Impact of maternal mental health interventions on child-related outcomes in low- and middle-income countries: a systematic review and meta-analysis

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Abstract

Aims. Observational studies have shown a relationship between maternal mental health (MMH) and child development, but few studies have evaluated whether MMH interventions improve child-related outcomes, particularly in low- and middle-income countries. The objective of this review is to synthesise findings on the effectiveness of MMH interventions to improve child-related outcomes in low- and middle-income countries (LMICs).

Methods. We searched for randomised controlled trials conducted in LMICs evaluating interventions with a MMH component and reporting children’s outcomes. Meta-analysis was performed on outcomes included in at least two trials.

Results. We identified 21 trials with 28 284 mother–child dyads. Most trials were conducted in middle-income countries, evaluating home visiting interventions delivered by general health workers, starting in the third trimester of pregnancy. Only ten trials described acceptable methods for blinding outcome assessors. Four trials showed high risk of bias in at least two of the seven domains assessed in this review. Narrative synthesis showed promising but inconclusive findings for child-related outcomes. Meta-analysis identified a sizeable impact of interventions on exclusive breastfeeding (risk ratio = 1.39, 95% confidence interval (CI): 1.13–1.71, ten trials, N = 4749 mother–child dyads, I² = 61%) and a small effect on child height-for-age at 6-months (std. mean difference = 0.13, 95% CI: 0.02–0.24, three trials, N = 1388, I² = 0%). Meta-analyses did not identify intervention benefits for child cognitive and other growth outcomes; however, few trials measured these outcomes.

Conclusions. These findings support the importance of MMH to improve child-related outcomes in LMICs, particularly exclusive breastfeeding. Given, the small number of trials and methodological limitations, more rigorous trials should be conducted.

Introduction

Mental health is critical to public health and contributes substantially to the global burden of disease (Whiteford et al., 2015). In low- and middle-income countries (LMICs), there are few resources to address this burden, resulting in large numbers of people with mental health concerns not receiving treatment (Demyttenaere et al., 2004). Calls have been made to make evidence-based treatments for mental disorders more accessible by integrating them into non-specialised health settings, such as primary, maternal and child care systems (Lancet Global Mental Health Group et al., 2007).

There are a number of compelling reasons to integrate mental health services into routine maternal and child health care in LMICs. First, mental disorders in the perinatal period are common and disabling (Baron et al., 2016). Second, maternal mental disorders are associated with poor child development and health (Surkan et al., 2011). Third, maternal and child health care settings provide good entry points for identification and treatment of maternal mental disorders because of the relatively good uptake of antenatal care in LMICs. Fourth, treatments for maternal mental disorders have been evaluated as effective in multiple LMICs and existing treatment guidelines for non-specialised providers include specific recommendations for pregnant women (Rahman et al., 2013).
Despite demonstrated links in the epidemiological literature, few systematic investigations have been conducted to examine whether maternal mental health (MMH) interventions can reduce potential negative impacts on children’s outcomes. The aim of this study was to conduct a systematic review and meta-analysis on this topic. Specifically, our research question was: do interventions with a dedicated psychiatric or psychosocial component delivered to pregnant women and mothers during the perinatal period improve children’s health and development in LMICs relative to standard antenatal care or interventions lacking a dedicated psychiatric or psychosocial component?

**Methods**

**Search strategy and selection criteria**

We searched PubMed/MEDLINE, PsycInfo, Cochrane CENTRAL, Embase, Web of Science, CINAHL, Popline, several grey literature sources (Global Health Library, UNFPA, UNICEF, WHO, World Bank, Emergency Nutrition Network, ALNAP and Eldis) and trial registration websites (clinicaltrials.gov). The searches were conducted through May 2020 without date, publication or language restrictions. Search strategies contained terms describing the perinatal period (e.g. ‘prenatal’, ‘postpartum’), mental and psychosocial health (e.g. ‘psychosocial’, ‘anxiety’, ‘depression’), LMICs (e.g. ‘low-income’, ‘developing country’, list of LMICs), randomised trial (e.g. ‘randomized’) and child development (e.g. ‘child growth’, ‘child development’, ‘nutrition’; online Supplementary material).

Randomised controlled trials (RCTs) were eligible for our systematic review if the study: (1) described interventions delivered during the perinatal period, defined as pregnancy through 1-year post-partum; (2) incorporated an MMH intervention component; (3) included a MMH outcome; (4) was conducted in an LMIC (http://data.worldbank.org/about/country-and-lending-groups) and (5) included a child health, nutrition or development outcome. We retained the child outcomes for inclusion broad LMICs. Quantitative results were extracted using data, and standardised mean difference (SMD) for continuous dichotomous outcomes. The risk of bias assessment followed the Cochrane Risk of Bias tool where reviewers rated several potential sources of bias as ‘high’, ‘low’ or ‘unclear’ risk in relation to random sequence generation, allocation concealment, masking of participants/personnel, masking of outcome assessors, attrition, reporting and any other sources of bias of each trial (Higgins and Greene, 2011). We considered overall risk of bias to be high if trials displayed high risk of bias in two or more of these seven domains. Discrepancies were resolved through discussion.

We employed the GRADE approach to assess the overall certainty of evidence and to interpret findings (Barbui et al., 2010). We adhered to the standard methods for the preparation and presentation of results outlined in the Cochrane Handbook for Systematic Reviews of Interventions and PRISMA guidelines (Higgins and Greene, 2011). We included the following outcomes in the GRADE evidence profiles: exclusive breastfeeding, cognitive development, psychomotor development, low birth weight, weight (continuous), height (continuous), underweight (i.e. weight-for-age z-score < −2), stunting (i.e. height-for-age z-score < −2) and weight-for-height.

**Data analysis**

Narrative synthesis: included trials were compared with respect to population, intervention, measurement and methodological features that may contribute to clinically relevant heterogeneity in the synthesis of the results. Reporting of these results followed PRISMA recommendations.

Quantitative synthesis: data from included trials were pooled using a random effects model for outcomes reported in at least two trials and expressed as relative risk (RR) for categorical data, and standardised mean difference (SMD) for continuous data. For categorical outcomes with evidence supporting an intervention effect across more than one study, we calculated the number needed to treat (NNT) to provide benefit (Furukawa et al., 2002). Review Manager was used for all analyses (The Nordic Cochrane Center, 2014). Data from cluster RCTs were adjusted with an intracluster correlation coefficient (ICC). If the ICC was not available, we assumed it to be 0.05 (Higgins and Greene, 2011). Below, we report intention-to-treat analyses including all randomised patients.

We conducted a sub-group analysis by intervention type: (1) focused MMH interventions (i.e. interventions mainly aimed at improving MMH) and (2) integrated interventions (i.e. interventions that included a mental health focused component, but also focused on other outcomes). We evaluated publication bias for outcomes that included more than ten studies.

**Results**

Searches yielded 13,918 results, with an additional 48 records identified through cross-referencing and expert recommendation (Fig. 1). After removal of duplicates (n = 1921), 12,045 articles were screened. Reviewers identified 273 articles that were potentially relevant and thus included in full text screening. Thirty-six articles representing 21 randomised trials met criteria for inclusion in this systematic review and seven articles were classified as awaiting assessment because eligibility could not be adequately evaluated given available information (Aracena et al., 2011; Aracena et al., 2012; Akbarzadeh et al., 2016; Shirazi et al., 2016; Frith et al., 2017; Kahalili et al., 2019;
Tran et al., 2019). The most common reasons for exclusion were studies that described an intervention that did not aim to improve MMH and studies that did not include a child outcome (Fig. 1). The 36 included articles represent data from 21 RCTs and 28,284 mother–child dyads.

Overview of study characteristics and quality

Population: most trials were conducted in upper-middle-income countries (Brazil, Chile, China, Iran, Lebanon, Malaysia, Mexico and South Africa) (Langer et al., 1998; Bastani et al., 2006; Aracena et al., 2009; Carvalho et al., 2009; Cooper et al., 2009; Le Roux et al., 2013; Le Roux et al., 2014; Rotheram-Borus et al., 2014a; Rotheram-Borus et al., 2014b; Tomlinson, 2014; Karamoozian and Askarizadeh, 2015; Murray et al., 2015; Tomlinson et al., 2015; Tomlinson et al., 2016b; Tomlinson et al., 2016a; Zhao et al., 2017, Rotheram-Fuller et al., 2018, Tomlinson et al., 2018; Mohd Shukri et al., 2019; Nabulsi et al., 2019; Rotheram-Borus et al., 2019; Guo et al., 2020; Zhao et al., 2020) followed by lower-middle-income (India, Nigeria and Pakistan) (Rahman et al., 2008; Tripathy et al., 2010; Maselko et al., 2015; Dabas et al., 2019; Fuhr et al., 2019; Gureje et al., 2019; Sikander et al., 2019; Rajeswari and SanjeevaReddy, 2020), low-income (Pakistan) (Rahman et al., 2008; Maselko et al., 2015) and a multi-site trial of lower-middle (Cuba) and upper-middle-income countries (Argentina, Brazil and Mexico) (Villar et al., 1992) (Table 1). Most trials enrolled pregnant women in their second and/or third trimester (Villar et al., 1992;
settings via a local female facilitator (Tripathy et al., 2010). The majority of interventions were child-focused, but all contained an MMH component.

MMH components included education surrounding self-esteem and/or problem-solving (Aracena et al., 2009; Tripathy et al., 2010; Le Roux et al., 2013; Le Roux et al., 2014; Tomlinson, 2014; Rotheram-Borus et al., 2014b; Tomlinson et al., 2015; Tomlinson et al., 2016a; Tomlinson et al., 2016b; Fuhr et al., 2019; Gureje et al., 2019; Kola et al., 2019; Mohd Shukri et al., 2019; Oladeji et al., 2019; Sikander et al., 2019; Guo et al., 2020; Rajeswari and SanjeevaReddy, 2020; Zhao et al., 2020). Four trials enrolled women that had recently given birth (Carvalho et al., 2009; Tripathy et al., 2010; Le Roux et al., 2013; Le Roux et al., 2014; Rotheram-Borus et al., 2014b; Tomlinson, 2014; Tomlinson et al., 2015; Tomlinson et al., 2016a; Tomlinson et al., 2016b; Fuhr et al., 2019; Gureje et al., 2019; Kola et al., 2019; Mohd Shukri et al., 2019; Oladeji et al., 2019; Sikander et al., 2019; Guo et al., 2020; Rajeswari and SanjeevaReddy, 2020; Zhao et al., 2020). Some trials enrolled specific subgroups of pregnant women including adolescents or young adults (Aracena et al., 2009), low-income (Cooper et al., 2009; Le Roux et al., 2013; Le Roux et al., 2014; Rotheram-Borus et al., 2014b; Tomlinson, 2014; Murray et al., 2015; Tomlinson et al., 2015; Tomlinson et al., 2016a; Tomlinson et al., 2016b, Rotheram-Fuller et al., 2018, Tomlinson et al., 2018; Dabas et al., 2019; Rotheram-Borus et al., 2019). Some trials enrolled pregnant women including adolescents or young adults (Aracena et al., 2009), low-income (Cooper et al., 2009; Le Roux et al., 2013; Le Roux et al., 2014; Rotheram-Borus et al., 2014b; Tomlinson, 2014; Murray et al., 2015; Tomlinson et al., 2015; Tomlinson et al., 2016a; Tomlinson et al., 2016b, Rotheram-Fuller et al., 2018, Tomlinson et al., 2018; Dabas et al., 2019; Rotheram-Borus et al., 2019). Several trials enrolled pregnant women meeting specific mental health criterion including having mild to moderate stress (Rajeswari and SanjeevaReddy, 2020), elevated anxiety or depressive symptoms (Bastani et al., 2006; Cooper et al., 2009; Murray et al., 2015; Guo et al., 2020) screening positive for depression based on PHQ9 ≥ 10 (Fuhr et al., 2019), EPDS ≥ 9 (Zhao et al., 2017; Zhao et al., 2020), EPDS = 12 (Karamoozian and Askarizadeh, 2015), anxiety based on the Pregnancy-Related Anxiety Questionnaire (PRAQ) (Karamoozian and Askarizadeh, 2015) or DSM-IV-TR criteria for major depressive episode (Rahman et al., 2008; Maselko et al., 2015).

Interventions (Table 2): nine trials delivered the intervention through home visits provided by health educators (Aracena et al., 2009), peers (Fuhr et al., 2019; Sikander et al., 2019), nurses (Villar et al., 1992), certified lactation consultants (Nabulsi et al., 2019), community health workers (Rahman et al., 2008; Cooper et al., 2009; Le Roux et al., 2013; Rotheram-Borus et al., 2014b; Tomlinson, 2014; Maselko et al., 2015; Murray et al., 2015; Tomlinson et al., 2015; Le Roux et al., 2014; Tomlinson et al., 2016a; Tomlinson et al., 2016b; Rotheram-Fuller et al., 2019, Rotheram-Borus et al., 2019, Rotheram-Fuller et al., 2018, Tomlinson et al., 2018), social workers (Villar et al., 1992) or a researcher (Mohd Shukri et al., 2019). Twelve trials delivered the intervention in hospital- or clinic-based settings by nurse researchers (Bastani et al., 2006), primary maternal care providers (Gureje et al., 2019), psychologists (Carvalho et al., 2009), doulas/midwives/lactation consultants (Langer et al., 1998; Nabulsi et al., 2019; Zhao et al., 2020), peers (Rotheram-Borus et al., 2014a; Fuhr et al., 2019; Sikander et al., 2019) or research staff (Zhao et al., 2017; Dabies et al., 2019; Majid Shukri et al., 2019; Rajeswari and SanjeevaReddy, 2020). One of these interventions was delivered online (Guo et al., 2020), and several supplemented in-person activities with audio/video materials (Carvalho et al., 2009; Dabies et al., 2019; Mahd Shukri et al., 2019). One of these clinic-based trials did not specify the provider (Karamoozian and Askarizadeh, 2015). The final trial delivered the intervention in community-based
| Study | Setting | Intervention | Control group | Target population | Child development outcome(s) | Timing of assessment(s) | Number of participants |
|-------|---------|--------------|---------------|-------------------|-------------------------------|------------------------|------------------------|
| Aracena et al. (2009) | Santiago, Chile | Home visits | Standard care (on average 10 prenatal visits and well-baby visits) | Adolescent primiparous women treated in 1 of 2 health centres in a low-income neighbourhood | Malnutrition (underweight, overweight), psychomotor development, Incidence of illness | Pre- and post-intervention (12–15 months) | 90 45 45 |
| Bastani et al. (2006) | Tehran, Iran | Applied relaxation training | Standard care (routine, hospital-based prenatal care) | Primiparous women in second trimester with high levels of anxiety | Low birth weight, average weight, preterm birth, instrumental delivery | Post-intervention (7 weeks) | 110 55 55 |
| Carvalho et al. (2009) | Sao Paulo, Brazil | Clinic-based psychological support and video and manual support materials | Standard care (clinic-based psychological support) | Mothers of preterm newborns and very low birth weights, hospitalised in a Neonatal Intensive Care Unit | Neonatal period (duration of hospitalisation in NICU (days), total duration of hospitalisation (days)) | Post-intervention (end of hospitalisation) | 59 36 23 |
| Cooper et al. (2009); Murray et al. (2015) | Cape Town, South Africa | Home visits | Standard care (home visits every 2 weeks) | Pregnant women in 3rd trimester with high levels of depression in two areas of a peri-urban settlement (Khayelitsha) in Cape Town | Attachment style; cognitive development | 18 months after birth | 449 220 229 |
| Dabas et al. (2019) | New Delhi, India | Audio-assisted relaxation technique | Standard care (hospital-based care) | Postpartum mothers whose children were born preterm | Milk output | 10 days after birth | 57 29 28 |
| Fuhr et al. (2019) | Goa, India | Thinking Healthy Program, peer-delivered | Enhanced usual care from gynaecologist who received depression screening results and mhGAP | Pregnant women in their 2nd or 3rd trimester receiving antenatal care | Exclusive breastfeeding; weight-for-age; height-for-age | 3 and 6 months | 280 140 140 |
| Guo et al. (2020) | Tianjin, China | Mindful self-compassion programme | Wait-list control group | Pregnant women in their 2nd or 3rd | Infant temperament | 3 and 12 months | 314 157 157 |

(Continued)
| Study                                      | Setting                     | Intervention                                      | Control group                                           | Target population                                                                 | Child development outcome(s)                                                                 | Timing of assessment(s) | Number of participants |
|-------------------------------------------|-----------------------------|---------------------------------------------------|--------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------|------------------------|
| Gureje et al. (2019); Kola et al. (2019);  | Oyo State, Nigeria          | Problem solving treatment                         | Enhanced usual care (low-intensity treatment)          | Pregnant women in their 2nd or 3rd trimester with major depressive disorder and seeking care in an enrolled primary maternal care clinic | Infant growth; infant health; exclusive breastfeeding; motor and cognitive development   | 6 months               | 686 452 234            |
| Oladeji et al. (2019)                     |                             |                                                   |                                                        |                                                                                  |                                                                                          |                        |                        |
| Karamoozian et al. (2015)                 | Kerman, Iran                | Cognitive behavioural stress management          | Standard care (clinic-based prenatal care)             | Pregnant women with anxiety and depression, referring to three health clinics in Kerman | Apgar score (infant health status)                                                       | 1 min and 5 min after birth | 30 15 15              |
| Langer et al. (1998)                      | Mexico City, Mexico         | Psychosocial support from doula during labour     | Standard care (not described)                         | Pregnant women with a single foetus, no previous vaginal delivery and no evidence of severe obstetric disease who arrived at the labour and delivery unit | Exclusive breastfeeding; full breastfeeding                                                | 1 month post-partum     | 724 361 363            |
| Le Roux et al. (2013, 2014); Rotheram-Borus et al. (2014b, 2019a, 2019b); Rotheram-Fuller et al. (2018); Tomlinson et al. (2014, 2015, 2016a, 2016b, 2018); Christodoulou et al. (2019) | Cape Town, South Africa     | Home visits                                       | Standard care (access to healthcare at government clinics and hospitals)         | Pregnant women living in townships surrounding Cape Town and obtaining care at government clinics | Birth weight, weight-for-age, height-for-age, weight-for-height, head circumference, exclusive breastfeeding, child health status, growth/development, diarrhoea, language, clinic visits | Post-birth, 6-months, 18-months and 36-months | 1238 644 594          |
| Study                          | Location          | Intervention                                                                 | Outcome Measures                                                                 | Duration                  | N1  | N2  | N3  |
|-------------------------------|-------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------|-----|-----|-----|
| Maselko et al. (2015); Rahman et al. (2008) | Punjab Province, Pakistan | Home visits; Thinking Healthy Program | Enhanced usual care – antenatal and postnatal services by community health workers; Married pregnant women with prenatal depression in rural Pakistan | Cognitive development; socioemotional development; physical development (height-for-age, weight-for-age, BMI-for-age) stunting (height-for-age); underweight (weight-for-age); exclusive breastfeeding | 7 years (Maselko) 6 months; 12 months (Rahman) | 705 | 360 | 345 |
| Mohd Shukri et al. (2019)     | Klang-Valley, Malaysia | Relaxation audio therapy and home visits | No intervention; First time pregnant women in their 2nd or 3rd trimester attending antenatal clinics who deliver a healthy, full-term infant and were exclusively breastfeeding | Infant behaviour; anthropometry; milk intake | 2-6 and 12 weeks | 64  | 33  | 31  |
| Nabalsi et al. (2019)         | Beirut, Lebanon    | Multicomponent breastfeeding support intervention | Standard obstetric and paediatric care; Healthy pregnant women in their 1st or 2nd trimester seeking antenatal care | Exclusive breastfeeding | 1, 3 and 6 months | 446 | 222 | 224 |
| Rajeswari & Sanjeevareddy (2020) | Chennai, India    | Progressive muscle relaxation | Standard antenatal care; Pregnant women in their 2nd trimester with minimal to moderate stress levels | Foetal/newborn complications; birthweight | Birth; 10 weeks | 250 | 125 | 125 |
| Rotheram-Borus et al. (2014a) | KwaZulu-Natal, South Africa | Clinic-based psychological support | Standard care (prevention of maternal-to-child HIV transmission services); Pregnant women testing positive for HIV in 1 of 8 clinics in KwaZulu Natal | Exclusive breastfeeding; weight-for-age; height-for-age; weight-for-height; postpartum bonding; normal development (50th percentile) | 1.5 months, 6 months and 12 months post-partum | 1200 | 544 | 656 |

(Continued)
| Study                  | Setting                                    | Intervention                                                                 | Control group                                                                                               | Target population                                                                                       | Child development outcome(s)                                                                 | Timing of assessment(s) | Number of participants |
|------------------------|--------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------|------------------------|
| Sikander et al. (2019) | Rawalpindi, Pakistan                        | Thinking Health Program, peer-delivered                                      | Enhanced usual care by doctors/midwives who were given screening results and mhGAP perinatal depression treatment guidelines | Pregnant women in their 3rd trimester with depressive symptoms                                           | Exclusive breastfeeding; infant growth                                                       | 3 and 6 months          | 494 283 211            |
| Tripathy et al. (2010) | Jharkhand and Orissa Districts, India      | Participatory Women’s Groups                                                 | Health committee focused on health services                                                                 | Women who had just given birth                                                                         | Neonatal deaths and mortality rate; stillbirths                                               | 1, 2 and 3 years post-partum | 19,140 9770 9260        |
| Villar et al. (1992)   | Latin America (Rosario, Argentina; Pelotas, Brazil; Havana, Cuba; Mexico City, Mexico) | Home visits                                                                   | Standard care (clinic-based routine prenatal care)                                                          | Women at high risk for delivery a low birth weight infant and are less than 20 weeks pregnant        | Low birth weight, incidence of infant morbidity (respiratory infection, gastrointestinal disease, nutritional complications, diarrhoea, dehydration), pregnancy outcomes | Birth, 40 days postpartum                      | 2235 1115 1120          |
| Zhao et al. (2017)     | Shanghai, China                            | Psychoeducational programme for first-time parents                           | Standard care (routine obstetrical care)                                                                    | Women with high-risk pregnancies and obstetric complications and at high-risk for postpartum depression | Breastfeeding; infant growth; infant sleep                                                        | 42 days postpartum                      | 352 176 176            |
| Zhao et al. (2020)     | Shanghai, China                            | Individualised mixed management intervention                                 | Standard obstetric care                                                                                   | Primiparous pregnant women in their 3rd trimester with depressive symptoms                             | Exclusive breastfeeding                                                                     | 3 days postpartum                      | 182 91 91              |

Exp, experimental group; Con, control group.
| Study                               | Total number of sessions (timing, session duration) | Number of sessions focused on mental health | Content of mental health sessions                                                                                                                                                                                                                                                                                                                                 | Content of other sessions | Types of facilitators                                                                 | Delivery mode                                      | Intervention timing                       |
|------------------------------------|---------------------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------|------------------------------------------|
| Aracena et al. (2009)              | On average 12 (1-h sessions over a year)          | NR                                         | Education and activities surrounding self-esteem and problem solving                                                                                                                                                                                                                                                                                                                                                       | Educational home visits covering topics on identity, goals, child care | Trained health educators supervised by a nurse-midwife | Individual; home-based                                                                   | Pregnancy and early postpartum               |
| Bastani et al. (2006)              | 7 (weekly, 90 min)                                | 7                                          | Entire intervention was relaxation training to reduce anxiety                                                                                                                                                                                                                                                                                                                                                             | N/A                       | Nurse researcher trained by a clinical psychologist                                  | Group education sessions; clinic-based          | 2nd trimester                            |
| Carvalho et al. (2009)             | 2 (not reported)                                  | 2                                          | Psychological guidance for mothers of preterm babies                                                                                                                                                                                                                                                                                                                                                                     | N/A                       | Psychologist                                                                        | Clinic-based psychological support groups; video and manual support materials | Infant’s hospitalisation                    |
| Cooper et al. (2009); Murray et al. (2015) | 16 (visited, ideally, twice antenatally, weekly for the first 8 weeks postpartum, fortnightly for a further 2 months, and then monthly for 2 months, 1-h visits) | 16                                         | Counselling and psychological support; promoting secure attachment                                                                                                                                                                                                                                                                                                                                                       | N/A                       | Lay community workers trained in intervention manual                                 | Individual; home-based                       | 3rd trimester to 6-months post-partum    |
| Dabas et al. (2019)                | 10 (daily sessions, 30 minutes)                   | 10                                         | Relaxation exercises including deep breathing, Suksham Vyayam, Anulom-Vilom, Brahmari, Progressive muscle relaxation, and deep breathing                                                                                                                                                                                                                                                                                       | N/A                       | Audio recording, supervised by researcher                                          | Audio recording on a laptop; hospital-based    | Post-partum                              |
| Fuhr et al. (2019)                 | 6–14 (30–45 min)                                  | 6–14                                       | Cognitive behavioural therapy with a focus on strategies that incorporate behavioural activation                                                                                                                                                                                                                                                                                                                                      | N/A                       | Peers selected based on their interest in helping/supporting other women in their community, and had good communication skills | Individual, home-based                       | Prenatal to 6 months postpartum          |
| Guo et al. (2020)                  | 36 (6 episodes per week, 15 min)                  | 36                                         | Mindfulness and self-compassion                                                                                                                                                                                                                                                                                                                                                                                          | N/A                       | Online-based                                                                        | Online-based                                   | Pregnancy                                |
| Gureje et al. (2019); Kola et al. (2019); Oladeji et al. (2019) | 12–16 (8 weeks prenatal, weekly or fortnightly postnatal, 30–45 min) | 12–16                                      | Problem-solving treatment including breaking down current stressors and exploring options for resolving these problems                                                                                                                                                                                                                                                                                               | N/A                       | Primary maternal care provider                                                      | Individual, primary maternal care clinic      | Prenatal to 8 weeks postnatal            |

(Continued)
| Study                                                   | Total number of sessions (timing, session duration) | Number of sessions focused on mental health | Content of mental health sessions                                                                 | Content of other sessions | Types of facilitators             | Delivery mode                              | Intervention timing                      |
|--------------------------------------------------------|-----------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------|------------------------------------|-------------------------------------------|------------------------------------------|
| Karamoozian et al. (2015)                              | 12 (12 weekly, 90 min)                              | 12                                          | Stress-coping techniques including an introduction to stressors and stress responses, relationship | N/A                      | Not stated                         | Group training sessions; clinic-based    | Pregnancy                               |
|                                                        |                                                    |                                             | between emotions and thoughts, negative thinking, relaxation training, correction of cognitive |                                                                        |                                    |                                           |                                          |
|                                                        |                                                    |                                             | distortions, training of effective coping responses and anger management                        |                                                                        |                                    |                                           |                                          |
| Langer et al. (1998)                                   | 1 (NR)                                             | 1                                           | Psychosocial support                                                                            | N/A                      | Doula                              | Individual; hospital-based              | Labour through immediate post-partum period |
| Le Roux et al. (2013, 2014); Rotheram-Borus et al. (2014b, 2019a, 2019b); Rotheram-Fuller et al. (2018); Tomlinson et al. (2014, 2015, 2016a, 2016b, 2018); Christodoulou et al. (2019) | On average, 6 antenatal visits (range 1-27), 5 postnatal visits (range 1-12) (about 1.4 sessions a month lasting 31 min on average) | NR                                          | Cognitive behavioural change strategies; teaching problem solving, infant bonding and alcohol use prevention/reduction | Perinatal home visits to teach nutrition, HIV testing/prevention and growth monitoring | Trained community health workers | Individual; home-based | Pregnancy through 6-months post-partum |
| Maselko et al. (2015); Rahman et al. (2008)             | 16 (a session in the last month of pregnancy, three sessions in the first postnatal month, nine 1-monthly sessions thereafter; session duration NR) | 16                                          | Cognitive behavioural intervention aimed at improving ‘positive and healthy thinking’            | N/A                      | Community health workers           | Individual; home-based                 | 3rd trimester through 10-months post-partum |
| Mohd Shukri et al. (2019)                              | 4 (every 2-4 weeks, 2-3 h)                          | 4                                           | Relaxation therapy tape to be used during breastfeeding or milk expression that involved guided imagery designed for breastfeeding mothers | Mothers also received standard breastfeeding support, a guidance booklet, and a list of resources | Researcher                          | Individual; home-based and audio tape  | Post-partum                             |
| Study                          | Duration | Frequency | Intervention Details                                                                 | Provider Details                                                                 | Setting                  | Timeframe                |
|-------------------------------|----------|-----------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------|--------------------------|
| Nabulsi et al. (2019)         | Minimum of 24 | Minimum of 24 | Emotional support and strengthening social capital                                      | Prenatal breastfeeding education, postpartum professional lactation support to improve maternal self-efficacy | Individual, combination of hospital visits, home visits and scheduled calls | Pregnancy to 6-months post-partum |
| Rajeswari & Sanjeevareddy (2020) | 2 (daily, 20–25 min) followed by 10 weeks of practice | 2 | Progressive muscle relaxation and deep breathing                                       | N/A                                                                              | Researcher                | Hospital-based, outpatient | Pregnancy                |
| Rotheram-Borus et al. (2014a) | 8 (4 antenatal, 4 postnatal) | NR | Education about establishing healthy routines without alcohol and smoking, building and maintaining a social network, bonding with the infant and normalising being a women with HIV | Counselling on adherence to recommended HIV care, obtaining a child support grant, condom use and preventing HIV transmission and HIV testing and disclosure | HIV-positive peer mentors trained in cognitive-behavioural skills | Clinic-based              | Pregnancy – 6-months post-partum |
| Sikander et al. (2019)        | 14 (10 sessions delivered during pregnancy and in first 3 months after childbirth 30–45 min) | 14 | Cognitive behavioural therapy with a focus on strategies that incorporate behavioural activation | N/A                                                                              | Peers who were local volunteers, married, 30–35 years, and had displayed communication skills | 10 individual sessions delivered at participants’ homes; 4 group sessions delivered at community health facilities or convenient location | Pregnancy – 6-months post-partum |
| Tripathy et al. (2010)        | 20 (monthly sessions, duration NR) | NR | Social support, problem-solving skills, discussion of MMH challenges                  | Identifying and prioritising maternal and newborn health problems; identifying strategies to address these problems and discussion their effects | Local female facilitator identified by community members | Community-based          | Monthly meetings          |
| Villar et al. (1992)          | 4 (approximately every 4 weeks, 1–2 h) | 4 | Psychosocial/emotional support and decision-making                                   | Promoting healthy behaviour; encouraging prenatal care visit attendance; health education | Social workers, nurses          | Individual, home-based   | 22–34 weeks gestation      |
| Zhao et al. (2017)            | 6 (Timing NR, 1.5 hours) | 5 | Antenatal anxiety, postpartum depression, coping skills, encouraging psychological adjustment | High-risk pregnancy knowledge, supportive husbands                              | Research staff              | Group-based; husband joined for 6th session; hospital-based | Pregnancy (enrolled before 28 weeks gestation) |

(Continued)
Scale (Rodríguez et al., 1974), the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) (Wechsler, 1989), the Strengths and Difficulties Questionnaire (SDQ) (Syed et al., 2007), the Spence Children’s Anxiety Scale (SCAS) (Spence, 1998), the Bayley Scales (version II) (Bayley, 1993) and the World Health Organization (WHO) gross motor milestones (Wijnhoven et al., 2004). Two trials focused on the mother–child relationship: one trial assessed attachment style (Cooper et al., 2009) and one trial measured postpartum bonding (Rotheram-Borus et al., 2014a). Several trials also assessed the incidence of infant morbidities and mortality (Villar et al., 1992; Aracena et al., 2009; Tripathy et al., 2010; Gurje et al., 2019; Rajeswari and SanjeevaReddy, 2020); however, outcome definitions varied substantially between trials. Other outcomes, which were measured in a single trial, include head circumference-for-age (Le Roux et al., 2013) and number of days in the neonatal intensive care unit (Carvalho et al., 2009).

Risk of bias and GRADE certainty of evidence

Few studies showed high risk of bias on two or more of the seven domains assessed in this review. While all included trials were RCTs, three trials did not describe how the randomisation sequence was generated leading to unclear risk of bias. Similarly, the method of allocation concealment was not well described in eight trials. Only ten trials described acceptable methods for blinding outcome assessors. Attrition and selective outcome reporting were common sources of bias that could compromise the validity of trials (Fig. 2). Certainty of evidence ranged from very low to high using the GRADE methodology. Downgrading was due to the high level of heterogeneity across studies (i.e. \(I^2\) above 55%), lack of information on masking of outcome assessors and attrition (online Supplementary File 1).

Narrative synthesis and meta-analyses

A summary of the results from meta-analyses is provided in Table 3. Growth indicators: the earliest growth indicator, low birth weight, was reported in four publications representing three trials. Findings were inconclusive as one trial reported a lower prevalence of low birth weight in infants of mothers in the intervention v. control (Bastani et al., 2006), while others found marginal (Le Roux et al., 2013; Rotheram-Borus et al., 2014b) or no difference in the prevalence of low birth weight between groups (Villar et al., 1992) (online Supplementary File 2). Standardised measures of weight-for-age and height-for-age were evaluated in five trials. Three trials reported weight- or height-for-age on a continuous scale (Rahman et al., 2008; Fuhr et al., 2019; Sikander et al., 2019). The observed effect of the intervention on greater height-for-age in the trial by Rahman and colleagues (2008) was nullified after adjusting for baseline covariates at 6- and 12-months. However, the pooled effect of three trials of the Thinking Healthy Program found a small effect of the intervention on greater height-for-age at 6 months (SMD = 0.13, 95% confidence interval (CI): 0.02–0.24; online Supplementary File 3). Two additional trials measured weight on a continuous scale (Mohd Shukri et al., 2019; Rajeswari and SanjeevaReddy, 2020), and when combined with the three Thinking Health Program trials, we did not find an effect of these interventions on child weight (online Supplementary File 4).

Several publications transformed height-for-age and weight-for-age into a binary variable indicating whether a child was...
stunted or underweight (Rahman et al., 2008; Aracena et al., 2009; Le Roux et al., 2013; Rotheram-Borus et al., 2014a; Tomlinson et al., 2015). Le Roux et al. (2013) found that infants in the home visit intervention group were less likely to be stunted at 6-months, but found no between-group differences for underweight. Tomlinson and colleagues found that infants of depressed mothers in the intervention group were comparable to infants of non-depressed mothers under intervention and control conditions in terms of height-for-age; whereas, infants of depressed mothers under control conditions had lower height-for-age at 6-months. Weight-for-age did not differ by condition or maternal depression (Tomlinson et al., 2015). At 18-months, there was no difference in the odds of stunting between intervention conditions among children of mothers with elevated symptoms of antenatal depression, yet the odds of being underweight were greater under control conditions had lower height-for-age at 6-months. Weight-for-age did not differ by condition or maternal depression (Tomlinson et al., 2015). At 18-months, there was no difference in the odds of stunting between intervention conditions among children of mothers with elevated symptoms of antenatal depression, yet the odds of being underweight were greater under control conditions (Tomlinson et al., 2015). A separate trial that identified a main effect of the intervention on the odds of not being underweight (odds ratio (OR) = 1.08, 95% CI: 1.01–1.16), but no intervention effects on stunting from birth to 12-months (OR = 0.99, 95% CI: 0.90–1.08) (Rotheram-Borus et al., 2014a). Meta-analyses of categorical growth indicators did not find evidence of pooled intervention effects on being underweight, being stunted, and severe acute malnutrition – weight-for-height (online Supplementary Files 5–7).

Fig. 2. Risk of bias in included studies.

Table 3. Summary of quantitative synthesis

| Outcome | Outcome type | Number of trials | Participants | Pooled effect estimate |
|---------|--------------|------------------|--------------|-----------------------|
| Exclusive breastfeeding | Dichotomous | 10 | 4749 | RR = 1.39 (95% CI: 1.13–1.71) |
| Low birthweight | Dichotomous | 3 | 3243 | RR = 0.73 (95% CI: 0.47–1.12) |
| Not stunted (HAZ ≥−2) | Dichotomous | 3 | 1880 | RR = 1.02 (95% CI: 0.97–1.08) |
| Not underweight (WAZ ≥−2) | Dichotomous | 4 | 2505 | RR = 1.00 (95% CI: 0.99–1.02) |
| Weight for height ≥−2 | Dichotomous | 2 | 1151 | RR = 0.92 (95% CI: 0.77–1.10) |
| Weight | Continuous | 5 | 1707 | SMD = 0.16 (95% CI: −0.05 to 0.36) |
| Height | Continuous | 3 | 1388 | SMD = 0.13 (95% CI: 0.02–0.24) |
| Psychomotor development | Continuous | 2 | 496 | SMD = 0.05 (95% CI: −0.13 to 0.23) |
| Cognitive development | Continuous | 3 | 1256 | SMD = 0.07 (95% CI: −0.04 to 0.18) |

Child health status: newborn health status was reported in seven trials and was operationalised as a function of growth and development indicators (Rajeswari and SanjeevaReddy, 2020), infant/foetal complications (Rajeswari and SanjeevaReddy, 2020), incidence of illness (Aracena et al., 2009; Gureje et al., 2019), Apgar score (Karamoozian and Askarizadeh, 2015; Rajeswari and SanjeevaReddy, 2020), duration of hospitalisation (Carvalho et al., 2009) or neonatal mortality (Tripathy et al., 2010). Heterogeneity in outcome definitions precluded meta-analysis of child health status, but independent studies reported positive intervention effects on Apgar scores and neonatal mortality (Tripathy et al., 2010). Heterogeneity in outcome definitions precluded meta-analysis of child health status, but independent studies reported positive intervention effects on Apgar scores and neonatal mortality (Tripathy et al., 2010). Heterogeneity in outcome definitions precluded meta-analysis of child health status, but independent studies reported positive intervention effects on Apgar scores and neonatal mortality (Tripathy et al., 2010). Heterogeneity in outcome definitions precluded meta-analysis of child health status, but independent studies reported positive intervention effects on Apgar scores and neonatal mortality (Tripathy et al., 2010). Heterogeneity in outcome definitions precluded meta-analysis of child health status, but independent studies reported positive intervention effects on Apgar scores and neonatal mortality (Tripathy et al., 2010).
### 2.6.1 Focused Mental Health Interventions

| Study or Subgroup | Intervention | Control | Risk Ratio M-H, Random, 95% CI |
|-------------------|-------------|---------|--------------------------------|
| Sikander 2019     | 18          | 227     | 0.94 [0.51, 1.75]              |
| Fuhr 2019         | 9           | 121     | 0.95 [0.40, 2.26]              |
| Zhao 2017         | 73          | 167     | 0.99 [0.77, 1.26]              |
| Rahman 2008       | 63          | 368     | 1.54 [1.06, 2.22]              |
| Langer 1998       | 41          | 334     | 1.64 [1.01, 2.64]              |
| Gureje 2019       | 73          | 382     | 1.88 [1.18, 2.99]              |

**Subtotal (95% CI)**

| Events | Total | Weight |
|--------|-------|--------|
| 1599   | 1397  | 56.6%  |

Total events: 277. Heterogeneity: $\tau^2 = 0.05; \chi^2 = 10.64, df = 5 (P = 0.06); i^2 = 53\%$

Test for overall effect: $Z = 1.91 (P = 0.06)$

### 2.6.2 Integrated Interventions

| Study or Subgroup | Intervention | Control | Risk Ratio M-H, Random, 95% CI |
|-------------------|-------------|---------|--------------------------------|
| Zhao 2020         | 20          | 91      | 1.15 [0.65, 2.05]              |
| Nabulsi 2019      | 57          | 162     | 1.25 [0.91, 1.72]              |
| Rotheram-Borus 2014 | 57 | 80      | 1.37 [1.08, 1.73]              |
| Le Roux 2013      | 59          | 573     | 3.32 [1.91, 5.78]              |

**Subtotal (95% CI)**

| Events | Total | Weight |
|--------|-------|--------|
| 906    | 847   | 43.4%  |

Total events: 193. Heterogeneity: $\tau^2 = 0.10; \chi^2 = 11.09, df = 3 (P = 0.01); i^2 = 73\%$

Test for overall effect: $Z = 2.28 (P = 0.02)$

**Total (95% CI)**

| Events | Total | Weight |
|--------|-------|--------|
| 2505   | 2244  | 100.0% |

Total events: 470. Heterogeneity: $\tau^2 = 0.06; \chi^2 = 22.84, df = 9 (P = 0.007); i^2 = 61\%$

Test for overall effect: $Z = 3.13 (P = 0.002)$

Test for subgroup differences: $\chi^2 = 0.54, df = 1 (P = 0.46), i^2 = 0\%$

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**Fig. 3.** Exclusive breastfeeding by type of mental health intervention (focused v. integrated).
Breastfeeding: ten trials included breastfeeding as an outcome. Results of the meta-analysis (n = 4749) including data across ten comparisons indicated a sizeable overall impact in favour of intervention with moderate certainty according to the GRADE assessment: RR of 1.39, 95% CI: 1.13–1.71, NNT = 22.00, 95% CI: 15.00–40.90 (Langer et al., 1998; Rahman et al., 2008; Le Roux et al., 2013; Rotheram-Borus et al., 2014a; Zhao et al., 2017; Fuhr et al., 2019; Gureje et al., 2019; Nabulsi et al., 2019; Sikander et al., 2019; Zhao et al., 2020) (Fig. 3). Heterogeneity was significant (I² = 61%) indicating substantial variation between interventions in their impacts on the outcome. Sub-group analyses revealed slightly larger effect sizes for integrated MMH interventions compared to focused MMH interventions, however uncertainty was high in these subgroups.

Maternal–child relationship outcomes: one trial focusing on the mother–child relationship found more secure attachment of infants of mothers under the intervention relative to the control conditions (74 v. 63%), which was driven by a higher probability of avoidant attachment in control infants (19 v. 11%) (Cooper et al., 2009). In contrast, results from another trial found the proportion of infants with ‘normal bonding’ similar under intervention (98%) and control (98.9%) conditions (Rotheram-Borus et al., 2014a).

Developmental outcomes: seven publications representing four trials evaluated one or more of the following domains of child development: cognitive development, language development, socio-emotional development, motor development, physical development, aggressive and prosocial behaviour and executive functioning. When evaluating development as one broad outcome, there were no differences between infants of mothers under the intervention relative to the control conditions in the short- and long-term (Aracena et al., 2009; Rotheram-Borus et al., 2014a; Rotheram-Borus et al., 2014b; Maselko et al., 2015). Results focusing on specific domains of child development were mixed (Aracena et al., 2009; Maselko et al., 2015; Murray et al., 2015). Cognitive and psychomotor developments were the only indicators measured in more than one study. We did not observe an impact of MMH interventions on cognitive development (3 trials, 1256 participants, SMD = 0.07, 95% CI: 0.04 to 0.18, I² = 0%; online Supplementary File 8) (Maselko et al., 2015; Murray et al., 2015; Tomlinson et al., 2018). Similarly, there was no effect of MMH interventions on psychomotor development (2 trials, 496 participants, SMD = 0.05, 95% CI: −0.13 to 0.23, I² = 0%; online Supplementary File 9) (Aracena et al., 2009; Le Roux et al., 2013).

Discussion

The aim of this systematic review and meta-analysis was to summarise existing experimental knowledge regarding the impact of MMH interventions on child-related outcomes. We identified 21 RCTs reporting on more than 28 000 participants. All trials focused on common mental disorders and most were conducted in middle-income countries.

The most commonly included outcome across these trials was exclusive breastfeeding. A recent meta-analysis found breastfeeding to be protective against child infections and malocclusion, associated with higher intelligence, and probable reductions in overweight and diabetes (Vicotra et al., 2016). Nevertheless, only 37% of children under 6-months are exclusively breastfed in LMICs (Vicotra et al., 2016). In our study, meta-analysis of ten comparisons with a combined number of 4749 women showed that with intervention 39% more children are exclusively breastfed than under control conditions.

Given the varied nature of the interventions, it is challenging to single out the unique influence of the MMH components on improved rates of exclusive breastfeeding. However, one broad observation supports the contribution that MMH components can make in improving rates of exclusive breastfeeding. Future studies can be improved in two ways to clarify the impact of mental health components on exclusive breastfeeding. First, trials could be designed specifically so that mediation analyses can be conducted to assess whether improvements in MMH are in turn associated with exclusive breastfeeding. Second, head-to-head comparisons of interventions with and without a mental health component would be helpful to estimate the additional contribution of MMH components in integrated interventions.

Meta-analyses on other outcomes did not identify sizeable benefits of intervention and there was high heterogeneity between studies. These meta-analyses were limited by fewer available publications relative to the exclusive breastfeeding meta-analysis and should be interpreted with caution. There was a significant pooled effect of intervention on child height, but the effect size was small and only incorporated findings from three trials. There were trends favouring intervention for cognitive and psychomotor development, low birth weight, weight-for-age and height-for-age, but these did not reach statistical significance. It is possible that MMH interventions may have impacts on particular development domains, but not on broad indicators of child development. Similarly, MMH interventions may have impacts on particular growth indicators at specific developmental stages.

Before discussing implications of this systematic review and meta-analysis, we note the strengths and limitations of the existing literature. Overall, few trials included in this systematic review showed high risk of bias. Attrition and lack of masking were the greatest sources of potential bias. We presented conservative intention-to-treat analyses, but attrition introduced significant uncertainty in estimates. A substantive limitation to the generalisability of this review is that all interventions were focused on common mental disorder. It would be helpful for future studies to also evaluate whether interventions for other mental health outcomes (e.g. psychosis) are associated with improvements in child-related outcomes. Additionally, only one trial was conducted in a low-income country. Scaling of interventions may be particularly challenging in such settings, so further studies assessing impacts in low-income countries would be useful. Finally, there was substantial variation in how outcomes were defined and assessed, which limited the possibility to conduct meta-analyses for some outcomes.

Results from this review should be considered in light of several limitations in the review process. First, we included trials with diverse populations, who may respond differently to MMH interventions. Second, we included child outcomes that were reported across different studies, but did not prespecify primary v. secondary outcome measures, increasing the risk for selective reporting. However, we attempted to report on all available outcomes, without focusing only on those that were included in statistical re-analysis. The data used for our meta-analysis were primarily extracted from unadjusted results (means, standard deviations for continuous outcomes; n, percentage for binary outcomes), which in few instances resulted in marginally different measures of associations compared to adjusted models reported in the original trial publications. However, restriction of our searches to RCTs should reduce concerns of confounding and selection bias and thus these differences in outcome-specific inferences are not expected to result in substantial bias in our meta-analyses. Third, we did not specify...
sub-group analyses a priori as we were not sure which different intervention types had been studied and our review protocol was not pre-registered. While we aimed to report on the complete set of studies, outcomes and interventions that met our eligibility criteria, it is possible that not having published the study protocol prior to conducting the review may have introduced meta-bias. It is also possible that due to publication bias, our review does not reflect a fully representative synthesis of the evidence on the effect of MMH interventions on child development outcomes (Bender et al., 2018). To mitigate this potential for publication bias, we searched eight non-academic databases to include unpublished literature meeting our eligibility criteria.

Notwithstanding these limitations, results of this systematic review and meta-analysis are promising and have implications for policy and practice. We identified a sizeable number of RCTs that evaluated the impact of MMH interventions on child-related outcomes in LMICs. Whereas impacts of these interventions on most child outcomes were uncertain, we identified a promising sizeable impact of MMH interventions on rates of exclusive breastfeeding, an outcome of vital public health importance globally. Evidence from this review further supports the importance of improving MMH, which has similarly been recommended by the WHO, as a strategy to further the critical effort to improve child health in LMICs.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S2045796020000864.

Data. Data extracted from included studies for the narrative review and meta-analysis are available online: https://osf.io/qwdet/.

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Author contributions. WAT and MCG developed the protocol. WAT and MCG developed and performed the search strategy. MCG and MEL screened titles and abstracts. WAT, MCG, MEL, MP and CB reviewed full texts and assessed study eligibility. MCG, MEL and MP assessed risk of bias and credibility of evidence. MP performed the meta-analysis and quantitative synthesis. WAT, MCG, MEL, KLR, CB, MP, MT and CB all contributed to writing, reading and approving this paper. The corresponding author, WAT, attests that all authors meet authorship criteria and no others meeting that criteria have been omitted.

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Ethical standards. Not applicable.

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