Information and Communication Technology Facilitated Parenting for Attention Deficit Hyperactivity Disorder

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ABSTRACT
Information and Communications Technology (ICT) has become an important resource of child-rearing. More and more new parents are reported to adopt online platforms to seek parental support. Multiple researchers have reported positive effects of interventions in Attention-Deficit/Hyperactivity Disorder (ADHD) adopting ICT. Nevertheless, a review about the articulation of ICT use in parenting for children aged 3-12 years old with ADHD is currently lacking. Therefore, this paper aims to investigate how ICT promotes the interventions of ADHD children in early childhood. ICT can facilitate parenting. Especially videoconferencing-related ICT interventions were considered as both more effective and accessible during the COVID-19 pandemic. Besides remote interventions, ICT can also be used for moment-to-moment measurement of interactions between parents and children. It was reported that the ICT also successfully facilitated interactions between parents and children with ADHD. Key factors that affect the effectiveness of ICT interventions were concluded in this paper, which are program intensity, program completion, level of severity in ADHD, and parental self-efficacy respectively. Direct use of ICT interventions in ADHD children and parental support can be implemented jointly to maximize the treatment outcomes, especially in improving children's working memory performance. Implications of ICT interventions in ADHD were also provided for parents and researchers accordingly. Future research could further explore the long-term effect of ICT interventions for children with ADHD. This understanding might contribute to the design of the forthcoming online parenting resources and interventions for ADHD.

Keywords: Information and Communications Technology, Parenting, Attention-Deficit/Hyperactivity Disorder, Mindfulness, COVID-19

1. INTRODUCTION

Parents, as the first teacher of children, play a pivotal role in children's development. Parenting, as the process by which parents raise a child from birth to adulthood, has a direct impact on children's development, including physical, cognitive, emotional, and social well-being areas. Literature had substantiated the positive association between active parental involvement and children's academic success, compared with insufficient parenting that were related with aggressiveness in puberty and juvenile delinquency [1]. Traditionally, as Nieuwboer and her colleagues concluded, parents obtained information via paper-based media, such as books, newspapers, and magazines [2]. Face-to-face consultations and therapies are major approaches to parenting support and interventions. Whereas, the current fast-speed, broad-band Internet was reported to notably increase parental activities online [3]. Differing from traditional face-to-face interventions, online parenting interventions have two major approaches. One is online therapy, referring to information exchanges between therapists and patients via email or chat. The other one is internet-based self-help treatment, in which patients independently get access to programs including texts,

videos, and interactive courseware through structured web pages [4].

Online parenting interventions have received increasing attention compared with traditional face-to-face interventions. Firstly, the increase in the reach and uptake of programs was observed among families whose children suffered behavioral, emotional, and developmental difficulties (i.e., ADHD, anxiety disorders, and dyslexia), while facing geographical, financial, or social barriers to the access of traditional face-to-face programs. For example, parents can book different online parenting sessions and attend them at home on weekday nights instead of traveling across the city during the weekends. Plus, ICT enables education professionals to tailor materials to meet individual parents' needs, to structure content in creative ways, and to create opportunities for interactions. It was reported that interventions were benefited when practitioners could ask parents to fill in the survey before and after the interventions to collect opinions [5]. The use of ICT in ADHD interventions could also benefit minority groups and families facing significant adversity, such as low-income families. ICT made low-price parenting interventions delivered by professionals possible. Another advantage of online parental support is anonymity. Interviews of families with experience of stressful life events, such as the loss of one of the siblings, revealed that parents were more comfortable seeking help online in anonymous or secret parenting groups [6].

Participating in online parenting interventions could lead to beneficial changes in both parents and children. Morgan et al. studied the influence of online parenting programs on preventing anxiety disorder in young children [7]. The results showed that children's anxiety symptoms had reduced significantly after 24-week interventions. Moreover, as reported by Nieuwboer et al., online parenting interventions could make a positive impact on parents with young children, through significantly increasing parenting knowledge in speech and communication skills, social skills, and intellectual skills [2]. Furthermore, parents' feeling of confidence in themselves also significantly rose after the programs. Another study showed that online self-help programs for parents of preschoolers with ADHD had effectively reduced children's inattentive behaviors, through increasing parenting competence and satisfaction in parenting roles [8]. Thus, it can be concluded that online parenting interventions are effective on improving children's performance, parents' positive attitudes, and behaviors in parenting.

Recent studies revealed that the characteristics of children, parents, and types of interventions might have an influence on the results of the online interventions. Notably, regression analyses showed that the more severe the behavioral problems were, the greater improvement of children was observed at the 9-month follow-up

assessment [9]. The same review further mentioned that low-intensity online parenting interventions could be efficacious for a broad range of users. It means that short interventions or programs with less frequency might predict a low drop-out rate of parents. Combining social support, such as communication with other parents, was also reported beneficial in the success of online parenting interventions. As reported by Baker and Sanders, parents who shared learned strategies on social media could gain emotional support and validation from praise and encouragement of other parents online [10]. This serves to enhance parents' efficacy and encourage them to follow through with the interventions even when implementing strategies are difficult.

As a chronic developmental disorder characterized by inattentive, hyperactive, and impulsive behaviors, ADHD is pervasive among children, adolescents, and adults [11]. Moreover, ADHD was reported to be associated with intellectual and language impairments [12]. In their review article, Yong and Amerasinghe summarized the currently available non-pharmacological interventions for young children, school-age children, adolescents, and adults with ADHD, based on a development psychopathological framework [11]. This article revealed that for preschool children with ADHD, parent training was the most appropriate intervention. Nevertheless, for older children and adults with different levels of impairments, usually combined interventions were recommended, as suggested by the National Institute for Health and Clinical Excellence (NICE) Clinical Guideline published in 2009 of the United Kingdom [13]. For example, for adolescents with ADHD, classroom interventions, cognitive-behavioral therapies, and social skills training were recommended. Plus, the treatments for children with ADHD at different age groups shifted from indirect intervention via parents or teachers (i.e., parent training) to direct intervention via the child or adult themselves (i.e., social skills training). For instance, parent training equips parents with parenting skills, such as monitoring problematic behaviors and rewarding prosocial behaviors of their child. Direct interventions, in which target older children and adults themselves, improve their abilities in social communication and problem-solving. Therefore, there is a transfer of the agent of interventions' target for children as they grow up.

In short, participation in online parenting interventions may pose positive changes for both parents and children. As online parenting interventions have gained increasing popularity compared with traditional face-to-face interventions, more research has been conducted in recent years. Previous studies mainly focused on how online parenting interventions could facilitate children's performance and parents' parenting skills. However, few reviews have investigated how ICT interventions might help children with ADHD, regarding parenting and the interactions. Therefore, this review

aims to provide evidence to support that ICT facilitates parent training. It discussed how ICT facilitated interactions between parents and children with ADHD, as well as factors influencing the efficacy of ICT.

2. ICT FACILITATED PARENT TRAINING

Due to the critical scarcity of available child mental health care, children who live in poverty or rural locations are less likely to have access to mental health treatments. Therefore, videoconferencing can be a good paradigm for addressing the imbalance in access to mental healthcare among populations in rural places. Dixon and colleagues conducted a study on the effectiveness of videoconferencing on teaching parent training skills to parents of children with ADHD [14]. The study recruited parents of children with ADHD from 6 to 14 years into the videoconference session (treatment group) and the face-to-face session (control group). The results indicated that parental training through videoconference could be equally helpful for children with ADHD as typical face-to-face conferences. According to the study, videoconferencing had the same effect as face-to-face groups in terms of assisting parents in developing better disciplinary practices, as measured by the Parent-Child Relationship Questionnaire for Child and Adolescents (PRQCA). In addition, videoconferencing was reported effective at improving the overall functioning of ADHD children including inattentive, hyperactive, oppositional, conduct, and anxiety symptoms, as measured by the Vanderbilt Rating Scale, Children Global Assessment Scale (CGAS), and Clinical Global Impression—Improvement (CGI-I). Therefore, enhancing the use of videoconferencing is not only likely to improve parents' mastery of their parenting skills but also indirectly benefit ADHD children's performance.

Given the recent global spread of the COVID-19, telepsychology delivery has gained popularity to accommodate parents' needs, especially for families with ADHD children. According to the study of Fogler and colleagues, a brief parent training group that adapted the rapid-cycle quality improvement methods (Bootcamp for Attention-Deficit/Hyperactivity Disorder; BC-ADHD) to caregivers of school-aged children from 5 to 11 years during the COVID-19 pandemic [15]. As a result, in comparison to in-person groups, telepsychology BC-ADHD was implemented with comparable levels of content and procedural fidelity and treatment satisfaction. In addition, there were many caregivers who agree with the convenience of telepsychology. Two-parent households jointly attended telepsychology sessions more than in-person ones. As a result, telepsychology parent training groups received high fidelity, which was also practical and acceptable for caregivers and clinicians while they might face some challenges in getting along with others and sharing over

video. Therefore, it would be reasonable to expect a greater degree and scope of use of telepsychology in the treatment of ADHD.

Although telepsychology was experimentally supported to be effective, there are still unsolved issues with existing apps on the market. In a study by Powell and colleagues, the suitability of the top 10 listed apps which were identified via the Google Play and iTunes store marketed for parents with ADHD children, was accessed [16]. Participants, including parents of children or young people with ADHD and clinicians who specialized in working with this demographic, were interviewed to learn their thoughts on the ten applications. Opinions were collected about what was believed to be the most important features for these apps and what are considered to be appropriate and beneficial for this community. Four themes emerged from the conversations to evaluate the aforementioned concerns: (1) the necessity of connecting with the app; (2) applications that help with ADHD-related issues; (3) how apps can alter family connections; and (4) apps as a learning tool. In addition, parents mentioned the importance of technology, and clinician interviews thought apps should be practical enough. As a result, the top 10 applications advertised to parents of children with ADHD did not appear to suit their demands, and, more importantly, did not have the critical features that they believed would make an app useful. As findings suggested that these apps may not adequately address the multifaceted needs of this parent demographic, more efforts should be made in the value of apps and the effectiveness of ICT interventions.

3. ICT FACILITATED INTERACTIONS BETWEEN PARENTS AND CHILDREN WITH ADHD

Traditionally, remote interventions collected information from parents' memory of their interactions with their kids, which rendered the record to recall bias. Notwithstanding, the moment-to-moment measurement recorded instant information about the interaction between parents and children, which was reported to be more accurate and convenient. For example, using ICT devices, such as smartphones, could minimize the recall bias, maximize ecological validity, and collect high temporal resolution (i.e., collect data every day) information on complex behaviors between parents and children. In a study by Li and Lansford, the effects of parental stress and child ADHD symptoms on the consistency of parenting behaviors were assessed through questionnaires, observations, and smartphone-based ecological momentary assessment (EMA) in a large sample of parents and their kindergarten children with or without ADHD [17, 18]. In the questionnaire, parents were asked to report their children's misbehaviors, their responses, and parent-child

interactions in both positive and negative dimensions. The research found that various parental stress (i.e., social stress, family stress, and parenting-related stress) and child ADHD symptoms would influence the consistency of parenting behaviors. Specifically, parents were more likely to become inconsistent in their discipline practices in response to child misbehavior when they felt overwhelmed by demands of parenting. What's more, the reduction of stress levels would increase the consistency of parental behaviors and lead to better child outcomes. Thus, the research suggested that the intervention program for children with ADHD should focus on alleviating parents' parenting pressure, e.g., offering coping strategies for parents. In addition, the study reported that the novel smartphone-based measure was valid to measure daily parent-child behaviors and the consistency of parental behaviors. The measure used a smartphone application platform, on which parents filled out a mobile survey about their interaction with their children on that day every evening for a week. In addition, the momentary smartphone-based measurement was useful for measuring parent-child interactions. Smartphones were used by parents often, so it was convenient for parents to record their daily interaction with their kids. As a result, moment-to-moment measurement is a useful method to record and monitor the interactions between parents and children.

Mindfulness is considered a possible treatment for parents and children with ADHD. In mindfulness practice, parents and children learn to be still and focus on their body or breath to bring their minds back, so that they can concentrate on the present moment. Bögels and his colleagues examined the effects of the family mindfulness-based treatment "MY mind" on children and their parents. The research adopted a pragmatic quasi-experimental waitlist design for the participants who are children aged 7 to 19 diagnosed primarily as ADHD and their parents [19]. Parents' emotional status was found significantly related to the interactions between parents and their kids with ADHD. For example, if parents are stressed, overreactive, impatient with children's behaviors, then their kids are more likely to show ADHD related behaviors. Furthermore, mindfulness was reported positive in alleviating parents' stress. Additionally, the study found that it was mindfulness intervention that had been substantiated to effectively diminish the ADHD symptoms, e.g., reducing the impulses and anxiety in children with ADHD. The researchers found that the MY mind program was equally effective across gender (i.e., male and female) and age (i.e., children and adolescents). Plus, the mindfulness treatment had long-lasting effects of at least one year on decreasing children's and parents' ADHD symptoms. Given the benefits of mindfulness practice, researchers suggested the practice could be applied to ADHD families in which parents could do mindfulness practice with their children daily. Therefore, mindfulness

intervention can be a useful tool for helping parents maintain a stable, calm, and peaceful state which could further improve parent-child relationships.

Aside from the face-to-face intervention, online mindfulness treatment may be the novel replacement for parents of children with ADHD during the COVID-19 pandemic. Mindfulness intervention is a long process and requires a strong time commitment, which posed new challenges for parents to make traditional off-line meetings. Research by Leitch et al. studied the feasibility, acceptability, and the preliminary effects of mindful parenting programs (Parents that Mind (PTM)) for children with ADHD [20]. The design of PTM aimed to enable parents to interact with their children in a non-judgmental way, care about their child's difficulties, and respond rather than react impulsively to their child [21]. The PTM usually lasted for five weeks, including two face-to-face group retreats and a five-week online home practice through a PTM App. The results showed that parents reported high acceptability and satisfaction with PTM. Firstly, the feasibility of parents attending one face-to-face session was also high according to the results. All interviewed parents thought the mindfulness program was useful and deserved recommendation because this program can help reduce their parenting stress, mental difficulties, and improve their relationship with their kids. The PTM had benefits for children as well, including reduced ADHD symptoms for both internalizing and externalizing symptoms. Compared with home practice, face-to-face sessions are preferred by most parents. Parents reported the benefits of sharing experiences and building connections with other parents during the off-line activities. Whereas, the attendance of the off-line meetings was not as promising as the feedback, nearly half of parents did not attend the second retreat because of the lack of time, work, exhaustion. Notably, some parents reported that the online mindfulness practice using the App was more desirable because of the convenience of engagement. Thirdly, regarding the effects of this program, it was shown that PTM could improve parenting stress, parent-child conflict, and mental health condition of both parents and children. Although face-to-face and online mindfulness practice are equally effective, online mindfulness treatment is more convenient, flexible, and accessible. Thus, online mindfulness treatment is a prospective way to provide assistance for parents to interact with their kids appropriately and enable more parents to get access to mindfulness resources without time and space barriers.

4. FACTORS IMPACTING THE EFFECTIVENESS OF ICT AND DIRECT USE OF ICT FOR ADHD

It is well-known that implementing ICT interventions are effective with ADHD children. However, research that attempted to replicate the program outcome has

produced similarly inconsistent findings. Therefore, it is reasonable to assume that certain factors might affect the success of the ICT interventions for ADHD, and further research was conducted to underpin the key factors affecting the reduction of ADHD behavior and ineffective parenting using online parenting programs [22]. According to Day and colleagues, four predictors were reported to relate to the significant reduction in both child behavioral problems and dysfunctional parenting, which were program intensity, program completion, level of severity in ADHD, and parental self-efficacy respectively [22]. Researchers collected data of seven published trials of the Triple P, which included families with children aged between 2 and 12 years. The Triple P (Positive Parenting Program) achieved a significantly positive effect in both decreases in ADHD disruptive behaviors and ineffective parenting [10]. The Triple P is an 8-module self-directed intervention conducted online by parents. Two variables of Triple P were also included in the seven trials, which are an enhanced version with professional support and a brief version with 2-5 modules only [10]. First, unlike what was expected, the program intensities did not predict incremental improvement in ADHD behaviors or ineffective parenting. Whereas, programs of greater intensity, or with supports for longer-term engagement might have enhanced outcomes. Secondly, the program completion was observed creating a strong decrease in child behavior problems and dysfunctional parenting at post-intervention. Moreover, completing the minimum recommended number of modules, regardless of program variant, was related to the maintenance of improvements in dysfunctional parenting at follow-up. These findings implied that the improvement is more strongly related to contact time, or dosage, rather than program content. Thirdly, a higher level of severity in child behavior difficulties or dysfunctional parenting at baseline reported greater reductions in these areas following the program. Notably, significant improvement was only observed at standard programs, the brief version of Triple P. Last but not the least, parental self-efficacy was demonstrated successfully predicting more improvement in child behavior problems and dysfunctional parenting over time. Furthermore, parents with more adjustment difficulties, such as depression, showed significantly less improvement in both areas [10]. Notably, all sociodemographic variables of participants, including children, parents, and their relationships failed to affect both children's behavioral problems and dysfunctional parenting significantly. This finding implied that online programs can be universally effective for parents from diverse sociodemographic backgrounds, which promised broader application in the future.

Working memory, featured with the dual processing, involves operating on information while concurrently storing the same or different information, continuous updating refers to the active addition and deletion of items from working memory, and serial reordering refers to the mental manipulation of temporal or sequential order [23]. Working memory deficits are present in a substantial portion of ADHD children. Further, research indicated that working memory deficits in ADHD have a pervasive influence on impairments in academic, social, organizational, and family functioning [24]. Unlike the impulsivity, working memory deficits showed limited improvement with interactive interventions. Direct use of ICT in ADHD children might be more effective compared with parenting training at Working memory deficits in particular. Recent research on Behavioral Parent Training (BPT) failed to produce a significant elevation of working memory capacity. Kolfer and colleagues hypothesized that this discrepancy is because the current BPT failed to target the working memory sufficiently [25]. BPT focuses exclusively on STM (simple storage/rehearsal) rather than the dual processing, which is specifically characterized by the working memory construct. Therefore, Central Executive Training (CET), which is a software-based treatment protocol directly designed for children, was introduced to provide specific training in the working memory compared. Children with ADHD ages 8 –13 and their parents were recruited and assigned to CET and BPT programs separately. Results suggested that CET was feasible in improving the working memory, as well as was superior to BPT outcomes at post-treatment. Moreover, CET was also rated as highly usable and acceptable to both parents and children, which was equivalent to BPT. The results indicated that CET is not only effective in improving the key deficit of ADHD but also a superior online intervention compared with traditional offline behavioral interventions.

Even though the research demonstrated that the direct use of ICT interventions in ADHD children from 3-8 years-old are effective, many children reported the difficulty in completing the interventions on their own. Researchers proposed the possibility of implementing ICT, such as smart device, to maximize the intervention retention. Further investigation was conducted by Cibrian et al. to explore the Digital Health Intervention (DHI) implementing smart devices on ADHD children from 10 to 15 years old [26]. The DHI included a smartwatch and a smartphone with synchronized Google calendars across devices to guide children through daily schedules and support their schoolwork. Parent interviews were followed to evaluate the use of smartwatches and the impact on children's functioning. It was designed to facilitate children's organizational skills, involved in the regulation of goal-directed behavior and including abilities, such as attentional control, strategic planning, organization, and cognitive flexibility. At the same time, parents were able to monitor children's daily routine and adjust accordingly based on the data generated by the smartwatch. Positive results were observed that children with ADHD can wear and

charge a smartwatch regularly, and successfully adopted the support and schedule provided. In addition, parents believed the intervention was helpful, especially in supporting the development of organizational skills in their children. In general, the research provided professional practitioners with future directions of how even simple DHIs, e.g., using smartwatches to promote the daily organization and task completion, have the potential to support children and families, particularly during periods of distance learning [26].

5. LIMITATION AND FUTURE DIRECTION

The existing studies mainly focused on the short-term effects of ICT parent training on children with ADHD. Accordingly, future research can carry out long-term follow-ups, such as longitudinal research studies. Moreover, the current research primarily measured the effectiveness of a certain ICT application on ADHD. Therefore, in the future, researchers can systematically explore how to combine different ICT applications to provide better virtual intervention programs for ADHD comprehensively. In terms of the previous reviews and empirical studies, children with ADHD were mainly studied in group interventions. As a result, future research can continuously explore the individualized intervention methods for children with ADHD.

6. CONCLUSION

ICT interventions, such as the videoconferencing is useful and effective for parent training for ADHD. Increasing the use of videoconferencing is likely to boost parents' confidence in their parenting skills and enables them to use positive and effective parenting skills more frequently. As supported by previous studies, telepsychology is a high-quality approach to the treatment of ADHD, which could meet parents' needs during the COVID-19 pandemic. Therefore, it is realistic to expect telepsychology to be used to a wider extent and scope in the treatment of ADHD. However, more efforts could be made in the validity of apps and the efficiency of technology-based therapies, as data revealed that these applications may not sufficiently address the multifarious demands of the parent group.

Compared with the traditional remote intervention that relied on parents' memories of their interactions with their children, a novel moment-to-moment measurement is a more objective method to record information. The use of ICT device is also more effective in recording and monitoring interactions between parents and children. In addition, mindfulness interventions can help parents maintain a steady, calm, and tranquil emotional status, thus reducing the parental stress level. Therefore, online mindfulness treatment could be a promising way to improve the quality of parent-child connections.

Online programs can be universally effective for parents from a wide range of socioeconomic backgrounds, which bodes well for future applications. CET was not only as effective as traditional off-line behavioral interventions on improving behavioral problems, but also presented superior outcomes on treating the working memory deficit in ADHD. Even though research has shown that using ICT therapies directly in ADHD children aged 3 to 8 years old is effective, many children have expressed difficulty in completing the sessions on their own. Therefore, the implementation of DHIs is worthy further exploration.

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