



Contents lists available at ScienceDirect

Research in Developmental Disabilities

journal homepage: www.elsevier.com/locate/redevdis

Feasibility of an app-based mindfulness intervention among women with an *FMR1* premutation experiencing maternal stress



Jessica Ezzell Hunter^{a,*}, Charisma L. Jenkins^a, Valerie Grim^a, Sue Leung^a,
Krista H. Charen^b, Debra R. Hamilton^b, Emily G. Allen^b, Stephanie L. Sherman^b

^a Center for Health Research, Kaiser Permanente Northwest, Portland, OR, 97227, United States

^b Department of Human Genetics, Emory University, Atlanta, GA, 30322, United States

ARTICLE INFO

Keywords:

FMR1
Fragile X syndrome
Premutation
Mindfulness
Social anxiety

ABSTRACT

Background: Women who carry an *FMR1* premutation (PM) allele and are mothers of children with fragile X syndrome (FXS) experience elevated maternal stress. In-person mindfulness sessions have been shown to be effective in alleviating maternal stress-related outcomes among mothers of children with intellectual and developmental disabilities. Our prior studies indicate women with a PM are at risk of social anxiety, a potential barrier to in-person mindfulness sessions.

Aim: The main goals of this pilot study were to assess feasibility and adherence of an app-based mindfulness training program among mothers of children with FXS and to explore stress, social outcomes, and potential barriers to social support.

Methods: Participants (n = 18) completed questionnaires to assess stress and social anxiety, an app-based mindfulness program, and a semi-structured follow-up interview.

Results: Thirteen out of 18 (72%) participants completed the mindfulness program; of those, 10 (77%) found it helpful. Eight out of 18 (44%) participants met criteria for social anxiety and 11 (61%) reported having difficulties reaching out for help when needed. Women with social anxiety and those experiencing barriers to social support were more likely to find the program helpful.

Conclusions: This study provides guidance for future mindfulness-based interventions to alleviate maternal stress in mothers of children with FXS.

What this paper adds?

This is the first study to report on the use of a mindfulness-based intervention in mothers of children with fragile X syndrome. In addition, this is the first study to report on the use of a smart phone app-based mindfulness program in addressing elevated maternal stress among mothers of children with intellectual and developmental disabilities.

1. Introduction

Fragile X syndrome (FXS), the most common form of intellectual and developmental disability (IDD), is characterized by a range

* Corresponding author at: Center for Health Research, Kaiser Permanente Northwest, 3800 N. Interstate Avenue, Portland, OR 97227, United States.

E-mail address: Jessica.E.Hunter@kpchr.org (J.E. Hunter).

<https://doi.org/10.1016/j.ridd.2019.03.008>

Received 6 November 2018; Received in revised form 23 February 2019; Accepted 20 March 2019

Available online 05 April 2019

0891-4222/ © 2019 Elsevier Ltd. All rights reserved.

of cognitive and behavioral challenges, with roughly 50% of individuals with FXS having a comorbid diagnosis of autism spectrum disorder (ASD). (Hagerman, Au, & Hagerman, 2011) *FMR1*, the gene associated with FXS, contains a highly polymorphic CGG repeat in the 5' untranslated region (UTR) which, in rare cases, can become unstable and expand across generations. Expanded alleles with more than 200 repeats, termed full mutation (FM) alleles, have a frequency of roughly 1/7000 in males and 1/11,000 in females and are associated with FXS. (Hunter et al., 2014) Mothers of children with FXS typically carry an *FMR1* premutation (PM) allele, expanded alleles with approximately 55–199 repeats. PM alleles are estimated to have a frequency of roughly 1/850 in males and 1/300 in females, though population-based estimates in the U.S. are closer to 1/150 in females. (Hunter et al., 2014; Seltzer et al., 2012)

The PM allele is associated with a range of clinical outcomes. Women who carry a PM are at risk of fragile X-associated primary ovarian insufficiency (FXPOI), with 20–30% of women experiencing cessation of menses prior to age 40, and the late-onset fragile X-associated tremor/ataxia syndrome (FXTAS), typically after age 50. (Hagerman et al., 2004; Sherman, 2000) Studies also suggest an increased risk of other health conditions, including autoimmune disorders, chronic pain, endocrine disorders, and mental health conditions, including depression and anxiety. (Hunter, Rohr, & Sherman, 2010; Roberts et al., 2009; Rodriguez-Revenga, Madrigal, Alegret, Santos, & Mila, 2008; Wheeler, Bailey et al., 2014; Wheeler, Raspa et al., 2014) The lifetime prevalence of major depressive disorder among women with a PM has been estimated to be as high as 56%, far higher than the national average of 10–12%, and lifetime prevalence of anxiety disorders may be as high as 41%, compared to 17% in non-carriers. (Franke et al., 1998; Wheeler, Hatton, Reichardt, & Bailey, 2007) Our recent studies indicate that, among women who carry a PM who are mothers of children with FXS, a subset is at risk of elevated severity of symptoms associated with social anxiety. (Hunter et al., 2012) It is unclear, however, whether this greater frequency of mental health outcomes is due to physiological factors inherent to carrying a PM allele, environmental factors (e.g., the psychosocial, financial, and/or physical challenges of raising a child with IDD and behavioral problems), or whether the etiology is more complex.

Mothers of children with intellectual and developmental disabilities (IDD) experience high levels of maternal stress compared to mothers of children with typically developing children. (Abbeduto et al., 2004; Bailey, Sideris, Roberts, & Hatton, 2008; Smith et al., 2010) Maternal stress associated with caring for a child with IDD can decrease the mother's quality of life by elevating rates of depression and anxiety and other health problems. (Bailey et al., 2008; Lovell, Moss, & Wetherell, 2012; Miodrag & Hodapp, 2010; Roberts et al., 2009; Rodriguez-Revenga et al., 2008; Sarimski, 1997) Given women who carry a PM are already at an increased risk of mental health outcomes, including an increased risk of social anxiety which would impact the establishment of robust social support systems to alleviate stress and burden, interventions to reduce maternal stress are particularly critical for this population.

Most interventions for families of children with IDD are directed at improving child behavior and leave maternal stress largely unaddressed. However, a study by Dykens and colleagues, in which mindfulness practice sessions were conducted by peer mentors during in-person, 1.5 h weekly sessions of 6 weeks, suggests that Mindfulness-Based Stress Reduction (MBSR) is effective at reducing distress, improving mental health, and increasing wellbeing in mothers of children with ASD and other disabilities. (Dykens, Fisher, Taylor, Lambert, & Miodrag, 2014) While these results are encouraging, there are several potential barriers that could prevent mothers of children with FXS from benefitting from in-person MBSR programs. First, maternal social anxiety may keep mothers from attending or make it more difficult for them to derive benefit from the program. In addition, many women may find it difficult to fit lengthy sessions into their weekly routine. Lastly, because FXS is rare, it could be difficult to recruit enough mothers for the program in many areas. Thus, a mindfulness program women can access electronically on their own schedule may be more accessible than in-person sessions.

Headspace is a smartphone app-based mindfulness training program that delivers meditative sessions through audio files that a user can access at any time (www.headspace.com). The Headspace app is free to download with links to the Apple App Store and Google Play on the Headspace website. The user starts with a free Take 10 program, a beginner's course that consists of 10 guided mindfulness exercises, and any access to additional sessions requires a subscription fee. We chose Headspace for this study for several reasons. First, Headspace scored highest on the Mobile Application Rating Scale compared to other mindfulness apps. (Mani, Kavanagh, Hides, & Stoyanov, 2015) In addition, Headspace has been shown to reduce stress and improve well-being in several controlled trials (Bostock, Crosswell, Prather, & Steptoe, 2018; Howells, Laurie Rauch, Ives-Deliperi, Horn, & Stein, 2014; Yang, Schamber, Meyer, & Gold, 2018), and offers a potential alternative to in-person MBSR programs. To date, no studies have assessed the effects of mindfulness apps on maternal stress specifically.

In this study, we used a mixed-methods approach to assess the feasibility of an app-based mindfulness intervention in a small sample of women with a PM who are mothers of a child with FXS. A secondary goal was to further explore stress, social anxiety, and barriers to social support in this population.

2. Methods

2.1. Recruitment

Women were recruited from the Emory University Fragile X Research cohort. Potential participants were emailed a link to an informational electronic REDCap (Harris et al., 2009) survey which explained the purpose of the study, assessed interest and whether the potential participant met eligibility criteria, and consented interested and eligible participants. Women were eligible to participate if they: 1) were at least 18 years old, 2) had a confirmed *FMR1* PM allele, 3) had at least one child any age with FXS living at home, 4) had reliable access to an Apple or Android smartphone, 5) were willing to download an app on their phone, 6) had no prior experience of regular mindfulness practice, and 7) were fluent in English. All protocols and consent forms for enrollment were approved by the Institutional Review Board at Kaiser Permanente Northwest (KPNW).

2.2. Stress and social anxiety questionnaires

After enrollment, participants were mailed a questionnaire battery to assess stress and social anxiety. Stress was measured by the Parenting Stress Index (PSI) (Abidin, 1995) and the Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983), while the Life Change Index Scale (LCIS) assessed stressful life events (Holmes & Rahe, 1967). Social anxiety was measured by the Social Phobia and Anxiety Inventory (SPAI), where a total score of 80 or greater is indicative of probable social anxiety (Turner, Beidel, & Dancu, 1996).

2.3. Mindfulness sessions

The Headspace Take 10 program consists of 10 guided mindfulness exercises that last for 10 min each, to be completed on 10 consecutive days. Each session consists of audio narration to guide the listener through the basics of meditation and mindfulness, such as establishing a mediation position, breathing, and body scans.

After completion and return of the questionnaires, participants were emailed instructions to download the Headspace mindfulness training app and complete its Take 10 program. The study team contacted each participant a single time by phone (2–5 days following sending the code) to confirm receipt of the code and to help address any barriers to downloading and registering the app. To track participant adherence, Headspace provided the study team with codes for each participant to enter when registering the app. At the end of the study, Headspace provided user information for each participant, including time and day of access to the app, which sessions were accessed, and whether each session was completed.

2.4. Follow-up interviews

After completion of the mindfulness program, participants completed a 30-minute semi-structured telephone interview. An open-ended interview guide was based on expertise from the study team and explored participant experiences with the Headspace Take 10 program and social outcomes. For Take 10, participants were asked whether they completed all 10 sessions and if they found it helpful. For social outcomes, participants were asked whether they felt they had enough social support and whether they had a hard time reaching out for help. A single team member (VG) completed all interviews, which were audio-recorded and transcribed. VG and JEH developed a coding dictionary based on review of interviews, where codes represented both responses to the questions as well as additional participant comments. Using the coding dictionary, VG and JEH independently coded all interviews and discussed for consensus.

2.5. Statistical analyses

Descriptive statistics were used to assess the proportion of participants who completed the Take 10 program and to assess participant perception of the program. Unadjusted exploratory analyses were performed to explore whether self-reported stress, social anxiety, and social support were related to perceptions of the Take 10 program. Associations between severity of parental stress (PSI total score) and perceived helpfulness of the program were assessed with a t-test; associations between perceived helpfulness and the presence of social anxiety (SPAI scores < 80 (unlikely or mildly possible) vs. \geq 80 (probable)) and social support (any self-reported lack of social support and any self-reported trouble reaching out for help) were assessed with Fisher's exact tests.

To assess whether social anxiety was related to stress variables, those whose SPAI scores were indicative of probable social anxiety (\geq 80) were compared to those whose SPAI scores were not indicative of probable social anxiety in terms of 1) number of children with FXS (Fisher's exact test); 2) parental stress (PSI total score; t-test); 3) perceived stress (PSS total score; t-test); and 4) stressful life events (LCIS total score; t-test). All statistical analyses were performed in SAS software Version 9.4 (SAS Institute Inc., Cary, NC).

3. Results

3.1. Participants

Of the 59 women who were sent the recruitment email, 25 completed the eligibility survey. Of those, two were deemed ineligible (one due to lack of genetic confirmation of a PM and one due to prior mindfulness practice) and two changed their mind about participating (one after completing the eligibility survey but before consenting and one after consenting to participate). Questionnaires were mailed to the remaining 21 women. Three failed to return the questionnaires, and 18 completed the questionnaires and the telephone interview. These 18 participants comprise the study sample.

Participant characteristics are described in Table 1. The sample was made up primarily of White, non-Hispanic (83.3%), married (83.3%) women. Most had a college degree (77.8%) and half had household incomes of \$75,000 or higher (50.0%). Half (9 of 18) of the participants had a single child with FXS (44.4% had one son with FXS, 5.6% had one daughter); 38.9% (7 of 18) had 2 children with FXS (22.2% had two sons, 16.7% had one son and one daughter); and 11.1% (two participants) had three children with FXS (in both cases, one son and two daughters).

Table 1
Participant Characteristics.

Variable	Values	Numbers
Age	Range	38-62
	Mean	47.9 (SD = 6.5)
Education	Some high school, no degree	0 (0%)
	High school degree or GED	0 (0%)
	Trade or vocational school	2 (11.1%)
	Some college, no degree	2 (11.1%)
	College degree	11 (61.1%)
	Graduate or professional degree	3 (16.7%)
Income	< \$10,000	0 (0%)
	\$10–25,000	1 (5.6%)
	\$25–50,000	4 (22.2%)
	\$50–75,000	4 (22.2%)
	\$75–100,000	2 (11.1%)
	> \$100,000	7 (38.9%)
Employment	Employed full-time	5 (27.8%)
	Employed part-time	6 (33.3%)
	Not employed	7 (38.9%)
Race/Ethnicity	White, non-Hispanic	15 (83.3%)
	White, Hispanic	1 (5.6%)
	Black, non-Hispanic	1 (5.6%)
	Other, non-Hispanic	1 (5.6%)
Marital Status	Single	1 (5.6%)
	Married	15 (83.3%)
	Living with a partner	0 (0%)
	Divorced	1 (5.6%)
	Separated	0 (0%)
	Widowed	1 (5.6%)
On anxiety/depression meds	No	12 (66.7%)
	Yes	6 (33.3%)
N Children with FXS	1	9 (50.0%)
	2	7 (38.9%)
	3	2 (11.1%)
Age of FXS Children	Range	4-32
	Mean	18.3 (SD = 5.3)

Note. SD = standard deviation, GED = general equivalency diploma, FXS = fragile X syndrome.

3.2. Perspectives on headspace app

Patient perspectives on the use of Headspace and the Take 10 program are shown in Table 2, including illustrative quotes from the telephone interviews. Seventy-two percent of participants reported that they had completed the Take 10 program, either within 10 days as directed (n = 5) or within two weeks (n = 8). Of those who did not complete the Take 10, three reported completing zero sessions, and 2 reported completing some, but not all, sessions. This self-reported adherence matched app usage data provided by Headspace. Of the 5 participants who did not complete the program, 3 reported that they forgot to use the app and 2 reported that they did not enjoy the guided meditation exercises.

Of the 13 participants who completed the Take 10 program, 10 (77%) indicated that the program was helpful or somewhat helpful, 2 (15%) indicated that it was not helpful, and 1 (8%) indicated that the program was not long enough to determine whether it was helpful or not (Table 2). Of the 5 participants who did not complete the Take 10 program, 2 found it helpful or somewhat

Table 2
Interview Findings Related to Perceptions of the Headspace App Take 10 Program.

Outcome	N	Example Quotes
Completed Take 10 program	Yes	13
	No	5
Found Take 10 helpful ^a	Yes	9
	Somewhat	1
	No	2
	Not sure	1

Note. ^aOf the 13 who completed the program.

Table 3
Stress and Social Anxiety Scores.

Score	Values	Numbers
PSI Total Score	Range	194–355
	Mean	263.4 (SD = 48.5)
PSS Total Score	Range	6–30
	Mean	17.5 (SD = 6.1)
LCIS Total Score	Range	13–624
	Mean	233.6 (SD = 175.4)
SPAI Total Score	Range	7–153
	Mean	69.4 (SD = 33.9)
SPAI Probable Social Anxiety ^a	No	10 (55.6%)
	Yes	8 (44.4%)

Note. PSI = Parenting Stress Index, PSS = Perceived Stress Scale, LCIS = Life Change Index Scale, SPAI = Social Phobia and Anxiety Inventory, SD = standard deviation.

^a SPAI score of 80 or great is indicative of probable social anxiety.

helpful and 3 indicated that it was not helpful. Participants who indicated that the Take 10 program was helpful had higher parental stress scores on the PSI compared to those that did not find the program helpful, although this difference did not reach statistical significance ($p = 0.06$).

Interestingly, significantly more participants with probable social anxiety ($SPAI \geq 80$) reported that the Take 10 program was helpful (8/8, 100%) than those without probable social anxiety (4/10, 40%, $p = 0.01$). Similarly, 83% (10/12) of those who reported finding the program helpful also reported having trouble reaching out for help, compared to only 17% (1/6) of those who did not find the program helpful ($p = 0.01$). However, perceived lack of social support was not associated with finding the Take 10 program helpful in our sample ($p = 0.61$).

3.3. Stress and social anxiety

Stress and social anxiety scores are shown in Table 3. Eight participants (44.4%) had SPAI scores in the range indicative of probable social anxiety ($SPAI \geq 80$). However, the number of children with FXS ($p = 0.7984$), parental stress ($p = 0.6914$), perceived stress ($p = 0.1659$), and stressful life events ($p = 0.7149$) were not associated with the presence of probable social anxiety.

3.4. Social support

Participant perspectives on social outcomes are shown in Table 4. Twenty-eight percent of participants ($n = 5$) indicated that they did not feel they had enough social support, and 61% ($n = 11$) indicated that they had a hard time reaching out for help at least sometimes. Interviews brought up several themes that speak to personality characteristics related to experiencing barriers in

Table 4
Interview Findings Related to Stress and Social Outcomes.

Outcome	N	Example Quotes
Felt they had enough social support	Yes	12 “My friends and family are great. My mom and dad help me out tremendous amount. My brother helps me out. I have a few handful of good friends here for me.”
	No	5 “Friends are few and far between, that is something that I struggle with.”
	Don't need it	1 “I don't think I need it. It is up to me to wrap my head around it, to come to terms with it, to decide how I deal with it.”
Have trouble reaching out for help	Yes	6 “I am kind of ashamed I need help. Like I am supposed to be invisible, but deep down I know that I am not.” “I tend to not want to burden anyone else with the things I have to take care of. I more frequently take the burden on myself.”
	Sometimes	5 “Yes, sometime cause I don't like asking for help.” “It depends on who it is for. If it is something for the kids, I am more apt to reaching out, if it's for me, not so much.”
Other themes that emerged	No	7 “If I think it is something someone can help me with, I will ask for it.”
	Like being alone	3 “I usually want to be more alone than with people whenever I am too stressed.”
	Feel isolated	2 “When my son was younger he was a full time job sometimes. And it can be very isolating.”
	Internalize stressful situations	2 “When I get real stressed, I tend to get quiet and much more introverted than others. That is a struggle.”
	Related to autistic traits in their child	2 “I feel like because I am a carrier for fragile X, it explains a lot once I found out about my children and not reaching out for help. I think there are lots of other people who don't reach out for help, don't tell people they are depressed. It might be harder for us sometimes if we do have the autistic traits like our children to ask for help.”

establishing social supports: several participants mentioned that they like being alone ($n = 3$), they feel isolated ($n = 2$), or they internalize in stressful situations ($n = 2$). Two participants explicitly drew connections between their child's autistic traits and their own. An SPAI score indicative of probable social anxiety was not associated with a perception of having enough social support ($p = .6078$). However, the association between probable social anxiety and having a hard time reaching out for help approached significance ($p = .0656$).

4. Discussion

This is the first study to implement an app-based mindfulness intervention for maternal stress. We found that women who carry a PM and have children with FXS were willing and able to adhere to an app-based mindfulness intervention, and roughly three in four women who completed the intervention reported finding it helpful. Further, the intervention appeared to be particularly helpful for mothers who were most at risk of poor outcomes: those with high stress, elevated social anxiety, and/or who reported having trouble reaching out for help. Overall, these findings indicate that mindfulness app interventions are feasible and promising for alleviating maternal stress in this population.

Consistent with prior findings (Hunter et al., 2012), our survey and interview data demonstrated that many mothers of FXS children who carry a PM struggle with social anxiety and with accessing social support. Forty-four percent of women reported experiencing elevated social anxiety and 61% reported at least some difficulty reaching out for help when needed. These findings highlight the unique challenges in providing resources and support to alleviate maternal stress in mothers of children with FXS and demonstrate why app-based methods may be particularly appropriate for this population.

The primary goal of this study was to determine the feasibility of an app-based mindfulness intervention for mothers of children with FXS. While the sample size and study design were sufficient to demonstrate feasibility, the lack of comparison group and short timeline preclude strong conclusions about the effectiveness of the intervention. Nonetheless, given the low cost and high accessibility of this intervention and the overwhelmingly positive responses of women in our sample, clinicians may consider recommending app-based mindfulness to mothers with a PM and a child with FXS if they seem likely to benefit.

In future work, we plan to test the effectiveness of this intervention in alleviating stress and symptoms associated with mental health outcomes with a larger sample of mothers who have a child with FXS. Interactions between app usage and effectiveness with participant characteristics, such as social and mental health outcomes, are likely to be complex. Thus, future studies may identify subgroups of women who are more likely to benefit from this type of intervention. In addition, future studies should further explore social support networks in mothers of children with FXS to better understand the barriers and potential facilitators to accessing maternal resources. A better understanding of these dynamics could guide the development of interventions to reduce maternal stress in mothers of children with FXS and other at-risk populations. Lastly, it is important to note that other mothers experiencing elevated maternal stress may also benefit from app-based mindfulness interventions. In addition, social anxiety and other barriers to social support may not be specific to women who carry an *FMR1* premutation allele with a child with FXS and could be a general outcome among other women experiencing elevated maternal stress. Ongoing studies are exploring mindfulness and social outcomes among mothers of children with other IDD.

Acknowledgements

This work was supported by Kaiser Permanente Northwest's Community Benefit Initiative, United States. The authors would like to thank all the participants who make this work possible. We would also like to thank Neon Brooks for her editorial support as well as the Headspace research team. Parts of this study have been presented as oral presentations at the 3rd International Conference on *FMR1* Premutation in Jerusalem, Israel in September 2017 and at the 51st Annual Gatlinburg Conference in San Diego, California in April 2018.

References

- Abbeduto, L., Seltzer, M. M., Shattuck, P., Krauss, M. W., Orsmond, G., & Murphy, M. M. (2004). Psychological well-being and coping in mothers of youths with autism, Down syndrome, or fragile X syndrome. *American Journal of Mental Retardation*, *109*(3), 237–254.
- Abidin, R. R. (1995). *Parenting stress index: Professional manual* (third edition). Lutz, FL: Psychological Assessment Resources.
- Bailey, D. B., Jr., Sideris, J., Roberts, J., & Hatton, D. (2008). Child and genetic variables associated with maternal adaptation to fragile X syndrome: A multi-dimensional analysis. *American Journal of Medical Genetics Part A*, *146A*(6), 720–729.
- Bostock, S., Crosswell, A. D., Prather, A. A., & Steptoe, A. (2018). Mindfulness on-the-go: Effects of a mindfulness meditation app on work stress and well-being. *Journal of Occupational Health Psychology*, *24*(1), 127–138.
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396.
- Dykens, E. M., Fisher, M. H., Taylor, J. L., Lambert, W., & Miodrag, N. (2014). Reducing distress in mothers of children with autism and other disabilities: A randomized trial. *Pediatrics*, *134*(2), e454–463.
- Franke, P., Leboyer, M., Gansicke, M., Weiffenbach, O., Biancalana, V., Cornillet-Lefebvre, P., et al. (1998). Genotype-phenotype relationship in female carriers of the premutation and full mutation of *FMR1*. *Psychiatry Research*, *80*(2), 113–127.
- Hagerman, R., Au, J., & Hagerman, P. (2011). *FMR1* premutation and full mutation molecular mechanisms related to autism. *Journal of Neurodevelopmental Disorders*, *3*(3), 211–224.
- Hagerman, R. J., Leavitt, B. R., Farzin, F., Jacquemont, S., Greco, C. M., Brunberg, J. A., et al. (2004). Fragile-X-associated tremor/ataxia syndrome (FXTAS) in females with the *FMR1* premutation. *American Journal of Human Genetics*, *74*(5), 1051–1056.
- Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, *42*(2), 377–381.
- Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, *11*(2), 213–218.

- Howells, F. M., Laurie Rauch, H. G., Ives-Deliperi, V. L., Horn, N. R., & Stein, D. J. (2014). Mindfulness based cognitive therapy may improve emotional processing in bipolar disorder: Pilot ERP and HRV study. *Metabolic Brain Disease*, 29(2), 367–375.
- Hunter, J., Rivero-Arias, O., Angelov, A., Kim, E., Fotheringham, I., & Leal, J. (2014). Epidemiology of fragile X syndrome: A systematic review and meta-analysis. *American Journal of Medical Genetics Part A*, 164A(7), 1648–1658.
- Hunter, J. E., Leslie, M., Novak, G., Hamilton, D., Shubeck, L., Charen, K., et al. (2012). Depression and anxiety symptoms among women who carry the FMR1 premutation: impact of raising a child with fragile X syndrome is moderated by CRHR1 polymorphisms. *American Journal of Medical Genetics Part B*, 159B(5), 549–559.
- Hunter, J. E., Rohr, J. K., & Sherman, S. L. (2010). Co-occurring diagnoses among FMR1 premutation allele carriers. *Clinical Genetics*, 77(4), 374–381.
- Lovell, B., Moss, M., & Wetherell, M. (2012). The psychosocial, endocrine and immune consequences of caring for a child with autism or ADHD. *Psychoneuroendocrinology*, 37(4), 534–542.
- Mani, M., Kavanagh, D. J., Hides, L., & Stoyanov, S. R. (2015). Review and evaluation of mindfulness-based iPhone apps. *JMIR MHealth and UHealth*, 3(3), e82.
- Miodrag, N., & Hodapp, R. M. (2010). Chronic stress and health among parents of children with intellectual and developmental disabilities. *Current Opinion in Psychiatry*, 23(5), 407–411.
- Roberts, J. E., Bailey, D. B., Jr., Mankowski, J., Ford, A., Sideris, J., Weisenfeld, L. A., et al. (2009). Mood and anxiety disorders in females with the FMR1 premutation. *American Journal of Medical Genetics Part B*, 150B(1), 130–139.
- Rodriguez-Reventa, L., Madrigal, I., Alegret, M., Santos, M., & Mila, M. (2008). Evidence of depressive symptoms in fragile-X syndrome premutated females. *Psychiatric Genetics*, 18(4), 153–155.
- Sarimski, K. (1997). Behavioural phenotypes and family stress in three mental retardation syndromes. *European Child & Adolescent Psychiatry*, 6(1), 26–31.
- Seltzer, M. M., Baker, M. W., Hong, J., Maenner, M., Greenberg, J., & Mandel, D. (2012). Prevalence of CGG expansions of the FMR1 gene in a US population-based sample. *American Journal of Medical Genetics Part B*, 159B(5), 589–597.
- Sherman, S. L. (2000). Premature ovarian failure in the fragile X syndrome. *American Journal of Medical Genetics*, 97(3), 189–194.
- Smith, L. E., Hong, J., Seltzer, M. M., Greenberg, J. S., Almeida, D. M., & Bishop, S. L. (2010). Daily experiences among mothers of adolescents and adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 40(2), 167–178.
- Turner, S. M., Beidel, D. C., & Dancu, C. V. (1996). *Social phobia and anxiety inventory: Manual*. Toronto, Ont: Multi-Health Systems, Inc.
- Wheeler, A., Hatton, D., Reichardt, A., & Bailey, D. (2007). Correlates of maternal behaviours in mothers of children with fragile X syndrome. *Journal of Intellectual Disability Research: JIDR*, 51(Pt. 6), 447–462.
- Wheeler, A. C., Bailey, D. B., Jr., Berry-Kravis, E., Greenberg, J., Losh, M., Mailick, M., et al. (2014). Associated features in females with an FMR1 premutation. *Journal of Neurodevelopmental Disorders*, 6(1), 30.
- Wheeler, A. C., Raspa, M., Green, A., Bishop, E., Bann, C., Edwards, A., et al. (2014). Health and reproductive experiences of women with an FMR1 premutation with and without fragile X premature ovarian insufficiency. *Frontiers in Genetics*, 5, 300.
- Yang, E., Schamber, E., Meyer, R. M. L., & Gold, J. I. (2018). Happier healers: Randomized controlled trial of mobile mindfulness for stress management. *Journal of Alternative and Complementary Medicine*, 24(5), 505–513.