American Journal on Intellectual and Developmental Disabilities

Mindfulness and Psychoeducation are Associated with Improved Perceived and Physiological Health Outcomes in Caregivers of Children with Autism

--Manuscript Draft--

Manuscript Number:	AJIDD-D-24-00007R2
Article Type:	Research Report
Keywords:	Autism; Caregiver Stress; Mindfulness; Psychoeducation
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Abstract

Bidirectional effects between parent emotional experience and child outcomes are highlighted in families of children with developmental disabilities, including autism. Parents of autistic children also experience less favorable outcomes than the general population on objective health measures, including arthritis, cardiovascular risk factors, and stress response. Interventions including behaviorally-oriented and mind-body programs are associated with decreased stress and increased mental health. This study extended previous research by systematically evaluating outcomes in a larger sample and obtaining objective measurement of health outcomes. Caregivers (n=22) of autistic children (aged 5-12) were randomized to group psychoeducation or mindfulness program for 8 weeks. Psychological and physiological measures were obtained at baseline and exit, including heart rate variability (HRV), sleep, parental stress, and perceived health. Both groups demonstrated improvement in outcomes for HRV, perceived parental stress, and perceived global health. The mindfulness group showed an advantage on certain outcomes, including root mean squared successive difference (RMSSD), somatization, and perceptions of their child's behavior as difficult. No changes in sleep outcomes were noted. While preliminary, these results highlight the promise of short-term interventions for improving multiple aspects of the health experience for caregivers of autistic children. Findings warrant replication in larger, more definitive clinical trials.

Keywords: Autism, Caregiver Stress, Mindfulness, Psychoeducation

Introduction

Parenting Stress and Health in Autism

The well-being of parents of children with autism[1] is paramount, considering the bidirectional effects between parent emotional experience and child outcomes that have been highlighted in families of children with developmental disabilities (Staunton, Kehoe, & Sharkey, 2023) and those with autism (Al-Oran & Khuan, 2021; Voliovitch et al., 2021). The parenting experience for any child often brings great joy along with its challenges (Herbst & Ifcher, 2012). In the context of the ups and downs of any parenting experience, parents of autistic children report higher levels of stress and affective symptoms compared to parents of other children, including those with disabilities and chronic illness (Abbeduto et al., 2004; Staunton, Kehoe, & Sharkey, 2023). Beyond affecting *parent* experience, caregiving stress and other health needs can worsen important *child* outcomes, including behavior problems (Al-Oran & Khuan, 2021; Olson et al, 2022), child response to behavioral treatment (Osborne et al., 2008), family functioning (Streisand, Kazak, & Tercyak, 2003), and medication adherence (DeMore et al., 2005). Broader implications of psychological and physical distress associated with caregiving children with healthcare needs might include negative public health outcomes, such as reduced preventive care, more days sick, increased use of other healthcare (Kiecolt-Glaser, et al., 1991), and interference with parents' ability to engage in self-care and effectively care for their children. For example, studies have identified negative financial impact of parenting a child with autism, including documented loss of earnings that have been estimated at over $10,000 per year per caregiver (Liao & Li 2020; Moore, Zhu, & Clipp, 2001). Addressing the experience of caregivers could also have implications for child outcomes. For example, caregivers who engaged in treatment to reduce stress and increase engagement demonstrated increases not only in parent treatment engagement but also child adjustment (Melnyk et al., 2004).

For years, the majority of the extant research on health outcomes in parents of children with

[1] We recognize that preferences for the use of person first versus identity-first language can vary greatly within the autism self-advocacy community. To respect diverse preferences, we alternate between both in this paper.

intellectual and developmental disabilities involves subjective measurement of stress and health, and this approach is still represented in current literature (Al-Oran & Khuan, 2021; Lopez-Wagner et al., 2008; Olson et al, 2022). Increasing research in this population has suggested that parents experience less favorable outcomes than parents in the general population on more objective measures of health and stress, including arthritis (Yamaki, Hsieh, & Heller, 2009), cardiovascular (CV) risk factors (Yamaki et al., 2009), BMI (Seltzer et al., 2011), and cortisol reactivity (Seltzer et al., 2010). Further, parents of autistic children exhibit abnormal metabolic profiles (Hollowood-Jones et al., 2020; James et al., 2008), which are established risk factors for CV disease, neurodegenerative diseases, and autoimmune diseases. Functional measures of health are strongly linked to the development of disease (e.g., CV and metabolic disease) over time. For instance, heart rate variability (HRV; variation in interbeat intervals) represents the body's ability to respond to stress, is influenced by chronic stress (Horsten et al., 1999) and is linked to CV disease development (Tsuji et al., 1996). Emerging research suggests that mothers of children with autism can show increased heart rate and cortisol response upon stress testing, as compared to mothers of children without autism (Pattini et al., 2019), indicating increased physiological reactivity in this group. Fathers of children with autism may also be at risk for elevated HRV and CV risk (Foody, James, & Leader, 2015). In addition to direct effects on stress, HRV is associated with other health-implicated factors, such as sleep quantity and quality. In a recent study, both HRV and sleep exerted effects on the relationship between stress and mental health in caregivers (Chelsea da Estrela et al., 2021), and sleep outcomes have shown improvement upon intervention in caregiver samples (Hasuo, Kanbara, & Fukunaga, 2020).

Despite efforts to more systematically utilize objective health measures, this overall body of literature is limited, and few studies have examined these outcomes in parents of children with autism, particularly as they related to participation in interventions. Parent training programs are associated with improvement in *parent-reported* stress and health (Allik, Larsson, & Smedje, 2006; Iadarola et al., 2018; Tarver et al., 2019). However, the dearth of objective health-related outcomes is a significant limitation to the literature.

Parent Support Interventions in Autism

Behavioral and Psychoeducational Interventions. Various parent support and/or education interventions have been developed, with variable empirical evidence. Programs to teach caregivers behavioral strategies are associated with positive effects for parents of autistic children (e.g., reduced stress, increased sense of competence) and children (e.g., decreased irritability, decreased challenging behavior; Bearss et al., 2015; Iadarola et al., 2018; Tarver et al., 2019). Psychoeducational interventions focus more on general parental support and education about the diagnostic and service landscape, as compared to specific skills. Often used as a comparison condition in randomized trials, recent research suggests that psychoeducation can be a useful intervention in its own right (Magaña, Lopez, & Machalicek, 2017; McAleese, Lavery, & Dyer, 2014), although less effective in some trials for changing specific parent stress and child outcomes in autism, compared to structured parent training programs (Iadarola et al., 2018; Kasari, et al., 2015).

Mindfulness-Based Interventions (MBI). Mindfulness encompasses a body of techniques that emphasizes awareness of thoughts, beliefs, and feelings, the objective of which is to change an individual's relationship to and experience of distressing sensations. MBI is evidence-based for psychological and physiological outcomes in the general and clinical populations (Heckenberg et al., 2018; Morone, Greco, & Weiner, 2008; Scott-Sheldon et al., 2020). Further, MBI is positively associated with immune function (Alhawatemah et al., 2022), CV functioning (e.g., heart rate; Ditto, Eclache, & Goldman, 2006), blood pressure (Carlson et al., 2007), mortality (Schneider et al., 2005), and HRV (Ditto et al., 2006; Scott-Sheldon et al., 2020; Wu & Lo, 2008). Psychologically, MBI has specific implications for parents of autistic children because predictors and moderators of stress in this group (e.g., parental avoidance, distancing, directiveness, lack of perceived control (Dunn et al., 2001; Hastings et al., 2005) are not necessarily targeted by behavioral or psychoeducational treatments. Over the years, MBI has gained empirical support for parents of children with autism (Lunsky et al., 2017; Weitlauf et al., 2020). Current research primarily includes self-report outcomes; however, considering the emerging evidence regarding health differences, there is a need to directly measure health outcomes in this group. The

relationships among the functional measures of health, psychological functioning, external stressors, and stress reduction-based interventions suggests that MBI may exact physiological health benefits in parents. Psychological benefits may be mediated through changes in functional measures of health, which directly influence each other as well as the body's response to external stressors. Alternatively, reduction of distress may improve physiological functions such as HRV and sleep, which subsequently affect the individual's immune response, as well exert beneficial effects on the individual's cognitive processes (i.e., parent is more well-equipped to engage in positive coping strategies).

The Current Study

In previous work, we evaluated the feasibility of running mindfulness-based group interventions for parents of children with autism with an active comparison group (Ferraioli & Harris, 2013). Results supported the feasibility of the proposed interventions and provided initial support for further research. This study aims to extend previous research by 1) systematically evaluating outcomes in a larger sample and 2) obtaining objective measurement of health outcomes. By measuring the potential effects of treatment on parent-reported *and* objective measurement of both psychological and functional measures of health outcomes, we aim to inform translational analyses of how interventions affect parents of children with autism, thereby providing important information on how to maximize the benefits of and access to supportive programs for this population.

Methods

Study Design

A small, randomized trial was conducted, in which participants were assigned to one of two group-based interventions (i.e., MBI or psychoeducation [PEI]). The MBI group was considered the experimental group. The PEI group was chosen to control for a) the non-specific treatment effects of participation in group-based interventions, b) the positive outcomes seen in PEI interventions in previous research; and c) access to a professional with expertise in autism.

Recruitment and Inclusion/Exclusion Criteria

Participants were eligible if: 1) they self-identified as the primary caregivers of a child with a previous diagnosis of autism; 2) their autistic child was age 12 or younger; and 3) they scored above the clinically significant cutoff (i.e., 90th percentile) on a standardized measure of parenting stress (i.e., Parenting Stress Index, 3rd Edition – Short Form; PSI-SF). Only one parent from each household was eligible to participate in the study, to control for the confound of potential additional practice effects in families where both parents would have received intervention. Exclusion criteria were: 1) Limited English Proficiency (given that the groups were facilitated in English and there were no bilingual therapists); and 2) not being the legal guardian for the child with autism. Recruitment occurred through a local developmental disabilities diagnostic and clinical services center, as well as dissemination of research flyers through community-based avenues (school districts, private agencies, social media). Potential participants were also identified through a local research registry for autistic children and their families.

Participants

We enrolled 22 participants, with 10 participants in the PEI group and 12 participants in the MBI group. Participants primarily identified as female, with a mean age of 40 years. The majority of participants identified as women, white and Non-Hispanic/ Latine. This sample included some diversity in education and family income; most participants were married (65%). See Table 1 for participant characteristics by group. There were no baseline group differences on any demographic variables.

Procedures

Interested participants attended a baseline visit, conducted in the Exercise Physiology and Kinesiology lab at an academic medical center. Baseline visits included the informed consent process, confirmation of child diagnosis via record review, completion of caregiver self-report forms (via Research Electronic Data Capture link), and collection of functional health measures (i.e., blood pressure, height, weight, and resting HRV). Resting HRV was obtained using the Firstbeat device, which includes two electrodes and the measurement device. Electrodes were placed on clean skin, with one lead under the collarbone, and one lead on the left side of the body, just under the rib cage. Participants were asked to sit

still for 20 minutes in relative quiet and asked to "try to clear your mind and relax." Although a full 20 minutes' worth of data were recording, these readings were later trimmed 5 minutes at the beginning and the end, leaving a 10-minute reading that was used in data analysis. This is double the minimum recommended recording length for short-term observations (Catai et al., 2020). At the baseline visit, participants were also given their Actiwatches, which were used to collect sleep data. Participants were asked to wear the watch on their non-dominant hand, 24-hours per day, for 7 days (excepting when showering and swimming). The watches were accompanied by a daily diary, on which participants were asked to record items related to sleep (e.g., time went to bed, time awoke, estimated time to fall asleep) as well as exercise (e.g., type and duration of exercise, perceived exertion).

Following baseline and eligibility determination, participants were randomly assigned to MBI or PEI. Once a full cohort (i.e., all consented participants) was randomized to MBI or PEI, the groups were scheduled; both groups ran concomitantly for each of two cohorts. Groups were offered in the evenings, at a community location with free parking. Both interventions consisted of eight weekly meetings of two hours each and were conducted in groups of 6-8 parents. Group leaders included master's or doctoral-level clinicians with experience in autism and parent training and/or mindfulness, and all groups were either co-facilitated or supervised by a licensed psychologist.

To ensure that the interventions were delivered with adequate fidelity, group leaders completed treatment fidelity checklists on the main discussion topics, exercises, and activities that are outlined in the treatment manual for each session. To demonstrate reliability, 20% of sessions for each group were randomly selected to be coded by independent observers. Per the fidelity process, any group leaders whose fidelity ratings fell below 80% received additional training. The average number of sessions attended for MBI was 7.5 (range 6-8). The average number of sessions attended for PEI was 7.25 (range 6-8).

Outcome measures were collected at two time points (i.e., baseline, T1 and post-treatment, T2;) for self-report measures and functional health outcomes. Participants were paid $25 each for their completion of the T1 and T2 assessments. All participants provided written informed consent, which was reviewed in person by study staff. Study procedures were approved and monitored by the institution's

Research Subjects Review Board.

Interventions

Mindfulness-Based Intervention (MBI). This program was adapted primarily from the 8-week course outlined in Segal, Williams, and Teasdale's book on mindfulness-based cognitive therapy for depression (Segal, Williams, & Teasdale, 2018), with some elements of the mindfulness module of Linehan's skills training manual for borderline personality disorder (Linehan, 1993). The primary intervention goal is for subjects to incorporate mindfulness techniques into their daily lives. Five core mindfulness skills (observing, describing events and personal responses; nonjudgmental acceptance; distancing from thoughts; staying present; and being effective) are addressed throughout the program. Each session includes orientation to the current skill, practice exercises, group discussion, and homework to be reviewed in the following week. Subjects are encouraged to engage in ongoing practice of the skills learned throughout the program and then share these experiences and how they relate to their children with autism. See Supplementary Materials for intervention outline.

Psychoeducational Intervention (PEI). PEI includes a systematic presentation of topics such as the definition of autism, understanding and interpreting clinical evaluations, medical considerations, developmental concerns across the life span, school placement, the role of advocacy groups, current treatments and service options. This intervention was adapted from the psychoeducational model used in an ongoing, multi-site parent training study at the study site (Scahill et al., 2016) on the following dimensions: a) to accommodate a group delivery model, and b) to align with the program format of two-hour weekly sessions across eight weeks. See Supplementary Materials for intervention outline.

Interventionists and Training. Both interventions were conducted by postdoctoral-level providers with backgrounds in psychology and other mental health related fields, who had respective experience in autism, parent education, behavioral intervention, and mindfulness. For both conditions, interventionists utilized a structured manual that included scripts, major objectives, and activities for each session.

Therapists were trained to fidelity through watching videos of the interventions, co-facilitating groups, then facilitating groups independently with ongoing supervision (including review of videorecordings).

Measures

Physiological Stress Response via Heart Rate Variability (HRV): HRV data is a physiological assessment allowing us to evaluate a person's capacity to respond to stress by returning the body to homeostasis. Data were collected using the Firstbeat® system, a portable device for measuring heart-rate that also measures R-R intervals with a rating sample of 1ms, which has been validated in clinical research (Parak & Korhonen, 2013). HRV outcomes included root mean squared successive difference (RMSSD) and LF/HF ratio. The Root Mean Square of Successive Differences (RMSSD) is time-based, measures interval differences, and is sensitive to short-term HRV changes. Low RMSSD values are suggestive of poor vagus-mediated HRV. It is considered a measure of autonomic nervous system activity and is negatively associated with health risk, such as sudden unexplained death in epilepsy (Shaffer & Ginsberg, 2017). LF/HF ratio represents the calming down of a person's physiological response after a stressor. This ratio is a frequency domain measure of LF (total spectrum power of all NN intervals between 0.04 to 0.15Hz), HF (total spectrum power of all NN intervals between 0.15 to 0.4Hz). LF/HF ratio represents the ratio between sympathetic and parasympathetic activity; it represents dominance of sympathetic activity and overall energy conservation. These outcomes were chosen because they are considered appropriate for short-term (i.e., less than 15 min) measurements (Camm et al., 1996).

Sleep Outcomes: Sleep outcomes (i.e., sleep efficiency, total sleep time, total night awakenings, wake after sleep onset [WASO]) were objectively assessed prior to and following the intervention via actigraphy monitoring. The Actiwatch-64 device is used in research and clinical settings to detect and record wrist motion of human subjects during wake and sleep periods (Weiss et al., 2010). The Actiwatch operates by registering changes in motion, which are recorded on board the device in non-volatile memory (i.e., the data are preserved even if the battery becomes exhausted). The recorded data are then transferred to a personal computer and can be subsequently analyzed to quantify activity during intervals characteristic of

both wake and sleep. Consistent with best practices for cleaning and filtering data, we manually entered parent-reported bedtime and waketimes to identify the sleep parameters. Data were trimmed to ensure that the algorithm only focused on intended data collection intervals. Actograms were visually reviewed to ensure consistent weartime, and any non-weartime of 2 or more hours was excluded from the analysis. Epoch lengths were set at 1 minute, following best practices for the Actiwatch (Mitter, 2006). Analyses were conducted via Actiware software algorithms and the standard activity statistics for sleep efficiency, WASO, total sleep time, and awakenings.

Parenting Stress Index – Short Form (PSI-SF) (Abidin, 1995) is a parental self-report measure assessing parenting stress. It includes 36 items relating to parental feelings and experiences, comprising constructs of Parental Distress, Parent-Child Dysfunctional Interaction, and Difficult Child Characteristics. Caregivers rate items on a 5-point Likert scale and include statements such as, "Since having a child I feel that I am almost never able to do things I like to do," and "Most times I feel that my child does not like me and does not want to be close to me."

General Health Questionnaire (GHQ) (Goldberg, 1978) is a 28-item, self-report measure of global health, comprising four subscales (somatic symptoms, social dysfunction, anxiety/insomnia, and depression). Participants use a 4-point Likert scale to rate statements regarding their health over the past few weeks, including questions such as, "Have you felt that you are ill?" and "Have you been able to enjoy your normal day-to-day activities?"

Statistical Analysis Plan

Our primary data analysis was based on intention-to-treat (ITT) analysis, including all assigned participants. We replaced missing data by using multiple imputations, and an automatic method was selected, which uses the monotone method if the data show a monotone pattern of missing values; otherwise, fully conditional specification was used (Van Buuren, 2007). Shapiro-Wilk and Levene's tests were used for deciding the violation of assumption test of normality and homogeneity of parametric test for detecting all the outcome variables based on the grouping variable (PEI and MBI) (Levene, 1960;

Shapiro & Wilk, 1965). Non-parametric tests were performed when the data with violation of normally and homogeneity assumptions. Descriptive statistics was calculated regarding the distribution of outcome variables based on two group participants' characteristics. Baseline differences between the groups of MBI and PEI were detected by using independent t-tests or Mann-Whitney U test. We evaluated participants' differences in improvement on psychological and physiological outcomes by comparing the outcomes on two levels: the within-group level and the between-group level. Paired t-tests and Wilcoxon Signed Ranks Tests was to investigate the within-group level difference. Then, the independent t-test or Mann-Whitney U test was used for determining the between- group level difference based on the score difference between time one (pre-intervention) and time two (post-intervention). All p-values were two-sided with significance set at 5%. Effect sizes of parametric tests were calculated in SPSS using Hedge's g, and effect sizes of nonparametric tests were calculated by r = Z/sqrt(n). Last, we conducted complete cases (CC) analysis to access the robustness of the findings or conclusions based on our primary data analyses; the CC analysis can often be considered as part of sensitivity analyses supplementary to MI (Li & Stuart, 2019). All these tests were calculated using IBM SPSS v.28.

Results

Within-Group Comparisons over Time

PEI Within-Group Comparisons: With respect to within-group comparisons over time (i.e., T1; pre-intervention and T2; post-intervention; Table 2), PEI participants experienced statistically significant improvements in HRV (i.e., an important marker of healthy stress response) at T2 compared to T1, including higher RMSSD scores, (z=-2.549, p=0.011) and lower LF/HF Ratio scores (z=-2.549, p=0.011). Higher RMSSD indicates that a better ability to control your stress response, and a lower LF/HF Ratio indicates a better ability to calm down after a stressor. With respect to parent report measures, the PEI group showed significantly lower scores on the Parental Distress subscale of the PSI-SF (z=-2.497, p=.013), the Parent-Child Interaction subscale (z=4.64; p=.001) as well as on the overall PSI Total Score (t =3.468, p=.007). In addition, participants in the PEI group experienced significant decreased on the

Anxiety/Insomnia subscale on the GHQ, (t=2.807, p=.020). There were no differences on sleep outcomes over time.

MBI Within-Group Comparisons: For participants in the MBI group, there were significant decreases in LF/HF ratio over time (z=-2.197, p=0.028), indicating improved ability in this group to return to homeostasis following a stressor. This group also experienced decreases on all three subdomains of the PSI-SF (Parental Distress, z=2.621, p=.009; Parent-Child Interaction, t=2.976, p=.013; Difficult Child, z=2.621, p=.001), as well as the Total Stress score (t=4.08, p=.002), with an overall decrease of 18.37 points at T2. Unlike the patterns seen in the PEI group, those in MBI reported more within-group overall improvements across GHQ domains, including Somatic (t=2.461, p=.032), Anxiety/Insomnia (t=3.297, p=.007), and Social Dysfunction (z=-2.358, p=.018). In combination, these contributed to an overall significant reduction in GHQ total score (t=4.234, p=.001). No within-group differences were observed on any sleep outcomes.

Between-Group Comparisons

There were no significant baseline differences in outcome variables found between the two groups at the 95% significant level (see Supplementary Materials). For comparisons from T1 to T2, positive scores indicate that the post-intervention score is lower than the pre-intervention score. As seen in Table 4, for both groups most of the mean or median outcomes scores were positive (i.e., decreased at T2). Those in the MBI group showed increases in RMSSD (M=-3.22, SD=5.91) as compared to the PEI group (M=-10.46, SD=9.66; $p<.05$). However, other than RMSSD, there were no significant group differences. The estimated effect sizes for within group comparisons are demonstrated in Table 3. Both groups demonstrated large effect sizes, ranging from .82 to .95 (PEI), and .80 to 1.28 (MBI).

Complete Case Analysis

To ensure integrity of the data, even with missing values, Complete Case (CC) analysis was conducted. Overall, the results of CC analysis were aligned with the ITT analysis, it reveals that MBI intervention worked better in GHQ than PEI intervention. The only difference in patterns were as follows.

Based on CC analysis, there were no statistically significant within-group change over time on the GHQ-related scales or on the Parental Distress subscale for the PEI group participants. Additionally, CC analysis revealed that in the PEI group there was significant difference over time for the Difficult Child subdomain (t=3.524, p=.010), which was not also found in the ITT analysis.

Discussion

This study expanded the literature on parent experience raising an autistic child by evaluating the effects of group-based interventions on both physiological and self-reported health outcomes. While both group programs – including a mindfulness intervention and a psychoeducational intervention – experienced improvements in sympathetic activity (i.e., LF/HF ratio), group differences revealed that the mindfulness group showed significantly higher increases in parasympathetic activity (i.e., RMSSD) post-intervention. Findings suggest that those participating in either group were better able to calm down following stressful events, after receiving intervention. However, only those participating in mindfulness experiences increased autonomic activity, meaning they were better able to cope with stressful events. Both groups were associated with improvements in aspects of reported parental stress and general health over time. Only the mindfulness group demonstrated significant change on perceptions of difficult child behavior, somatization, and aspects of social dysfunction, suggesting that there was a slight advantage to participation in this group for self-reported outcomes. These patterns align with previous research on self-reported stress outcomes in caregivers of children with autism, in which mindfulness-based stress reduction was superior to a psychoeducational intervention, even in the context of overall gains in both groups (Ferraioli & Harris, 2013; Lunsky et al., 2017).

It is unsurprising that mindfulness intervention was associated with improvements in HRV constructs, including increased parasympathetic activity and decreased sympathetic dominance. As a measure of physiological (and theoretically, psychological) self-regulation, HRV directly related to targets of mindfulness-based interventions (e.g., attentional awareness, emotional regulation). A recent scoping review on mind-body interventions supports the benefits of mindfulness practice on HRV

(Christodoulu, Salami, & Black, 2020), although the authors note the need for more standardized measurement. While the direct implications of shifts in HRV can be variable, they are related overall to reduced cardiovascular health risks, which may already be elevated in caregivers of children with autism. As such, mindfulness intervention may help mitigate negative long-term health consequences. It was less expected that the psychoeducational intervention would influence change in HRV. It is possible that improvements in RMSSD were mediated through associated improvements in psychological outcomes, specifically decreased parental distress and decreased perception of negative parent-child interactions. With a small sample size, we may have been underpowered to detect change; it is therefore encouraging that observed effect sizes for both groups were large, indicating meaningful improvements in psychological and physiological outcomes.

No changes in sleep outcomes were observed. It is possible that the 8-week intervention period may have been too short to exert effects. Additionally, sleep disturbances for caregivers of autistic children are strongly influenced by child characteristics (e.g., sleep, behavior, irritability), which we did not target in either program (Bangerter et al., 2020).

Limitations

Although we adjusted the analysis plan accordingly, the small sample size reduces faith in the replicability of the findings, as well as power to detect change in some of the outcomes associated with nonsignificant findings. Research on HRV and related health outcomes in caregivers of autistic children is emerging, but larger scale studies exploring the relationship among various caregiver-focused interventions and physical health are needed to solidify these patterns. Further, in the context of a fairly small sample size, we did not conduct any validity (CFA) and reliability (Cronbach alpha) tests for measurement scales. Child measures were not collected; therefore, potential differences in caregiver experiences could not be explored in the context of child characteristics. The limited diversity of the participants is a significant limitation, with the majority of the sample representing white, educated, resourced women. Increasing representation of research samples is critical for ensuring external validity

of findings, as well as for promoting true equity in research and associated implementation of interventions available within diverse communities. Limited sample diversity has been specifically highlighted as a contributor to racial bias in autism research (Yee, 2016). Future strategies to mitigate this bias in autism caregiving research may include: 1) monitoring ongoing enrollment with respect to race, ethnicity, income, and heritage language; 2) engaging in specific outreach to historically excluded communities; 3) engaging community partnerships to ensure cultural responsiveness of intervention studies and to assist with recruitment; 4) partnering with community organizations that engage under-resourced families to develop meaningful relationships, and 5) utilizing specific engagement strategies in research, including providing stipends, transportation, childcare, and translation.

Conclusion

While quite preliminary, the overall findings suggest the promising nature of both mindfulness and psychoeducational interventions for improving aspects of caregiver experience in autism, including psychological functioning, physiological health functioning, and perceived health. Large-scale clinical trials are needed to provide more definite evidence of these patterns. The improvements observed in both groups warrant evaluation into mechanisms of change, as well as exploration of potential combination programs (i.e., those that include elements of both psychoeducation and mindfulness instruction). Intervention options that build knowledge and self-regulation skills may be critical to both promoting positive experience for caregivers of autistic children and improving aspects of physical functioning – all of which could reduce long-term health risks.

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Table 1. Participant Characteristics.

	All participants (N=22)	PEI (n=10)	MBI (n=12)
Age (M, SD)	40.00(6.79)	41.60(4.58)	38.67(8.16)
Number of Children (M, SD)	2.41(1.40)	2.40(1.35)	2.42(1.50)
Age of Child's first diagnosis (M, SD)	2.71(1.11)	2.50(1.18)	2.86(1.07)
Gender			
Female	20 (90.9%)	10 (100%)	10 (83.3%)
Male	2 (9.1%)	0	2 (16.7%)
Race and Ethnicity			
Hispanic/ Latine	2 (9%)	2 (20%)	0 (0%)
Not Hispanic/ Latine	20 (81%)	8 (80%)	12 (100%)
Indigenous	0 (0%)	0 (0%)	0 (0%)
Hawaiian/ Pacific Islander	0 (0%)	0 (0%)	0 (0%)
Asian	1 (5%)	0 (0%)	1 (8%)
Black/ African American	4 (18%)	2 (20%)	2 (17%)
White/ Caucasian	19 (86%)	9 (90%)	10 (83%)

Relation to child			
Biological parent	21 (95.5%)	10 (100%)	11 (91.7%)
Adoptive parent	1 (4.5%)	0	1 (8.3%)
Education Level			
Some high school	5 (22.7%)	2 (20.0%)	3 (25.0%)
Some college	4 (18.2%)	1 (10.0%)	3 (25.0%)
College graduate	11 (50.0%)	6 (60.0%)	5 (41.7%)
Graduate school	2 (9.1%)	1 (10.0%)	1 (8.30%)
Family Annual Income			
Under $10,000	1 (4.5%)	1 (10.0%)	0
$10,001-$25,000	4 (18.2%)	3 (30.0%)	1 (8.3%)
$25,001-$45,000	4 (18.2%)	2 (20.0%)	2 (16.7%)
$45,000-$60,000	3 (13.6%)	2 (20.0%)	1 (8.3%)
Above $60,001	9 (40.9%)	1 (10.0%)	8 (66.7%)
Prefer not to answer	1 (4.5%)	1 (10.0%)	0

Table 2. Within-Group Comparisons for Psychoeducation and Mindfulness-Based Intervention Groups.

	PEI (n=10)					MBI (n=12)				
	Time 1	Time 2	Within-group Comparison			Time 1	Time 2	Within-group Comparison		
	M (SD)	M (SD)	Mean diff (95% CI)	Statistics	Sig.	M(SD)	M(SD)	Mean diff (95% CI)	Statistics	Sig.
RMSSD	23.80 (14.16)	34.26 (17.85)	-10.46 (17.37, -3.55)	-2.549[w]	**.011**	21.86 (7.53)	25.07 (8.89)	-3.22 (-6.97,.54)	-1.726[w]	.084
LF/HF Ratio	166.52 (89.59)	107.35 (62.02)	59.17 (5.50,112.84)	-2.293[w]	**.022**	175.97 (65.05)	128.16 (66.95)	47.82 (11.53,84.10)	-2.197[w]	**.028**
Sleep Latency (mins)	28.08 (22.91)	19.54 (10.36)	8.53 (-7.66,24.72)	-1.07[w]	.285	20.18 (23.87)	18.08 (13.51)	2.11 (-15.24,19.45)	-.314[w]	.754
Sleep Efficiency (%)	76.73 (7.52)	82.11 (7.13)	-5.38 (-11.50,.74)	-1.988[t]	.078	77.49 (11.01)	80.33 (6.22)	-2.83 (-9.42, 3.75)	-.947[t]	.364
WASO (mins)	60.43 (22.71)	53.41 (27.87)	7.02 (-9.04,23.07)	.988[t]	.349	58.52 (32.00)	55.90 (19.31)	2.62 (-16.53, 21.77)	.301[t]	.769

Sleep Total (mins)	352.70	377.37	-24.67	-1.727[t]	.118	339.20	360.84	-21.64	-1.387[t]	.193
	(58.28)	(32.94)	(-56.98,7.64)			(66.33)	(54.07)	(-55.98,12.70)		
PSI: Parental Distress	39.90	30.51	9.39	-2.497[w]	**.013**	41.17	34.71	6.46	-2.624[w]	**.009**
	(7.11)	(7.68)	(3.02,15.76)			(6.18)	(8.31)	(2.29,10.63)		
PSI: Child Interaction	34.20	26.44	7.76	4.651[t]	**.001**	38.67	33.48	5.19	2.976[t]	**.013**
	(5.14)	(4.40)	(3.99,11.53)			(7.16)	(7.59)	(1.35,9.02)		
PSI: Diff Child	41.60	35.66	5.94	1.981[t]	.079	44.92	38.12	6.79	4.547[t]	**.001**
	(5.91)	(10.90)	(-.84,12.72)			(4.66)	(6.86)	(3.50,10.08)		
PSI Total	115.70	92.98	22.72	3.468[t]	**.007**	124.75	106.38	18.37	4.08[t]	**.002**
	(15.90)	(20.20)	(7.90,37.53)			(14.60)	(21.23)	(8.46, 28.28)		
CGSQ Objective Strain	2.94	2.59	.35	-1.423[w]	.155	3.05	2.82	.23	-1.299[w]	.194
	(0.94)	(0.74)	(-.18,.89)			(0.37)	(.59)	(-.10,.55)		
CGSQ Internalized Strain	3.67	3.29	.38	1.954[t]	.082	3.55	3.48	.07	.357[t]	.728
	(0.68)	(0.57)	(-.06,.82)			(0.73)	(.74)	(-.38,.53)		
CGSQ Externalized Strain	2.03	1.82	.21	.892[t]	.396	2.38	2.27	.10	.460[t]	.655
	(0.69)	(0.62)	(-.32,.73)			(0.38)	(.81)	(-.38, .59)		
CGSQ Total Strain	8.61	7.73	.88	1.78[t]	.109	8.98	8.36	.62	1.183[t]	.262
	(1.77)	(1.38)	(-.24,2.00)			(1.21)	(2.01)	(-.53, 1.76)		

GHQ Somatic	8.90	6.27	2.63	1.799[t]	.106	8.92	5.65	3.27	2.461[t]	**.032**
	(4.53)	(3.53)	(-.68,5.93)			(4.21)	(2.52)	(.35,6.19)		
GHQ Anxiety/Insomnia	10.30	6.13	4.17	2.807[t]	**.020**	11.00	6.34	4.66	3.297[t]	**.007**
	(4.52)	(3.44)	(.817.54)			(4.59)	(3.08)	(1.55,7.77)		
GHQ Social Dysfunction	7.90	7.4	.50	-.475[w]	.635	9.42	6.49	2.93	-2.358[w]	**.018**
	(2.23)	(4.21)	(-3.47, 4.46)			(2.97)	(3.58)	(.59,5.27)		
GHQ Severe Depression	2.20	1.14	1.06	-1.436[w]	.151	1.92	1.43	.49	-.983[w]	.326
	(2.35)	(0.92)	(-.49,2.60)			(2.02)	(2.27)	(-.55,1.53)		
GHQ Total	29.30	20.93	8.37	1.835[t]	.100	31.25	19.76	11.49	4.234[t]	**.001**
	(9.82)	(10.44)	(-1.95,18.69)			(9.92)	(8.45)	(5.52,17.47)		

n = number of participants, statistics given for [t] paired t-tests, [w] Wilcoxon Signed Ranks Test for within group differences.

Note: CGSQ = Caregiver Strain Questionnaire. GHQ = Global Health Questionnaire. PSI = Parent Stress Index. WASO = Wake After Sleep Onset.

Table 3. Estimated Effect Sizes for Pairs Between Two Groups.

	PEI (n=10)	MBI (n=12)
Variables	Effect size	Effect size
RMSSD	.81[r]	
LF/HF Ratio	.73[r]	.63[r]
PSI: Parental Distress	.79[r]	.76[r]
PSI: Child Interaction	1.41[H]	.83[H]
PSI: Diff Child		1.27[H]
PSI Total	1.05[H]	1.14[H]
GHQ Somatic		.69[H]
GHQ Anxiety/Insomnia	.85[H]	.92[H]
GHQ: Social Dysfunction		.68[r]
GHQ Total		1.18[H]

[H] Effect size was based on Hedges' correction
[r] Effect size was calculated as: r = Z/sqrt(n)

Note: GHQ = Global Health Questionnaire. PSI = Parent Stress Index.

Table 4. Between-group Comparisons.

Variables	PEI (n=10)	MBI (n=12)	Sig.
Weight (lb)	-2.5 [-5.25,.00]	-3.5 [-7.50,2.00]	.817[m]
RMSSD	-10.46 (9.66)	-3.22 (5.91)	**.043[t]**
LF/HF Ratio	59.17 (75.02)	47.82 (57.11)	.691[t]
Sleep Latency (mins)	8.98 [-13.33,25.4]	-3.03 [-13.76,7.87]	.468[m]
Sleep Efficiency (%)	-3.09 [-14.36,1.26]	.10 [-3.75,2.54]	.468[m]
WASO (mins)	5.38 [-8.27,23.44]	.19 [-18.09,12.77]	.429[m]
Sleep Total (mins)	-24.67 (45.16)	-21.64 (54.04)	.889[t]
PSI: Parental Distress	9.39 (8.90)	6.46 (6.56)	.385[t]
PSI: Child Interaction	7.76 (5.28)	5.19 (6.04)	.305[t]
PSI: Diff Child	5.94 (9.48)	6.79 (5.18)	.791[t]
PSI Total	22.72 (20.715)	18.37 (15.60)	.581[t]
CGSQ Objective Strain	.35 (.75)	.23 (.52)	.639[t]
CGSQ Internalized Strain	.38 (.61)	.07 (.72)	.304[t]
CGSQ Externalized Strain	.21 (.73)	.10 (.77)	.747[t]
CGSQ Total Strain	.88 (1.57)	.62 (1.80)	.719[t]
GHQ Somatic	2.63 (4.62)	3.27 (4.60)	.749[t]

GHQ Anxiety/Insomnia	4.17 (4.70)	4.66 (4.90)	.816[t]
GHQ Social Dysfunction	.50 (5.54)	2.93 (3.69)	.233[t]
GHQ Severe Depression	1.06 (2.16)	.40 (1.64)	.492[t]
GHQ Total	8.37 (14.43)	11.49 (9.40)	.548[t]

Data given as mean ± SD, or median [IQR]. n = number of participants, p-values given for [I] independent t-tests, [m] Mann-Whitney-U-tests to test for baseline differences between two groups.

Note: CGSQ = Caregiver Strain Questionnaire. GHQ = Global Health Questionnaire. PSI = Parent Stress Index. WASO = Wake After Sleep Onset.