of the flanking fish on the child's score.

Five measures were used to assess parent functioning:

Parenting Stress Index Short Form (PSI-SF): The PSI included 36 items and was developed to reveal the sources of difficulties and the level of parenting stress (Abidin, 1995). The scale was divided into three subscales: parental distress, parental-child dysfunctional interaction, and difficult child. The Chinese version was validated and widely adopted in parenting studies (Lam, 1999). The internal consistency in this study for total score was 0.83.

Adult ADHD Self-Report Scale (ASRS): The ASRS was used to assess parent inattention and hyperactivity symptoms. It includes 18 items, 9 for inattention and 9 for hyperactivity and impulsivity (Kessler et al., 2005). The Chinese version of this scale has been validated in a sample from Taiwan which showed high intra-class correlations and internal consistency (Yeh, Gau, Kessler, & Wu, 2008). The internal consistency of the scale in this study was 0.91.

Interpersonal Mindfulness in Parenting (IMP): The IMP scale includes 31 items that assess the parent's quality of mindfulness specific to his or her family context (Duncan, Coatsworth, & Greenberg, 2009). The Chinese version of IMP include Compassion for Child, Non-judgmental Acceptance in Parenting, Emotional Awareness in Parenting, and Listening with Full Attention.

A scale validation study has been conducted by the first author and colleagues (Lo et al., in review). The internal consistency of the index in this study was 0.86.

World Health Organization Well-Being Index (WHO-5): The scale includes 5 items that measure the subjective psychological well-being (Heun, Burkart, Maier, & Bech, 1999). It is a short and generic global rating scale and each of the 5 items is scored from 5 (all of the time) to 0 (none of the time). WHO-5 has been widely adopted as an outcome measure in additional to symptom focused measures (Topp, Østergaard, Søndergaard, & Bech, 2015). The internal consistency of the index in this study was 0.93.

Parent heart rate variability (HRV): The HRV was adopted to understand how psychological stress could lead to poor health status, biological data were used together with psychological measures to evaluate the outcome of the program. Consistent research findings show that psychological distress and negative emotions affect the autonomous nervous system by inhibiting the cardiac parasympathetic system and decreasing HRV (Kreibig, 2010 and Taylor, 2010). HRV was a measure of cardiac autonomic function in which the cyclic variations in the RR intervals on an electrocardiogram are counted. It is also an early marker of cardiovascular risk (Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology, 1996). HRV is measured by using ambulatory electrocardiogram to reflect on mother's autonomous nervous system functioning for three minutes, using Polar heart-rate monitors (Polar Vantage NV, Polar Electro Oy, Finland). HRV is interpreted with the frequency-domain method according to the guidelines for the standard measurement and interpretation of HRV developed by a task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (TFESCNASPE, 1996). The indices of frequency-domain analysis include very-low-frequency (VLF), low-frequency (LF), and high-frequency (HF) in absolute values of power (ms2) and normalized units by using Kubios HRV (version 2.2) software (http://kubios.uef.fi).

One measure was used to assess treatment fidelity:

Mindfulness-Based Interventions–Teaching Assessment Criteria Scale (MBI-TAC): MBI-TAC was adopted to assess treatment fidelity as it included six domains of competence in instructing a mindfulness program that might also apply to a brief mindfulness-based intervention (Crane et al, 2013).

Statistical Analysis

The baseline characteristics of the intervention group and the waitlist control group were compared by analysis of covariance for continuous variables and chi-square tests for categorical variables. The baseline factors included the age of the children and the parents, the sex of the children and the parents, the children's medication status, and the pre-test scores of SWAN, CBCL, PSI, WHO5, and ASRS. Intervention group participants were assessed at baseline (T1) and after the intervention (T2). Waitlist-Control group participants were assessed at the same time with the intervention group, and would receive the same programme after post-test of intervention groups. The effects of FBMI was tested by analysis of covariance, comparing the FBMI group (arm 1) to the wait-list control group (arm 2). All analyses were carried out according to the intention-to-treat approach. The participants' missing values were imputed using the last-observation-carried-forward method. A two-sided P value of 0.05 or less was considered be statistically significant. In the case of significant results, effect sizes (Cohen's d) were calculated. Cohen (1988) suggested that $d = 0.2$ be considered a small effect size, 0.5 represents a medium effect size and 0.8 a large effect size.

This study further attempted to explore the mediating effects of child attention in other dependent variables. The PROCESS macro was used to test the mediating effects of child attention on the relationship between group difference as the independent variable, and parents' stress or well-being or children's behavioral problems as dependent variables (Hayes, 2013). Bootstrapped estimates of confidence intervals (CIs) for indirect effects were calculated. It is bias-corrected

because this approach does not assume distribution normality of sampled indirect effects (Preacher et al., 2007). If 95% CIs do not encapsulate 0, they are considered significant and mediating effects exist. All analyses controlled for the child age and pretest value of the corresponding dependent variable.

SPSS version 23 was used to administer the above statistical tests.

Results

Demographics

Parents on average were aged 39.21 and children were 6.25. 96% of the parents were female and 83% of the children were male. No significant differences were found in most demographics and pre-test scores between the intervention and control group (all $p > 0.05$), except the child's age. The proportion of children with ADHD diagnosis in intervention group (82%) was higher than those in waitlist control group (66%). The difference in ADHD diagnoses and SWAN scores between groups were closed to level of significance. Adjustments on child's age and SWAN scores were made based on these two variables when further analysis was conducted.

Among the completers, the attendance rate of treatment groups was 80.21%, that of waitlist groups was 78.57%, and that of all groups was 79.44%.

Outcome Variables

As presented in Table 4, significant Time x Group interactions were shown in SWAN total score ($F_{1, 98} = 15.80$, $p < 0.001$), SWAN inattention score ($F_{1, 98} = 13.73$, $p < 0.001$), SWAN hyperactivity score ($F_{1, 98} = 15.49$, $p < 0.001$). These results indicated that after completing the FBMI, comparing with the control group, children from the intervention group were found to have significant improvements in their inattention and hyperactivity symptoms. Similar significant Time x Group interactions were shown in CBCL total score ($F_{1, 98} = 13.76$, $p < 0.001$), CBCL

anxiety score ($F_{1, 98}$ = 7.82, p = 0.006), CBCL somatic complaint score ($F_{1, 98}$ = 8.30, p = 0.005), attention problem score ($F_{1, 98}$ = 14.76, p < 0.001), CBCL aggression score ($F_{1, 98}$ = 6.49, p = 0.012), CBCL internalizing problem score ($F_{1,98}$ = 10.22, p = 0.002), and CBCL externalizing problem score ($F_{1, 98}$ = 7.90, p = 0.006). These results showed that positive improvements were also found in other aspects of child behaviours.

The ANOVA of ANT results are presented in Table 5. Following Ratcliff's recommendations, trials with incorrect responses or with RTs lower than 200 ms or greater than 2000 ms were removed from analyses (Ratcliff, 1993). Child ANT conflict monitoring showed a Time x Group interaction, $F_{1, 98}$ = 4.82, p < 0.05. Simple analyses revealed a significant decrease in ANT conflict monitoring at post-test in the treatment group, t_{49} = 2.48, p = 0.017, but not control group, t_{47} = -0.53, p = 0.598.

As presented in Table 4, significant Time x Group interactions were shown in parent PSI total score ($F_{1, 98}$ = 10.99, p = 0.001), PSI parental distress scores ($F_{1, 98}$ = 7.08, p = 0.009), for parent-child dysfunctional interaction score ($F_{1, 98}$ = 8.26, p = 0.005), PSI difficult child score ($F_{1, 98}$ = 7.88, p = 0.006). The intervention group also reported a significant improvement in parents' WHO5 subjective well-being ($F_{1, 98}$ = 8.32, p = 0.005). However, changes in parent ADHD symptoms and interpersonal mindfulness were insignificant.

As presented in Table 6, parent low-frequency HRV showed a Time x Group interaction, $F_{1, 61}$ = 4.38, p = 0.041. Simple analyses revealed no significant changes in parent low-frequency HRV at post-test neither in the treatment group, t_{34} = 0.140, p = 0.889 nor the control group, t_{27} = 1.89, p = 0.069.

Since this study involved children with and without ADHD diagnosis, subgroup analyses were conducted to examine if there was significant differences in outcomes. Based on the sample in intervention group, independent t-tests were administered and t-scores for three outcomes SWAN, CBCL-total score, and PSI were 0.08, 0.29, and 0.18 respectively (all p > .05).

Mediation Analyses

The effect of the treatment on the mediator was examined using group (treatment vs. control) as the independent variable; PSI total score, WHO5 score, and CBCL total score as the dependent variables; and change of SWAN score, change of CBCL attention problem score and change of ANT conflict monitoring score as mediators, controlling for the child age and pretest value of the corresponding dependent variable. All results were summarized in table 7.

10000 replications were used in the bootstrapped estimates of CIs. Predicting PSI total score, there was a significant indirect effect from group via change of SWAN score (*ab* = -3.76, *SE* = 1.77, 95% CI = [-8.00, -1.06]), via changes of CBCL attention problem score (*ab* = -3.95, *SE* = 1.60, 95% CI = [-7.38, -1.11]), and via change of ANT conflict monitoring score (*ab* = -0.62, *SE* = 0.59, 95% CI = [-10.01, -0.69]), as shown in figure 2.

Predicting WHO5 score, there was a significant indirect effect from group via change of SWAN score (*ab* = 0.74, *SE* = 0.42, 95% CI = [0.09, 1.74]), but not via changes of CBCL attention problem score (*ab* = 0.60, *SE* = 0.46, 95% CI = [-0.05, 1.80]) nor via change of ANT conflict monitoring score (*ab* = 0.23, *SE* = 0.19, 95% CI = [-0.001, 0.83]), as shown in figure 3.

Predicting CBCL total score, there was a significant indirect effect from group via change of SWAN score (*ab* = -0.04, *SE* = 0.02, 95% CI = [-0.09, -0.01]), but not via change of ANT conflict monitoring score (*ab* = -0.01, *SE* = 0.01, 95% CI = [-0.03, 0.003]), as shown in figure 4.

Feedback and Implementation Fidelity

Good feedback was received from the participants after completing the intervention. We invite the 76 parents who had completed all session of FBMI to complete the feedback form. 59 parents completed the questionnaire and the response rate was 77.6%. 93% of the respondents felt satisfied

with the content of FBMI and 96% of them considered that their management of stress and emotions were enhanced.

For the implementation fidelity, the average rating of MBI-TAC was 4.2 (range 4.0 to 4.33) out of 6, and the fidelity checklist for child program were 4.5 in adherence and 4.67 in competence out of 5.

Discussion

Although ADHD is one of the most common mental disorders in early childhood, existing treatments have limitations, and the families of children with ADHD experience high levels of stress that create a great burden to school systems and the community. Poor management of child behavior and family relationships further increase the risks of other comorbid psychopathologic conditions, such as oppositional defiant disorders and conduct disorders in children and major depressive disorders in caregivers. The search for effective treatments to improve the functioning and quality of life of families of children with ADHD should be a priority in the mental health care and education sectors.

Previous literature focused on investigating the effects of mindfulness training on adolescents and adults. Although some children have late onset of ADHD before 12, a valid diagnosis of ADHD in young children is possible as early as the age of 4 (Lahey et al., 2004). This is the first randomized control trial to study the feasibility of mindfulness-based intervention in working with ADHD symptoms of young children. Multiple outcome measures including behavior assessments and a biomarker HRV were included. The positive result on the child primary outcome measure, reductions in inattention and hyperactivity symptoms, have provided initial evidence regarding FBMI as a treatment option to ADHD. The improvement of overall behaviour problem also suggested such intervention could lead to reduction of internalizing and externalizing problems to the children. A recent meta-analysis of mindfulness-based intervention reported that adults with

ADHD may benefit more from mindfulness training than children with ADHD (Cairncross & Miller, in press). The medium effect sizes of our study, based on SWAN inattention and hyperactivity scores, 0.60 and 0.59 respectively, were similar to the results of six child studies in the meta-analysis. It suggested that mindfulness could significantly reduce the problems arising from ADHD from an early stage.

Although the study was not restrictive to children with ADHD diagnosis, our subgroup analyses suggested that there was no significant difference in their outcomes between children with formal diagnoses and those without diagnoses. The male children dominated sample might look suspicious at first sight but such sex differences was consistent with the prevalence of ADHD medication prescription among Hong Kong Chinese, in which the male prevalence was 4.7 to 9.8 times of female (Man et al.. in press). More studies are recommended for clinical samples and female children with ADHD.

Since mindfulness-based interventions target to improve attentional capacity, it assumed that such positive changes will lead to further improvements in children's self-regulation and overall functioning (Cairncross and Miller, in press). Such speculation was partly supported in our mediation analyses, as we found children's improvements in attention mediated their changes in overall behaviors.

The benefits to parents is also impressive. The overall reduction of parental stress and increase in psychological well-being, demonstrating the value of mindfulness in enhancing parent's stress management and self-management. Although there is no separate measure on family functioning, one of the subscales of PSI parent-child dysfunctional interaction showed the relational effects of mindfulness. It suggested that mindfulness training contributed to symptom reduction for individual family member but also for cultivating a nurturing living environment.

Another strength of the present study is to include multiple measures for attention and parent's stress reactivity. The significant improvement in ANT for children suggested that the

change of attentional process in treatment could be evaluated in a time limited behaviour assessment procedure and it should be adopted in accompany with self-reported scales to strengthen the evidence-base of FBMI. In this study, we did not find positive change in HRV after mindfulness training and the reason is unclear. Researchers may explore a refined procedure for data collection to reduce the number of missing data. An alternative explanation is that HRV is a less favourable measure for evaluating ADHD symptoms, compared with other internalizing symptoms, such as depression.

There are three major limitations of this study. The first limitation was that parents as the informant of many child outcome measures of the study is also involved in the intervention. Although positive change was also found in child ANT, that was not influenced by parental behaviour, such effect size was smaller than those of parent ratings. It is not certain that to what extent parent's report of change should be attributed to parent's improved well-being after mindfulness training, or child's own improvements after their participation of the program.

The second limitation was that the short project period did not allow us to investigate the sustainability of the treatment effects. Further studies should also consider a 6-month or 1-year follow-up period to verify the sustainability of the treatment effects. Lastly, we were aware of the relative small proportion of female sample in our study. It is unclear how these findings can be generalized to female children. Further studies may consider a stratified sample based on child sex and make sure adequate female samples can be recruited.

This study helps to guide future research by highlighting the need for more methodologically rigorous studies to provide more evidence for the use of mindfulness training in children with ADHD and their families. It suggests that children aged 5 to 7 can benefit from the family based training. Future research is required to strengthen the evidence of effects of mindfulness in young children and other age groups. The possible bias in female children suggested more studies should investigate the program effectiveness among female young children. The use of objective tests to

assess changes in inattention and hyperactivity is critical, especially for young children, who have problems to report their symptoms accurately. Investigators should also collect the ratings of other informants, such as teachers, to evaluate the effects of children in other settings of daily lives. Application of FBMI may also be considered for children with other clinical problems, such as autism spectrum disorder, severe behavioural problems, conduct disorders, depression, and anxiety. More studies of FBMI are recommended for strengthening the evidence base of this recently developed approach.

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