Massage intervention for promoting mental and physical health in infants aged under six months (Review)

Underdown A, Barlow J, Chung V, Stewart-Brown S

THE COCHRANE COLLABORATION®

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2009, Issue 1

http://www.thecochranelibrary.com

TABLE OF CONTENTS

[Intervention Review]

Massage intervention for promoting mental and physical health in infants aged under six months

Angela Underdown[1], Jane Barlow[2], Vincent Chung[3], Sarah Stewart-Brown[2]

[1]Institute of Education, Warwick Medical School, Coventry, UK. [2]Health Sciences Research Unit, Warwick Medical School, Coventry, UK. [3]School of Public Health (Room 509), Chinese University of Hong Kong, NT, Hong Kong, China

Contact address: Angela Underdown, Institute of Education, Warwick Medical School, University of Warwick, Coventry, CV4 7AL, UK. angela@underdown5.freeserve.co.uk,a.underdown@warwick.ac.uk.

Editorial group: Cochrane Developmental, Psychosocial and Learning Problems Group.
Publication status and date: Edited (no change to conclusions), published in Issue 1, 2009.
Review content assessed as up-to-date: 10 August 2005.

Citation: Underdown A, Barlow J, Chung V, Stewart-Brown S. Massage intervention for promoting mental and physical health in infants aged under six months. *Cochrane Database of Systematic Reviews* 2006, Issue 4. Art. No.: CD005038. DOI: 10.1002/14651858.CD005038.pub2.

ABSTRACT

Background

Infant massage is increasingly being used in the community for low-risk babies and their primary care givers. Anecdotal claims suggest benefits for sleep, respiration, elimination and the reduction of colic and wind. Infant massage is also thought to reduce infant stress and promote positive parent-infant interaction.

Objectives

The aim of this review was to assess the effectiveness of infant massage in promoting infant physical and mental health in population samples.

Search strategy

Searches were undertaken of CENTRAL 2005 (Issue 3), MEDLINE (1970 to 2005), PsycINFO (1970 to 2005), CINAHL (1982 to 2005), EMBASE (1980 to 2005), and a number of other Western and Chinese databases.

Selection criteria

Studies in which babies under the age of six months were randomised to an infant massage or a no-treatment control group, and utlising a standardised outcome measuring infant mental or physical development.

Data collection and analysis

Weighted and standardised mean differences and 95% confidence intervals are presented. Where appropriate the results have been combined in a meta-analysis using a random effects model.

Main results

Twenty-three studies were included in the review. One was a follow-up study and thirteen were included in a separate analysis due to concerns about the uniformly significant results and the lack of dropout. The results of nine studies providing primary data suggest that infant massage has no effect on growth, but provides some evidence suggestive of improved mother-infant interaction, sleep and relaxation, reduced crying and a beneficial impact on a number of hormones controlling stress. Results showing a significant impact on

number of illnesses and clinic visits were limited to a study of Korean orphanage infants. There was no evidence of effects on cognitive and behavioural outcomes, infant attachment or temperament. The data from the 13 studies regarded to be at high risk of bias show uniformly significant benefits on growth, sleep, crying and bilirubin levels.

Authors' conclusions

The only evidence of a significant impact of massage on growth was obtained from a group of studies regarded to be at high risk of bias. There was, however, some evidence of benefits on mother-infant interaction, sleeping and crying, and on hormones influencing stress levels. In the absence of evidence of harm, these findings may be sufficient to support the use of infant massage in the community, particularly in contexts where infant stimulation is poor. Further research is needed, however, before it will be possible to recommend universal provision.

PLAIN LANGUAGE SUMMARY

Massage for promoting mental and physical health in infants under the age of six months

This review aimed to assess the impact of infant massage on mental and physical outcomes for healthy infants in the first six months of life. A total of 23 randomised controlled trials were included. Thirteen of these that were assessed to have a high risk of bias and were analysed separately. One study reported follow-up data only. It was only possible to combine the results of the remaining studies for a very small number of outcomes. The results of nine studies suggest that infant massage has no effect on growth, but provides some evidence suggestive of improved mother-infant interaction, improved sleep and relaxation, reduced crying and a beneficial impact on a number of physiological processes. Results showing a significant impact on number of illnesses and clinic visits were limited to a study of Korean orphanage infants. There is no evidence of any impact on infant attachment, temperament, psychomotor or mental development. These results provide tentative evidence to support current practice with regard to the teaching of infant massage in the community during the first six months of life, but fall short of the evidence needed to recommend universal provision. Further research is needed to identify the relative benefits in different population groups, its influence on outcomes such as mother-infant interaction, and the physiological mechanisms involved. Further research is also needed to identify the relative benefits of the different approaches to infant massage, the best approach to teaching parents and the optimum frequency and intensity.

BACKGROUND

In many areas of the world especially in the African and Asian continents, indigenous South Pacific cultures and the Soviet Union, infant massage is a traditional practice (Field 1996b). A recent survey of 332 primary caretakers of neonates in Bangladesh, for example, found that 96% engaged in massage of the infant's whole body between one and three times daily (Darmstadt 2002). Health care practitioners in Western cultures have become interested in infant massage primarily as an intervention for infants in neo-natal intensive care units (NICU) where the environment is stressful and lacking in tactile stimulation. Massage is thought to benefit sleep, respiration, elimination and the reduction of colic and wind (Field 2000b) as well as parent-infant interaction. Increasingly, parents and carers of low-risk babies in the Western world are being taught massage to promote infant development.

The practice of infant massage varies across the world. For example, while the International Association of Infant Massage teaches the use of nurturing touch and respectful communication in its training, other methods of training may emphasise yoga based movements and flexibility. Therefore, although infant massage practitioners may have received common training their individual approaches often vary.

Physiological and psychological benefits of infant massage

Investigations into the effects of infant massage have been conducted mainly with pre-term infants and focus on outcomes important in this group including weight gain, activity levels and length of stay in hospital (Vickers 2004; Ireland 2000). Vickers 2004 found that massage improved daily weight gain in this group by 5.1g (95% CI 3.5, 6.7g) and reduced the length of hospital stay by 4.5 days (95% CI -1.2, 1.6g). This review also found some evidence that massage interventions had a small positive effect on

weight at 4-6 months. However, serious concerns were raised about the methodological quality of the studies, particularly in respect of selective recording of outcomes. Ireland 2000 reviewed literature on massage and therapeutic touch in children, examining seven studies of massage therapy for preterm infants without other co-morbid conditions. This review also showed a beneficial effect on weight-gain, activity level, and hospital stay.

Some of the mechanisms by which massage might promote growth have been investigated. Uvnas-Moberg 1987 reported that massage increased vagal activity and secretion of insulin and gastrin improving the absorption of food, and Field 1996b reported that massage results in a reduction in salivary cortisol. High cortisol levels have damaging effects on the developing brain (Chugani 2001; Carlson 1997) and impair the development of circadian rhythms which control sleep patterns. Other claims for physiological benefit are wide and include improvements in sleep, elimination and the reduction of colic and wind (Field 2000b). These effects are likely to be important in families where infants are stressed and sleep regulation is problematic.

Early parent-infant relationships are important for normal mental and emotional development (Stern 1998; Sroufe 1996; Steele 1996). The more sensitive the parent is to an infant's signals and cues at two months the better the outcomes for cognitive and emotional development (Murray 1992). Lack of such synchrony may be the foundation of behavioural and physiological difficulties (Gianino 1988). The quality of the parent-infant interaction relies to a large extent on the parent's ability to read and respond appropriately to the infant's emotional state (Kropp 1987; Zeanah 2000). Infants who are responded to sensitively with gentle touch, eye contact and infant-directed speech, which is taught in massage groups, are more likely to form secure attachments and to have a solid foundation for positive mental health (Tronick 1982).

Gunnar 1993 has demonstrated that infants who receive responsive care are likely to have an effective dyadic stress regulatory system by six months whereas infants who experience repeated unregulated stressful experiences are likely to have anxious dispositions. Other research shows a clear association between poor maternal-infant relationships and outcomes such as emotional and cognitive deficits (Cogill 1986) and a range of mental health problems (Fonagy 1997).

The use of imaging techniques that can capture brain functioning suggests that such early interactions between carer and infant can influence the development of brain structures responsible for the individual's socio-emotional functioning for the rest of the lifespan (Schore 1994) and environmental stimulation which includes touch, has been shown to influence the myelination of neurons and proliferation of dendrites (Schore 1994; Carlson 1997).

The need for the current review

In many Western cultures health staff and independent practitioners are undertaking training to teach infant massage techniques to parents of healthy babies in the community with the aim promoting mother-infant interaction, and optimal infant development. Numerous evaluations have assessed the effectiveness of infant massage offered to normal babies, but the evidence from these has not to date been summarised in a systematic review.

OBJECTIVES

To assess

a) whether infant massage intervention is effective in promoting infant mental health including infant-adult interaction in population samples;

b) the role of infant massage intervention in the promotion of infant physical health in population samples.

METHODS

Criteria for considering studies for this review

Types of studies

Studies were included if participants had been randomised to either an infant massage group or a control group that received no intervention. The review also included quasi randomised study designs.

Types of participants

Babies under the age of six months were eligible for inclusion. Studies focusing on pre-term and low birth-weight babies receiving massage within a hospital setting were excluded.

Types of interventions

Studies were included if they evaluated the effectiveness of infant massage, irrespective of the theoretical basis or cultural practice underpinning the massage. Infant massage was defined in this review as systematic tactile stimulation by human hands. This included studies where the technique of infant massage had been specifically taught to parents and/or staff, and evaluations of infant massage where it was used as a routine cultural practice. Multimodal interventions, of which massage was a part, were also included provided evidence of the benefits of massage as a separate intervention could be elicited.

Types of outcome measures

To be eligible for inclusion in the review, studies had to include at least one standardized instrument measuring the effect of infant massage on either infant mental health (for example, the CARE-Index to measure infant-adult interaction) or on physical health (for example, growth monitoring).

Search methods for identification of studies

Electronic searches

Relevant studies were identified through electronic searches of the following electronic databases:
Cochrane Central Register of Controlled Trials (CENTRAL) 2005 (Issue 3)
MEDLINE (1970 to August 2005)
PsycINFO (1970 to August 2005)
CINAHL (1982 to August 2005)
EMBASE (1980 to August 2005)
Dissertation Abstracts (1981 to August 2005)
AMED (Alternative and Complementary Medicine) (1985 to August 2005)
LILACS (Latin American & Caribbean Health Sciences Literature) (1982 to August 2005)
The National Research Register (2005) Issue 3
Clinicaltrials.gov (1966 to 2005)
Cochrane Neonatal Review Group specialised register (1966 to 2005)
VC undertook a search of the following Chinese database(s):
Chinese Scientific Journal Database (Jan 89-Oct 05)
Traditional Chinese Medicine Database (Jan 84 - Sept 05)
Chinese BioMedical Database (Jan 89 - Oct 05)
China Academic Journal Full Text Database (Jan 94 - Oct 05)
China Proceedings of Conference Databases (Jan 99 - Oct 05)
China Doctorate / Master Dissertations Full Text Databases (Jan 99 - Oct 05)
The search terms were adapted for use in different databases. No methodological terms were included to ensure that all relevant papers were retrieved.
The following strategy was used to search CENTRAL:
#1 MASSAGE (Mesh)
#2 Massage next therap*
#3 Therapeutic next touch
#4 THERAPEUTIC TOUCH (Mesh)
#5 TOUCH
#6 Tactile next stimulation
#7 #1 or #2 or #3 or #4 or #5 or #6
#8 infant* or baby or babies
#9 #7 and #8
The strategy used for MEDLINE, AMED and CINAHL was:
#1 exp MASSAGE/ or massage.mp.
#2 (massage adj therap$).mp
#3 (therapeutic adj touch).mp
#4 exp TOUCH/ or exp THERAPEUTIC TOUCH/ or touch.mp.
#5 (tactile adj stimulation).mp.
#6 1 or 2 or 3 or 4 or 5
#7 (infant$ or baby or babies).mp.
#8 6 and 7
The strategy used for EMBASE was:
#1 exp MASSAGE/ or massage.mp.
#2 (massage adj therap$).mp
#3 (therapeutic adj touch).mp
#4 exp TOUCH/ or touch.mp.
#5 (tactile adj stimulation).mp.
#6 1 or 2 or 3 or 4 or 5
#7 (infant$ or baby or babies).mp.
#8 6 and 7 (1415)
The strategy used for LILACS was:
massage or massage therapy or massage therapies [Words] or therapeutic touch or touch or tactile stimulation [Words] and infant or infants or baby or babies [Words]
The strategy used for PsycINFO was:
#10 (infant* or baby or babies) and (#1 or #2 or #3 or #4 or #5 or #6 or #7)
#9 infant* or baby or babies
#8 #1 or #2 or #3 or #4 or #5 or #6 or #7
#7 tactile adj stimulation
#6 therapeutic touch
#5 TOUCH
#4 therapeutic adj touch*
#3 massage adj therap*
#2 massage
#1 MASSAGE
The strategy used for the National Research Register was:
#1 MASSAGE (Mesh)
#2 Massage next therap*
#3 Therapeutic next touch
#4 THERAPEUTIC TOUCH (Mesh)
#5 TOUCH
#6 Tactile next stimulation
#7 #1 or #2 or #3 or #4 or #5 or #6
#8 infant* or baby or babies
#9 #7 and #8
Dissertation Abstracts, ClinicalTrials.gov, Cochrane Neonatal Review Group specialised register and the Chinese databases were searched using the terms:
Infant or infants or baby or babies AND massage
There was no language restriction. Relevant papers were translated or data extracted by researchers fluent in written Chinese where necessary.

Searching other resources

Reference lists of articles identified through database searches and bibliographies of systematic and non-systematic review articles were examined to identify further relevant studies.

Data collection and analysis

Selection of trials

Titles and abstracts of trials identified through searches of electronic databases were independently reviewed by two reviewers to determine whether they met the inclusion criteria (AU and JB; and VC and JH for Chinese studies). Abstracts that did not meet the inclusion criteria were rejected. Two independent reviewers (AU and JB; and VC and YH for Chinese studies) assessed full copies of papers that appeared to meet the inclusion criteria. Uncertainties concerning the appropriateness of studies for inclusion in the review were resolved through consultation with a third reviewer (SSB).

Assessment of quality and susceptibility to bias

Critical appraisal of the included studies was carried out by two reviewers (AU and JB). Disagreement was resolved by consultation with a third reviewer (SSB).

Trials were assigned a quality category based on allocation concealment because of the potential for bias where allocation is not concealed (Alderson 2004). Categories are described in the Cochrane Collaboration Handbook and are as follows:

(A) indicates adequate concealment of allocation (for example, by telephone randomisation, or use of consecutively numbered, sealed, opaque envelopes); these studies have a low risk of bias.

(B) indicates uncertainty about whether the allocation was adequately concealed (for example, where the method of concealment is not known); these studies have a medium risk of bias.

(C) indicates that the allocation was definitely not adequately concealed (for example, open random number lists or quasi-randomisation such as alternate days, odd/even date of birth, or hospital number) and at high risk of bias.

Quasi-randomised trials were allocated to category C.

The following aspects of the study, which may increase bias, were also appraised: the numbers in each group, number of children lost to follow-up, the method of dealing with attrition/drop outs, use of blinding to assess outcomes, and whether there was any assessment of the distribution of confounders. Where there was insufficient information provided about any aspect of study quality, clarification was sought from the trial authors.

Data Management

Data were extracted independently by two reviewers and entered into RevMan 4.2.7. Where data were not available in the published trial reports, authors were contacted to supply missing information.

Tests of homogeneity

An assessment was made of the extent to which there were variations in the methods, population, intervention or outcome. Consistency of results was assessed by visual inspection of the forest plot and by examining I^2 (Higgins 2002), a quantity which describes the approximate proportion of variation in point estimates that is due to heterogeneity rather than sampling error. We supplemented this with a test of homogeneity to determine the strength of evidence that the heterogeneity was genuine. The possible reasons for heterogeneity were explored by scrutinising the studies and where appropriate performing sub-group analyses.

Synthesis of the data

There was some clinical heterogeneity across the included studies (see below - Description of studies), and also some statistical heterogeneity for the small number of outcomes for which it was possible to combine the data. Quantitative syntheses of the data have therefore been undertaken using a random effects model.

Continuous outcomes were analysed if the mean and standard deviation of endpoint measures were presented. Where mean scores were not available, significance levels reported in the paper have been presented. Where baseline or pre-treatment means were available, these were examined to determine similarities between groups. For the meta-analyses of continuous outcomes, weighted mean differences (WMDs) between groups were estimated. In the case of continuous outcome measures where data were reported on different and incompatible scales, data were analysed using the standardised mean difference (SMD).

Where it was not possible to synthesise the data, effect sizes and 95% confidence intervals are presented for individual outcomes in each study.

In one study Argawal 2000 four different types of massage oil were compared with outcomes for a control group. In order to incorporate the results of this study it was necessary to calculate combined means and SDs for the four active treatments in order to compare them to the control without double-counting the control group. A formula supplied by Dr Julian Higgins to the CDPLPG was used.

Sensitivity Analysis

A sensitivity analysis was used to assess the robustness of the findings by examining the impact of one large study (Kim 2003). This was undertaken because we were concerned that this study dominated the meta-analysis and that the results of this study may have been due to the fact that the sample comprised infants receiving orphanage care (i.e. with unusually low levels of tactile stimulation) whereas the remaining studies comprised infants receiving usual levels of tactile stimulation from parents.

13 studies considered to be at high risk of bias have been analysed separately. This was a post hoc decision based on concerns about the uniformly positive results, inadequate information about the design and conduct of these studies, and the reported absence of any dropout.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Results of the search

Of the 809 abstracts reviewed from Western databases, most were of no relevance to full-term infants. After closer inspection of 35 abstracts, 9 studies were identified as being suitable for inclusion, one of which was a follow-up only (Koniak-Griffin 1995). A hand-search of references was conducted, which resulted in the identification of one further study (Ke 2001). Of the 100+ abstracts reviewed from the Chinese databases 12 studies were identified as suitable for inclusion, producing in total 13 Chinese studies (Liu Chun 2005; Liu 2005; Lu 2005; Na 2005; Shao 2005; Sun 2004; Ye 2004; Xua 2004; Duan 2002; Shi 2002; Ke 2001; Zhai 2001; Wang 1999), one Korean (Kim 2003), one Israeli (Ferber 2002), one British (Onozawa 2001) and six North American (Elliott 2002; Cigales 1997; Jump 1998; Field 1996; Koniak-Griffin 1995; Koniak-Griffin 1988).

Included studies

All included studies were parallel group trials.

One of the included studies focused on orphanage infants (Kim 2003). This study was included because there was no indication in the paper that the infants were not healthy full-term babies. One study where the control group received rocking (Elliott 2002) was also included as this was considered to be usual soothing behaviour.

Types of massage

The massage programmes evaluated in the included studies varied in terms of duration and frequency. In one study infants were massaged once only for 8 minutes (Cigales 1997). In another, infants received a daily 30 minutes intervention over 14 days (Ferber 2002). In the Kim 2003 study infants were massaged 15 minutes, twice daily for 4 weeks. In further studies, infants received 10 minutes of massage daily over a four week period (Argawal 2000) or a minimum of 10 minutes massage daily over 16 weeks (Elliott 2002). In the Field 1996 study infants received 15 minutes of massage twice weekly over a period of six weeks and in the Koniak-Griffin 1988 study infants received 5-7 minutes of massage daily over 3 months. In Jump 1998 and Onozawa 2001, mothers were taught massage techniques for approximately an hour per week as part of four, weekly, group-based sessions, following which the continuation of this practice at home varied according to parental motivation. In the 13 Chinese studies infants were mostly massaged for fifteen minute periods up to three times a day over a period extending up to 6 weeks (Liu 2005; Liu Chun 2005; Lu 2005; Na 2005; Shao 2005; Sun 2004; Ye 2004; Xua 2004; Duan 2002; Shi 2002; Ke 2001; Zhai 2001; Wang 1999). In Cigales 1997 massage was administered only once prior to the conduct of an experimental task to assess the impact of massage on cognitions.

The person offering the massage also varied from study to study. In three studies it was offered by research associates (Cigales 1997; Field 1996; Kim 2003). In the Kim 2003 study, orphans received a multi-modal intervention of massage, talking and eye contact from research associates who were trained to be responsive to the infant's responses. Although it was not possible to isolate the effects of eye contact and talking, this study was included because both these components are an intrinsic part of some included infant massage programmes. Field 1996 used trained researchers to massage the infants of depressed adolescent mothers.

In four further studies (Argawal 2000; Elliott 2002; Ferber 2002; Koniak-Griffin 1988) parents were taught massage techniques prior to them conducting massage on their infants in the home. In Argawal 2000 mothers were given instruction and training and their technique was monitored each week when they attended clinic to collect more oil. In the Elliott 2002 study mothers were taught the massage strokes when their infants were between 7 and 10 days old, and a research assistant visited the home to monitor the parents use of the technique. Parents also received an instructional videotape and written guidance. In Ferber 2002, mothers were instructed how to massage their infants as part of the bedtime routine and a research assistant telephoned on three occasions to ensure compliance. In Koniak-Griffin 1988, mothers were instructed how to massage their infants and the massage technique was monitored using maternal self-report. In the 13 Chinese studies the massage was mostly administered by a nurse with specialist training in infant massage, following which the technique was taught to the parents who continued the massage at home.

In two studies (Jump 1998 and Onozawa 2001), mothers were taught infant massage as part of a weekly group-based session. In the Jump 1998 study mothers and infants attended group sessions on a weekly basis for 45 - 60 minutes over the course of 4 weeks. During this time mothers were taught the massage techniques and were also given information about infant development. In the Onozawa 2001 study mothers attended weekly group-based sessions for 70 minutes over the course of five weeks. The class leaders were trained by an International Association of Infant Massage teacher (I.A.I.M) who aimed to encourage parents to observe and respond to their infant's cues and adjust their touch accordingly.

It was clear from a small number of studies where information was provided that the intensity or the amount of pressure applied during the massage varied from studies to study. In Koniak-Griffin 1988 infants were massaged using a six step sequential, cephalocaudal progression of stroking and gentle massage of the ventral and dorsal surfaces of the infant's body. In Kim 2003 researchers were trained to stroke each part of the infant's body in sequence

and the process, intensity and pace of the intervention was agreed and reliability maintained at 96% during the course of the study. In Cigales 1997 the infants were massaged only on one occasion prior to an habituation task and this massage is described as deep, but gentle massage of the whole body. Argawal 2000 used a standardised regimen based on traditional Swedish Massage practices. The mothers were given instructions and training for uniformity of massage strokes in terms of technique (force and direction) and time spent massaging individual body parts. Elliott 2002, Jump 1998 and Onozawa 2001 do not describe the amount of pressure used. Field 1996 gives a detailed description of each massage stroke and ensured that the researchers applied the correct intensity and pressure was applied. Where it was possible to obtain this information for the 13 Chinese studies a variety of amounts of pressure were used. For example, Ke 2001 describes how an additional method of kneading the back was added to the traditional massage method.

It was rarely possible to identify massage which focused on carer infant communication from massage which was more physically based.

The mean age of the study infants was below six months, and they were all healthy, full-term babies.

Outcomes measured

Four studies (Kim 2003; Argawal 2000; Field 1996; Koniak-Griffin 1988) assessed the impact of massage on physical outcomes including height, weight, and head circumference. Field 1996 also measured formula intake. Argawal 2000 investigated the effect of different massage oils on physical growth and on physiological changes in blood flow and vessel diameter. Field 1996 measured levels of cortisol, epinephrine, norepinephrine and serotonin before and after massage, and Ferber 2002 measured 6-sulphatoxyymelatonin in urine. Two studies assessed the impact of massage on the mother-infant relationship (Onozawa 2001; Jump 1998). Cognitive outcomes such as habituation were measured by Cigales 1997. Other outcomes included infant temperament (Elliott 2002; Jump 1998; Field 1996) and infant development (Koniak-Griffin 1988). Several studies evaluated the effects of massage on sleep using a range of different measures (Argawal 2000; Field 1996; Ferber 2002). Ferber 2002 also measured activity patterns. The 13 Chinese studies focused on growth, sleep, crying and bilirubin levels (Liu Chun 2005; Liu 2005; Lu 2005; Na 2005; Shao 2005; Sun 2004; Xua 2004; Ye 2004; Duan 2002; Shi 2002; Ke 2001; Zhai 2001; Wang 1999).

Excluded studies

The main reason for exclusion of studies was the absence of randomisation Darmstadt 2002; Clarke 2000; Stack 1990; Fernandez 1998; Peláez-Nogueras 1997; Peláez-Nogueras 1996; Peláez-Nogueras1997b; Pardew 1996; Ineson 1995) or lack of an appropriate control group (Field 2004; Huhtala 2000). In addition, one study was excluded due to the use of an ineligible intervention (Field 2000b). Two studies were excluded because of ineligible populations - in one the infants were HIV-exposed and were lower gestational age and birth weight than normal (Scafidi 1996), and in the second infants were above six months of age (Cullen 2000). One was a repeat of data published elsewhere (Glover 2002). Full details can be found in the table of excluded studies.

Risk of bias in included studies

The methodological quality of the 13 studies thought to have a high risk of bias due to the uniformly positive results and the absence of dropout is not reported further here.

Allocation concealment

All studies in this review used at least quasi-randomised methods of allocating participants to groups. Some studies specified details of randomisation, for example Argawal 2000 used a random number table. Kim 2003 and Jump 1998 used the flip of a coin to assign the first infant and the remaining infants were alternatively allocated to the intervention or control group. Elliott 2002 used a repeated measures design involving a randomised two-way layout with treatment factors 'carrying' and 'massage' as two levels to ensure that every dyad had an equal chance of being assigned to one of four groups. The remaining studies did not specify the method of allocation concealment.

Dropout

Several studies reported no dropout or attrition (Argawal 2000). Argawal 2000 was strictly regulated with mothers attending weekly to have their massage techniques monitored and to return empty oil bottles before collecting their next week's supply of specific oils. Field 1996 reported no dropout for 40 post-natally depressed mother-infant dyads because the infants were being cared for by teachers in a nursery school during the six week study.

The remaining studies all reported some dropout. Jump 1998 reported a 21% drop out rate; although mothers from both groups who left the study were less educated and had younger infants than those remaining in the study, the groups were otherwise alike demographically. A total of 15% of mothers dropped out of Elliott 2002 - five withdrew because they no longer met the eligibility criteria (the infants required hospital care), 1 infant was still born, 4 left because of family issues and 7 dropped out because they found the study too time consuming. Ferber 2002 reported a dropout rate of 20% with no significant differences between the two intervention and control groups; they attribute this to their demanding research protocol. Koniak-Griffin 1988 reported a drop out rate of 2% at 4 months and 7% at 8 months among 81 infants, mainly

due to families moving out of the area. Cigales 1997 excluded 34% of infants from the investigation due to excessive crying or fussing (n =12), falling asleep (n =3), experimenter error (n =4) and fatigue (n =1), which may have biased the results. In Onozawa 2001 a total of 35% of the sample dropped out because the time of the class was inconvenient (7 from the massage and 2 from the control group did not complete and a further 2 mothers in the massage group and 1 in the control group did not have interactions recorded because their infants were unsettled). The infants who started and did not complete the study were not significantly different demographically from those that completed.

Only two studies undertook follow-up (Kim 2003; Koniak-Griffin 1995). Kim 2003 lost 22% of 58 orphaned infants at the 6-month follow-up, due to adoption. The loss was evenly spread between the groups, impacting on the power but not the quality of the study. Koniak-Griffin 1995, which was a follow-up from Koniak-Griffin 1988, presented data for only 41 children at 4-, 8- and 24-months representing an attrition rate of 39%. This was due in the main to families moving out of the area. Communication with the author confirmed that in the follow-up study (Koniak-Griffin 1995) data were shown at 4- and 8-months only for those 41 infants who had completed the study at 24-months

Intention to treat analysis

None of the included studies explicitly state that they were conducted on an intention-to-treat basis. Three studies do not have any dropout (Onozawa 2001; Argawal 2000; Field 1996).

Blinding to treatment

Blinding of the facilitators or parents who provided the infant massage intervention was not possible in most studies, although in the Field 1996 study nursery teachers and parents were unaware of the infants' allocation. Four studies (Kim 2003; Elliott 2002; Cigales 1997; Koniak-Griffin 1988) used independent assessors who were blind to the intervention group. Kim 2003 highlights the fact that despite precautions being taken to keep the orphanage staff blind to group assignment (staff members were out of the room during the intervention period) the staff may have become aware of the group assignment. In Onozawa 2001 the assessment of mother-infant interaction scores was completed by the researcher who was aware of the infants' allocation groups. However, 10 dyads were coded by an experienced independent rater who was blind to study group and the researcher's reliability ratings were checked against the blinded coder. Two groups of dimensions did not meet the reliability standards and these were eliminated from the study. Ferber 2002 states that both the actigraph measurements and the 6-sulphatoxyymelatonin secretions were analysed separately but does not clarify whether the assessors were blind to the participant group. Jump 1998 did not use independent assessors.

Distribution of confounders

While the use of randomisation should in theory ensure that any possible confounders are equally distributed between the arms of the trial, small numbers of trial participants may result in an unequal distribution of confounding factors. It is therefore important that the distribution of known potential confounders is i) compared between the different study groups at the outset or ii) adjusted for at the analysis stage. Seven studies (Kim 2003; Elliott 2002; Ferber 2002; Onozawa 2001; Jump 1998; Field 1996; Koniak-Griffin 1988) provided an analysis of the distribution of baseline demographic factors. The remaining studies did not report checks of the similarity of demographic details.

Effects of interventions

A. Massage versus control group (excluding studies at high risk of bias)
1.1 Physical health outcomes
1.2 Mental health outcomes
B. Results of studies at high risk of bias
C. Follow-up results (excluding studies at high risk of bias)
D. Follow-up results for studies at high risk of bias
(NB: a minus sign indicates that the result favours the intervention group

A. MASSAGE VERSUS CONTROL GROUP (excluding studies at high risk of bias)

1. INFANT OUTCOMES

1.1 PHYSICAL HEALTH

1.1.1 Growth

1.1.1.1 Weight

Four studies (Kim 2003; Argawal 2000; Field 1996; Koniak-Griffin 1988) evaluated the impact of massage on infant weight. The four studies report a sample of 264 infants and the results of the meta-analysis indicate that there was a non-significant increase in infant weight (gms) -297.72 [-859.26 to 263.81].

1.1.1.2 Length

Two studies evaluated the impact of massage on infant length (Kim 2003; Argawal 2000). The two studies report a sample of 183 infants and the results of a meta-analysis show a non-significant increase in length (cms) favouring the intervention group -0.76 (-2.67 to 1.15).

1.1.1.3 Head Circumference

Two studies evaluated the impact of massage on infant head circumference (Kim 2003; Argawal 2000). The two studies report a sample of 183 infants, and the results of a meta-analysis show a non-significant increase in head circumference (cms) favouring the intervention group -0.87 (-2.62 to 0.87).

1.1.1.4 Midarm/midleg circumference

One study evaluated the impact of infant massage on midarm and midleg circumference (Argawal 2000). The results indicate very little difference between the two groups (13.1 cms cf 12.4cms) and (13.3 cms cf 13.1cms) for midarm and midleg respectively.

1.1.2 Sensitivity Analysis - Weight (gms)

A sensitivity analysis was undertaken to assess the impact of one large study of orphaned infants (Kim 2003) in terms of weight. The remaining three studies (Argawal 2000; Field 1996; Koniak-Griffin 1988) comprised a total sample of 206 infants and the results indicated a non-significant increase in weight (gms) favouring the control group 4.12 [-223.91 to 232.16]. The exclusion of this study thereby eliminates any real difference between the two groups.

1.1.3 Hormones

1.1.3.1 Norepinephrine, Epinephrine and Serotonin (ng/gm creatinine)

Norepinephrine and epinephrine are produced in response to stress, and serotonin is a neurotransmitter involved in numerous functions in the human body including the control of appetite, sleep, memory and learning, temperature regulation, mood, behaviour, cardiovascular function, muscle contraction, endocrine regulation and depression.

Field 1996 measured norepinephrine, epinephrine and serotonin in urine samples which were frozen and sent for high-pressure liquid chromotography assays with electrochemical detection. Results showed significantly reduced levels of norepinephrine -60.30 (-111.88 to -8.72) and epinephrine -13.00 (-20.08 to -5.29) among the infants in the treatment group. A non-significant difference favouring the intervention groups was reported for levels of serotonin -295.50 (-705.25 to 114.25).

1.1.3.2 6-Sulphatoxyymelatonin secretion (ng/night)

6-Sulphatoxyymelatonin secretion enhances circadian rhythms.

Ferber 2002 evaluated the effect of massage therapy on melatonin secretion rhythms in the nocturnal secretion of 6-sulphatoxyymelatonin in urine. The results indicated significantly higher levels in the massaged group -523.03 (-664.51 to -381.55).

1.1.3.3 Cortisol (urine and saliva) (ng/gm creatinine and ng/dl)

Field 1996 measured salivary cortisol levels 20-minutes after the completion of each of the massage or rocking interventions (corresponding to plasma levels at the end of the massage session) and showed no significant difference between groups -0.20 (-4.60 to 4.20). Urinary cortisol was measured using radioimmune assay on day 12 of the intervention, and was significantly lower in the massage group -360.40 (-633.79 to -87.01).

1.1.4 Sleep/wake behaviours

1.1.4.1 Activity cycle

At 8-weeks postnatal, Ferber 2002 observed peak activity during the time period 3 - 7 a.m. in the massaged group treatment group compared with 11 p.m. - 3 a.m. in the control group. A secondary peak of activity was observed in the treated children between 3 p.m. and 7 p.m. while in the control group a secondary peak occurred between 11 a.m. to 3 p.m. The interaction between treatment and timing of peak activity was statistically significant (p =0.042). This suggests a delay in peak activity in massaged infants, and that the treated infants achieved a more favorable adjustment of their rest-activity cycle (Ferber 2002). No significant differences were found between groups in total movement. No differences were found for measurements performed 1-day before and 1-day after the intervention and at 6-weeks of age.

1.1.4.2 Sleep

Field 1996 assessed sleep/wake behaviours using an adaptation of the system of sleep recording developed by Thoman et al (Thoman 1981). Significantly less crying -8.20 (-12.24 to -4.16) and significantly increased active sleep was observed in the massage group -37.00 (-50.86 to -23.14). Infants in the control group spent significantly more time in an inactive alert state 12.70 (6.02 to 19.38) and had a non-significant increase in measures of quiet sleep 6.30 (-7.56 to 20.16). There was no significant difference between massage and control groups in the amount of drowsiness -2.00 (-4.19 to 0.19).

Argawal 2000 assessed duration of sleep and number of naps after four weeks of massage. The results show no difference between the two groups - a loss of 1.7 hours of sleep for both groups post-intervention and approximately one fewer naps for both groups - (0.7 cf 0.5) respectively.

1.1.5 Blood flow

Argawal 2000 assessed the impact of infant massage on blood velocity, vessel diameter and blood flow after four weeks of massage. The results show a non-significant difference favouring the intervention group for blood velocity -1.3 (-3.15 to 5.75), and for blood flow -0.55 to (-0.91 to 0.19), and a non-significant difference favouring the control group for vessel diameter 0.04 (0.06 to -0.02).

1.1.6 Formula Intake

Field 1996 measured the impact of massage on formula intake and indicated a non-significantly higher intake in the control group (i.e. a gain of 1.4 cf 2.8 ml respectively).

1.2 MENTAL HEALTH

1.2.1 Infant Temperament

Field 1996 measured aspects of temperament using the Colorado Child Temperament Inventory (CCTI (Rowe 1977)) . There was no significant difference in emotionality -0.17(-0.79 to 0.45) and although measurements of activity strongly favoured the treatment group -1.60 (-4.41 to 1.21) the findings were not significant. Measures of infant sociability -0.37 (-0.99 to 0.26) and infant soothability -0.63 (-1.26 to 0.01) also favoured the treatment group but were not significant. There were no differences between massage and control groups for infant persistence 0.10 (-2.38 to 2.58) or food adaptation 0.12 (-0.50 to 0.74).

Elliott 2002 measured temperament using the nine scales comprising the Early Infant Temperament Questionnaire (Medoff-Cooper 1993) at 16 weeks, but did not provide adequate data to calculate effect sizes. He reports no significant group differences for any of the following:- Activity, Rhythmicity, Approach, Adaptability, Mood, Persistence, Distractibility, Intensity or Threshold.

Jump 1998 measured a range of aspects of infant temperament after the treatment group had participated in 45 minutes to one-hour of massage weekly for four weeks. There were no differences between intervention and control groups for duration of orienting 0.00 (-0.82 to 0.82), distress to limitations -0.08 (-0.49 to 0.33), soothability 0.03 (-0.59 to 0.65), fear -0.06 (-0.63 to 0.51) or amount of smiling 0.30 (-0.14 to 0.74). Infant activity level 0.56 (0.08 to 1.04) significantly favoured the control group.

1.2.2 Infant and mother-infant interactions

Onozawa 2001 video-recorded infant interactions with their postnatally depressed mothers following a five-week infant massage course and coded interaction using a standardised schema (Murray 1996). The results indicated significant improvements in infant interaction favouring the intervention group for all three dimensions: a) attentive-non-attentive -1.31 (-2.26 to -0.37); b) lively-inert -1.30 (-2.24 to -0.36) and c) happy to distressed -0.95 (-1.85 to -0.06).

Onozawa 2001 measured impact of massage on mother-infant interaction using global ratings of interactions (Murray 1996) and indicated a significant difference favouring the intervention group: 1.32 (-2.27 to -0.38) as well as a significant difference favouring the intervention group for the amount of warmth in the interaction -2.17 (-3.27 to -1.07) and a significant reduction in the intrusiveness of maternal interactions in the massage group -0.97 (-1.87 to -0.08).

1.2.3 Psychomotor and mental development

Koniak-Griffin 1988 evaluated the impact of infant massage on psychomotor development using the Bayley Scale of Infant Development (Bayley 1969). The results indicated no difference between massage and control groups 0.00 (-0.61 to 0.62).

Koniak-Griffin 1988 also used the Bayley Scale to measure mental development (Bayley 1969). The results indicated a non-significant effect favouring the control group 0.38 (-0.23 to 1.00).

1.2.4 Infant Attachment

Jump 1998 measured infant attachment at 1-year using the attachment Q-set (Waters 1985). The results for the whole sample indicated no significant effect on attachment security -0.06 (-0.16 to 0.04). Reported results indicated a significant effect on infant attachment security in an 'as treated' analysis in which data for infants that had not complied with treatment were omitted.

1.2.5 *Habituation*

Cigales 1997studied the impact of 8-minutes of massage on infant habituation. Two films were repeatedly shown until infants habituated (became bored indicating that they had learned the colour-tempo relationships and were ready to learn something new. To check that the infants had really habituated to these colour tempo combinations, infants then received two more trials of the same film (post-habituation trials). These indicated a non-significant difference in the time infants looked at the stimulus 2.00 (-2.43 to 6.43). Following the post-habituation trials, infants received two different test trials depicting new colour-tempo combinations and massaged infants looked significantly longer at the test trials -12.40 (-19.37 to -5.30) compared to the post-habituation trials, indicating that they recognised a difference in the new test trials.

B. STUDIES AT HIGH RISK OF BIAS

11. Growth

1.1 Weight (gms)

Ten studies (Liu 2005; Liu Chun 2005; Lu 2005; Na 2005; Sun 2004; Ye 2004; Duan 2002; Shi 2002; Ke 2001; Wang 1999) including 1570 infants evaluated the effectiveness of infant massage on weight and indicated significant increases favouring the intervention group -378.12 (-511.02 to -245.22).

Two further studies provided means and significance levels only (Shao 2005; Zhai 2001). The results for both studies indicated significant findings favouring the intervention groups ($p<0.05$).

1.2 Length (cms)

Six studies (Liu 2005; Lu 2005; Na 2005; Duan 2002; Shi 2002; Ke 2001) comprising a total of 1120 infants measured infant length. The results of a meta-analysis indicated that infant massage significantly increased length (cms) -0.93 (-1.21 to -0.64).

1.3 Head Circumference (cms)

Five studies (Liu 2005; Lu 2005; Na 2005; Duan 2002; Ke 2001) including 1040 infants measured infant head circumference. Meta-analysis indicated that infant massage significantly increased head circumference (cms) -1.48 (-1.70 to -1.26).

2. Sleep/wake behaviours

2.1 Sleep (hrs)

Three studies (Liu 2005; Sun 2004; Xua 2004) covering 434 infants (216 intervention and 218 in the control group) measured hours of sleep. Meta-analysis indicated that infant massage significantly increased the number of hours infants spent sleeping -0.62 (-1.12 to -0.12).

Xua 2004 measured the frequency of night waking and found that the infant massage group woke significantly fewer times -0.48 (-0.81 to -0.15. Xua 2004 also measured the duration of night waking and found that the infant massage group woke for significantly shorter periods of time -0.27 (-0.51 to -0.03)

2.2 Crying

One study Xua 2004 measured the frequency of bouts of crying and found that the infant massage group had significantly fewer bouts of crying -0.34 (-0.56 to -0.12). Xua 2004 also measured the duration of crying and found that the infant massage group cried for significantly shorter periods of time (hrs) -0.30 (-0.54 to -0.06)

2.3 Blood

Two studies (Lu 2005; Sun 2004) with a sample of 410 (205 intervention and 205 control) measured levels of bilirubin (mmol/l) 7 days after birth and found that levels had significantly decreased in the massaged infants -38.11 (-50.61 to -25.61)

C. FOLLOW-UP RESULTS (excluding studies at high risk of bias)

1. Growth

1.1 Weight (gms)

Two studies evaluated the effectiveness of infant massage on weight gain at 6-months (Kim 2003) and at 8-months (Koniak-Griffin 1988) post-intervention. Meta-analysis showed a significant increase favouring the intervention group -1087.24 (-1344.96 to -829.52).

1.2 Length (cms)

Kim 2003 evaluated the effectiveness of massage on infant length at 6-months post-intervention and found that the significant increase in the intervention group had been maintained - 3.48 (-5.04 to -1.92).

1.3 Head Circumference (cms)

Kim 2003 evaluated the effectiveness of infant massage on head circumference at 6-months post-intervention and found that the significant increase -3.04 (-3.60, -2.48) favouring the intervention group had been maintained.

2. Psychomotor and mental development

Koniak-Griffin 1988 measured the impact of infant massage on psychomotor and mental development at 8-months using the Bayley PDI and MDI subscales (Bayley 1969). The result show no effect for the PDI subscale -0.04 (-0.65 to 0.57), and a significant difference favouring the control group for mental development using the MDI subscale 0.74 (0.11 to 1.38).

At 24-months follow-up (based on a subsample of 49 infants) the results showed a medium but non-significant difference favouring the intervention group in psychomotor development on the PDI subscale -0.49 (-1.11 to 0.13), and a medium but non-significant difference favouring the intervention group for mental development using the MDI scale -0.50 (-1.13 to 0.12).

2. Child behaviour

Koniak-Griffin 1995 assessed the impact on child behaviour at 24-months (based on a subsample of 49 infants) using the Eyberg Child Behaviour Inventory (ECBI (Robinson 1980)). The results showed a small but non-significant difference favouring the control group for intensity 0.25 (-0.54 to 1.04), and no effect for the problem domain -0.05 (-0.83 to 0.74).

3. Mother-infant interaction

Koniak-Griffin 1995 measured the impact on massage on mother-infant interaction at 24-months (based on a subsample of 49 infants) using the Nursing Child Assessment Teaching Scale (NCATS (Barnard 1978)). The result showed a small, non-significant improvement in mother-infant interaction for the mother 0.18 (-0.61 to 0.96) and child -0.35 (-1.14 to 0.44). There was no difference between the two groups for the total score 0.09 (-0.70, 0.87).

4. Home environment

Koniak-Griffin 1995 also measured the impact of infant massage on the home environment at 24-months (based on a subsample of 49 infants) using the HOME Inventory (Bradley 1977) and showed no difference between groups 0.11 (-0.67 to 0.90).

6. Number of illnesses and clinic visits

There was a significant reduction in the number of illnesses -8.82 (-10.41 to -7.23) and clinic visits -5.98 (-6.94 to -5.02) for intervention group orphanage infants compared with control group orphanage infants (Kim 2003).

D. FOLLOW-UP FOR STUDIES AT HIGH RISK OF BIAS

1. Sleep and night waking (hrs)

Xua 2004 reported that at 3 months massaged infants slept significantly longer than control infants at 3 months -1.30 (-1.81 to -0.79), woke significantly less often than the control group at 3 month follow up -0.38 (-0.63 to -0.13), were awake for significantly less time during the night at 3 months -0.26 (-0.50 to -0.02).

At six months Xua 2004 reported that the infant massage group woke significantly less often at night at 6 months -0.35 (-0.56 to -0.14), were awake for significantly less time during the night -0.18 (-0.31 to -0.05), but no significant difference between the intervention and control groups in the number of hours slept -0.08 (-0.64 to 0.48).

2. Crying

Xua 2004 reported that at 3 months the infant massage group had significantly fewer crying times at 3 months -0.19 (-0.36 to -0.02) and cried for significantly less time at 3 months -0.21 (-0.40 to -0.20).

At six months Xua 2004 found that the infant massage group had significantly fewer crying times at 6 months -0.18 (-0.35 to -0.01), significantly fewer bouts of crying at six months -0.15 (-0.29 to -0.01)

DISCUSSION

The decision to analyse thirteen studies separately was made post hoc based on concerns about the uniformly significant results, inadequate information about the design and conduct of these studies, and the reported absence of any dropout. Concerns of this nature have been reported elsewhere with recommendation to be careful about the management of such data (Vickers 1997). In addition, despite the fact that these studies examined the effect of very similar amounts and durations of massage (i.e. fifteen minutes, twice daily over around six weeks), considerable statistical heterogeneity was noted, even after taking account of the individual results and the sample sizes. The reason for this is not clear. The results of these studies must therefore be viewed with considerable caution. Selective reporting has recently been documented in other fields (e.g. genetic epidemiology) of the Chinese Literature, although this phenomenon may not be restricted to Chinese studies (Pan 2005). There is also documented evidence in other countries of language bias in which significant results are reported

in the international literature while non-significant results appear in the local literature (Egger 1997).

Meta-analyses of growth in weight, length and head circumference in the nine studies that provided primary data showed non-significant differences favouring the intervention group that disappeared following a sensitivity analysis in which the results of one large Korean study of orphanage infants was removed. The highly significant findings of the Korean study may have been due to a lack of normal levels of stimulation in the orphanage control group infants. The Vickers 2004 review of massage for promoting growth and development in pre-term or low-birth weight infants concluded that massaged babies had a weight gain of 5g a day. However, they caution against this finding due to the quality of the included studies and the fact that few studies had included calorie intake. In the current review, the only evidence of any significant impact of massage on growth was similarly obtained from a group of studies regarded to be at high risk of bias.

While potential biological mechanisms for an increase in growth following tactile stimulation have been identified (e.g. decrease in growth hormone (ornithine decarboxylase) in rat pups removed from their mothers (Schanberg 1994); the identification of a gene underlying protein synthesis that responds to tactile stimulation (Schanberg 1994); and evidence that massage increases vagal activity which aids the secretion of gastro-intestinal hormones important for food absorption, particularly insulin and gastrin, Uvnas-Moberg 1987), further research is required to ascertain whether these physiological mechanisms are also pertinent to humans.

The Kim 2003 study of Korean orphaned infants suggested a significant reduction in illnesses and clinic visits, although this result may have been compromised by a loss of blinding in the nurse who assessed these outcomes. Again, one must question whether these findings are applicable to Western infants receiving normal levels of tactile stimulation. Emerging evidence suggests plausible biological mechanisms for an impact of massage on physical illness (raised glucocorticoids have many effects, including profound suppression of immunity Brunner 1997), and a number of studies point to the deleterious effects of social stress, and the stress buffering effects of maternal care on cell mediated immune function (e.g. Liu 1997; Cohen 1992 in Brunner 1997), but most of these findings are, once again, from animal studies.

The evidence of significance effects of massage on catecholamine (norepinephrine and epinephrine) and cortisol excretion are potentially very important given what we now know about the damaging effects of high levels of stress hormones on the development of pathways in the infant brain (Gunnar 1998). These results are also biologically plausible (e.g. tactile stimulation moderates cortisol production and promotes glucocorticoid receptors in the hippocampus - Liu 1997), although the evidence is also limited to animals.

Given the apparent effect of infant massage on stress hormones it is not surprising to find some evidence of an effect on sleep and crying. One study also reports an effect on release of melatonin (6-sulphatoxymelatonin) which is involved in the adjustment of circadian rhythms.

There was considerable heterogeneity in the infant massage interventions in terms of who administered the massage (mothers or researchers/professionals), their prior experience of massage, and how they were taught the massage skills. Teaching for mothers ranged from weekly classes of 45 - 60 minutes over 4 - 5 weeks to one demonstration and a single observation of performance. The duration and frequency of massage also varied from one episode for 8 minutes to 15 minutes three times a day for 6 weeks. Although specific detail was often not provided, it would appear that the approach to massage also varied including different massage oils in one study, tactile and kinaesthetic stimulation in another and responsiveness to infant cues in a third. This variation makes it very difficult to identify the core components of effective massage intervention.

AUTHORS' CONCLUSIONS

Implications for practice

Infant massage is increasingly being used in the community with low-risk mother-infant dyads to promote the mother-child relationship and to improve other outcomes such as sleep. The results of this review suggest that infant massage may have beneficial effects on a number of hormones influencing stress together with positive effects on sleep, crying and mother-infant interaction. However, these findings were obtained from a very small number of studies and no meta-analysis was possible for these outcomes. In the absence of evidence of any harm, these findings provide tentative evidence to support the current provision of services in which infant massage is taught in community settings during the postnatal period, particularly in areas where infant care may be deficient, but fall short of providing the evidence base to recommend universal provision.

Implications for research

Further trials are needed to assess whether the positive findings of this review with regard to sleep, crying and physiological effects apply to normal babies in the Western world. Such research should aim to distinguish effects in infants in homes where care is optimal from those where it is less than optimal. There is also a need for further research on the effect of infant massage on parent/carer-infant interaction.

Research into the optimum underlying approach, frequency and timing of massage are needed as well as further evaluations of the process of teaching massage to parents and carers. Whilst not nec-

essary to establish effectiveness, further examination of the physiological effects of massage is likely to be fruitful particularly in terms of the effects of different types of massage techniques.

ACKNOWLEDGEMENTS

We would like to thank Yongjian Hu for his help with co-reviewing the Chinese data. We would also like to thank Jane Dennis for her unstinting support and Jo Abbott for helping with the searches.

REFERENCES

References to studies included in this review

Argawal 2000 *{published data only}*
* Argawal K, Ashish G, Pushkarna R, Bhargava S, Prabhu M. Effects of massage and use of oil on growth, blood flow and sleep patterns in infants. *Indian Journal of Medical Research* 2000;**112**:212–217. [: 2000]

Cigales 1997 *{published data only}*
Cigales M, Field T, Lundy B, Cuadra A, Hart S. Massage enhances recovery from habituation in normal infants. *Infant Behavior and Development* 1997;**20**(1):29–34. [: 1997]

Duan 2002 *{published data only}*
* Duan Lihong, Li Weihong, Shi Fentao. Studying impact of touching on growth and development of infants. *Chinese Nursing Research* 2002;**16**:5.

Elliott 2002 *{published data only}*
Elliot MR, Reilly SM, Drummond J, Letourneau N. The effect of different soothing interventions on infant cryingand on parent-infant interaction. *Infant Mental Health Journal* 2002;**23**(3):310–328.

Ferber 2002 *{published data only}*
Ferber SG, Laudon M, Kuint J, Weller A, Zisapel N. Massage therapy by mothers enhances the adjustment of circadian rhythms to the nocturnal period in full-term infants. *Developmental and Behavioral Pediatrics* 2002;**23**(6):410–415.

Field 1996 *{published data only}*
Field T, Grizzle N, Scafidi F, Abrams S, Richardson S. Massage therapy for infants of depressed mothers. *Infant Behaviour and Development* 1996;**19**:107–112.

Jump 1998 *{published data only}*
Jump V. *Effects of infant massage on aspects of the parent-child relationship: an experimental manipulation*. Logan, UT: Utah State University, 1998.

Ke 2001 *{published data only}*
* Ke G, Ling X, Li L. Clinical survey of improved massage method developing infants' growth and development. *China Nurse* 2001;**36**(4):278–280.

Kim 2003 *{published data only}*
Kim T I, Shin YH, White-Traut AC. Multisensory intervention improves physical growth and illness rates in Korean orphaned newborn infants. *Research in Nursing & Health* 2003;**26**(6):424–33.

Koniak-Griffin 1988 *{published data only}*
* Koniak-Griffin D, Ludington-Hoe S, Verzemnieks I. Developmental and temperament outcomes of sensory stimulation in healthy infants. *Nursing Research* 1988;**37**(2):70–76.

Koniak-Griffin 1995 *{published data only}*
Koniak Griffin D, Ludington-Hoe S, Verzemnicks I. Longitudinal effects of unimodal and multimodal stimulation on development and interaction of healthy infants. *Research in Nursing and Health* 1995;**18**:27–38.

Liu 2005 *{published data only}*
Liu DY. Clinical experience in infant massage. 100 case studies. *Chongqing Medicine* 2005;**34**(7):301.

Liu Chun 2005 *{published data only}*
Liu Chun Li. The effect of touching on healthy infants' weight. *Journal of Huaihai Medicine* 2005;**23**(2):137.

Lu 2005 *{published data only}*
Lu Jiao, Li Ju Zhan, Wu Li Fang. A study of the effect of touch on health in infants. *Practical Clinical Medicine* 2005;**6**(2):119–121.

Na 2005 *{published data only}*
Na Zhuo Hua, Xie Hui Yun, Huang Jian Hua. The effect of infant massage on growth. *New Journal of Traditional Chinese Medicine* 2005;**37**(5):69–70.

Onozawa 2001 *{published data only}*
Onozawa K, Glover V, Adams D, Modi N, Kumar R C. Infant massage improves mother-infant interaction for mothers with postnatal depression. *Journal of Affective Disorders* 2001;**63**:201–207.

Shao 2005 *{published data only}*
* Shao L, et al.The effect of infant massage on health: a nursing experience. *Journal of Chinese Clinnical Research* 2005;**11**(11):1582–1583.

Shi 2002 *{published data only}*
Shi Li, Xue Li Rong. The clinical observation of touching towards the neonatal health's affection. *Journal of Henan University* 2002;**21**(4):26–27.

Sun 2004 *{published data only}*
Sun Hai Yun, Gao Xiang Yu, Zhao Xue Mei. A comparative study on influence of touching on growth, development and jaundice of normal infants. *Chinese Nursing Research* 2004; **18**(8B):1468–1469.

Wang 1999 *{published data only}*
Wang Bin, Shen Yue Hua, Jin Run Yan, et al.Improving infant growth by massage: a clinical study. *Chinese Journal of Perinatal Medicine* 1999;**2**(4):241–242.

Xua 2004 *{published data only}*
Xua Li Shuan, Qing Gui Romg, Ye Mei Yan, et al.Study of touch intervention of infant sleep disorder. *Journal of Nursing Continual Education* 2004;**19**(11):973–976.

Ye 2004 *{published data only}*
Ye Hong Yun. Clinical observation on infant massage. *Journal of Gan Nan Medical College* 2004;**3**:239–240.

Zhai 2001 *{published data only}*
* Zhai J, Pan Xian R, Hua JR, et al.The effect of massage on growth: a clinical study. *Journal of Sichuan continuing Education College of Public Health and Managerial Sciences* 2001;**20**(10):23.

References to studies excluded from this review

Clarke 2000 *{published data only}*
Clarke C, Gibb C, Hart J, Davidson A. Infant Massage: developing an evidence base for health visiting practice. *Clinical Effectiveness in Nursing* 2002;**6**(3-4):121–128.

Cullen 2000 *{published data only}*
* Cullen C, Field T, Escalona A, Hartshorn K. Father-infant interactions are enhanced by massage therapy. *Early Child Development and Care* 2000;**164**:41–47.

Darmstadt 2002 *{published data only}*
Darmstadt G, Samir K Saha. Traditional practice of oil massage of neonates in Bangladesh. *Journal of Health, Population and Nutrition* 2002;**20**(2):184–8.

Fernandez 1998 *{published data only}*
Fernandez Y, Fernandez-Arroyo M. [Study of pediatric massage]. [Spanish]. *Anales Espanoles de Pediatria* 1998;**48** (5):549–50.

Field 2000b *{published data only}*
Field T, Pickens J, Prodromidis M, Malphurs J, Fox N. Targeting adolescent mothers with depressive symptoms for early intervention. *Adolescence* 2000;**35**(138):381–414.

Field 2004 *{published data only}*
* Field T, Hernandez-Reif M, Diego M, Feijo L, Yanexy V, Gil K. Massage therapy by parents improves early growth and development. *Infant Behaviour and Development* 2004; **27**:435–442.

Glover 2002 *{published data only}*
Glover V, Onozawa K, Hodgkinson A. Benefits of infant massage for mothers with postnatal depression. *Seminars in Neonatology* 2002;**7**(6):495–500.

Huhtala 2000 *{published data only}*
Huhtala B, Lehtonen L, Heinonen R, Korvenranta H. Infant massage compared with crib vibrator in the treatment of colicky infants. *Pediatrics* 2000;**105**(6):1328.

Ineson 1995 *{published data only}*
Ineson M. The psychological and physiological effects of massage on full term 'normal' babies. *Journal of the Association of Association of Chartered Physiotherapists in Women's Health* 1995;**77**:3–7.

Pardew 1996 *{published data only}*
* Pardew EM. *The effects of infant massage on interactions between high risk infants and their care givers [PhD thesis]*. Corvallis, OR: Oregon State University, 1996.

Peláez-Nogueras 1996 *{published data only}*
Paelez Nogueras M, Gewirtz JL, Field T, Cigales M, et al.Infants' preference for touch stimulation in face-to-face interactions. *Journal-of-Applied-Developmental-Psychology* 1996 Apr–Jun;**17**(2):199–213.

Peláez-Nogueras 1997 *{published data only}*
Peláez-Nogueras M, Field T, Gewirtz JL, Cigales M, Gonzalez AS, et al.The effects of systematic stroking versus tickling and poking on infant attention and behaviour. *Journal-of-Applied-Developmental-Psychology* 1997;**Vol 18** (2):169–178.

Peláez-Nogueras1997b *{published data only}*
Peláez-Nogueras M, Field T, Hossain Z, Pickens J. Depressed mothers' touching increases infants' positive affect and attention in still-face interactions. *Child Development* 1996 Aug;**67**(4):1780–1792.

Scafidi 1996 *{published data only}*
Scafidi F, Field T. Massage therapy improves behavior in neonates born to HIV-positive mothers. *Journal of Pediatric Psychology* 1996;**21**(6):889–97.

Stack 1990 *{published data only}*
Stack DM, Darwin W. Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology* 1990 June;**8**(2):131–145.

References to studies awaiting assessment

Liu 2001 *{published data only}*
Liu, C. Liu, J. Lin, X. Effects of touch on growth and mentality development in normal infants. *Chinese Medical Journal (Chung-Hua i Hsueh Tsa Chih)* 2001;**81**(23): 1420–3.

Additional references

Barnard 1978
Barnard KE. *Nursing Child Assessment Teaching Scale manual*. Seattle, WA: Nursing Child Asessment Satellite Training, University of Washington, 1978.

Bayley 1969
Bayley N. *Bayley Scales of Infant Development*. New York: Psychological Corporation, 1969.

Bradley 1977
Bradley RH, Caldwell B. Home observation for measurement of the environment: A validation study of screening efficiency. *American Journal of Mental Deficiency* 1977;**81**:417–420.

Brunner 1997
Brunner E. Socioeconomic determinants of health: Stress and the biology of inequality. *British Medical Journal* 1997; **314**:1472.

Carlson 1997
Carlson M, Earls F. Psychological and neuroendocrinological sequelae of early social deprivation in institutionalised children in Romania. *Annals of the New York Academy of Sciences* 1997;**807**:419–428.

Chugani 2001
Chugani H, Behen M, Muzik O, Juhasz C, Nagy F, Chugani D. Local brain functional activity following early deprivation: a study of post-institutionalised Romanian orphans. *Neuroimage* 2001;**14**:1290–1301.

Cogill 1986
Cogill SCH, Alexandra H, Robson K, Kamar R. Maternal depression and the emotional development of the child. *British Medical Journal* 1986;**292**:1165–1167.

Cohen 1992
Cohen S, Kaplan JR, Cunnick JE, Manuck SB, Rabin BS. Chronic social stress, affiliation, and cellular immune response in nonhuman primates. *Psych Sci 1992* 1992;**3**: 301–4.

Egger 1997
Egger M. Language bias in randomised controlled trials published in English and German. *Lancet* 1997;**350**(9074): 326.

Field 1996b
Field T, Schanberg S, Davalos M, Malphurs J. Massage with oil has more positive effects on normal infants. *Journal of Prenatal and Perinatal Psychology and Health* 1996;**11**(2): 75–80.

Fonagy 1997
Fonagy P, Redfe S, Charman T. The relationship between belief-desire reasoning and a projective measure of attachment security (SAT). *British Journal of Developmental Psychology* 1997;**15**:51–61.

Gianino 1988
Gianino A, Tronick E. The Mutual Regulations Model: the Infant's self and interactive regulation, coping and defense. In: T Field, P McCabe, N Schneiderman editor(s). *Stress and Coping*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988:47–68.

Gunnar 1993
Gunnar M, Broderson L, Rigatuso J. 'Infant and Parent Contributions to the organization of adrenocorticol stress reactivity' Paper presented at the symposium on the development and organization of stress reactivity at the biennial meeting of the Society for Research in Child Development in New Orleans (Cited). In: CHJ Zeanah editor(s). *Handbook of Infant Mental Health*. 2nd Edition. New York: Guilford, 2000.

Gunnar 1998
Gunnar M. Quality of early care and buffering of neuroendocrine stress reactions: Potential effects on the developing human brain. *Preventive Medicine* 1998;**27**: 208–211.

Higgins 2002
Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine* 2002;**21**:1539–1558.

Ireland 2000
Ireland M, Olson M. Massage therapy and therapeutic touch in children: state of the science. *Alternative Therapies in Health and Medicine* 2000;**6**(5):54–60.

Kaufman 2000
Kaufman J, Plotsky P, Nemeroff C, Charney D. Effects of early adverse experiences on brain structure and function: Clinical implications. *Biological Psychiatry* 2000;**48**: 778–790.

Kropp 1987
Kropp J, Haynes O. Abusive and non-abusive mothers' ability to identify general and specific emotion signals of infants. *Child Development* 1987;**58**:187–190.

Liu 1997
Liu D, Diorio J, Tannenbaum B. Maternal Care, hippocampal glucocorticoid receptors and hypothalamic-pituitary-adrenal responses to stress. *Science* 1997;**277**: 1659–1662.

Medoff-Cooper 1993
Medoff-Cooper B, Carey W, McDevitt S. The early infancy temperament questionnaire. *Journal of Developmental and Behavioral Pediatrics* 1993;**14**(4):230–235.

Murray 1992
Murray L. The impact of post natal depression on infant development. *Journal of Child Psychology and Psychiatry* 1992;**33**:543–561.

Murray 1996
Murray L, Fiori-Cowley A, Hooper R, Cooper P. The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcome. *Child Development* 1996;**67**:2512–2526.

Pan 2005
Pan Z, Trikalinos TA, Kavvoura FK, Lau J, Ioannidis J. Local literature bias in genetic epidemiology: An empirical evaluation of the Chinese Literature. *PLoS Medicine* 2005;**2** (12):1309–1317.

Robinson 1980
Robinson EA, Eyberg SM, Ross AW. The standardization of an inventory of child conduct problem behaviours. *Journal of Clinical and Child Psychology* 1980;**9**:22–28.

Rowe 1977
Rowe DC and Plomin R Rowe DC and Plomin R (1977). Temperament in early childhood. Journal of Personality Assessment, 41, 150-156. Temperament in early childhood. *Journal of Personality Assessment* 1977;**41**:150–156.

Schanberg 1994
Schanberg S. Genetic basis for touch effects. In: Field, T editor(s). *Touch in early development*. Hillsdale, New Jersey: Erlbaum, 1994:67–80.

Schore 1994
Schore A. *After Regulation and the Origin of the Self: The Neurobiology of Emotional Development*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Sroufe 1996
Sroufe A. *Emotional Development: The Organisation of Emotional Life in the Early Years*. Cambridge: Cambridge University Press, 1996.

Steele 1996
Steele H, Steele M, Fonagy P. Associations among attachment classifications of mothers, fathers and their infants. *Child Development* 1996;**67**:541–555.

Stern 1998
Stern DN. *The interpersonal world of the infant*. London: Karnac, 1998.

Thoman 1981
Thoman EB, Deenberg VH, Sieval J, Zeidner L, Becker PT. State organisation in neonates: Developental inconsistency indicates risk for developmenta dysfunction. *Neuropaediatrica* 1981;**12**:45–54.

Tronick 1982
Tronick E, Ricks M, Cohn J. Maternal and Infant Affective Exchange: Patterns of Adaptation. Emotion and Early Interaction. In: T Field, A Fogel editor(s). *Emotion and Early Interaction*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1982.

Uvnas-Moberg 1987
Uvnas-Moberg K, Widstrom AM, Marchini G, Windberg J. Release of GI hormones in mother and infant by sensory stimulation. *Acta Paediatrica Scandinavica* 1987;**76**: 851–60.

Vickers 1997
Vickers A, Niraj G, Harland R, Rees R. Do certain countries produce only positive results? A systematic review of controlled trials. *Controlled Clinical Trials* 1998;**19**: 159–166.

Vickers 2004
Vickers A, Ohlsson A, Lacy JB, Horsley A. Massage for promoting growth and development of preterm and/or low birth-weight infants (Cochrane review). *Cochrane Database of Systematic Reviews* 2004, Issue 4. [DOI: 10.1002/14651858.CD000390.pub2]

Waters 1985
Waters E, Deane K E. Defining and assessing individual differences in attachment relationships: Q-methodology and the organization of behavior in infancy and early childhood. *Growing points in attachment theory and research (Monographs of the Society for Research in Child Development, Serial No. 209)* 1985;**50**(1-2):41–65.

Zeanah 2000
Zeanah CHJ (Ed). *Handbook of Infant Mental Health*. 2nd Edition. New York: Guilford Press, 2000.

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Argawal 2000

Methods	Randomised controlled trial
Participants	125 healthy infants
Interventions	Massage infants received (i) herbal oil, (ii) sesame oil, (iii) mustard oil, or (iv) mineral oil for massage daily over four weeks. No treatment control group
Outcomes	Anthropometeric measurements: microhaematrocrit; serum proteins, creatinine and creatine phosphokinase; blood flow using colour doppler Sleep pattern; Weight (kg); Length (cm); Head Circumference (cm); Mid-arm circumference (cm); Mid-leg circumference (cm); Microhaematocrit ; Serum proteins; Serum albumin; Serum Creatinine; Creatininie Phosphokinase.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	No	C - Inadequate

Cigales 1997

Methods	Randomised controlled trial
Participants	56 4-month-old infants
Interventions	Massaged infants were given either 8 minutes of massage, play, or no stimulation prior to an audiovisual habituation task. No stimulation control group
Outcomes	Average number of seconds of looking on two post habituation trials (PH) and two test trials (T) to yield a post habituation score and a test score
Notes	

Risk of bias

Cigales 1997 (*Continued*)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Duan 2002

Methods	Randomised controlled trial
Participants	160 newborn infants
Interventions	Massaged for fifteen minutes twice daily over 42 days. No treatment control group
Outcomes	Weight, length and head circumference.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Elliott 2002

Methods	Randomised controlled trial
Participants	111 first time parents-infants dyads (newborns)
Interventions	Group I: Massage Group 2: Supplemental carrying Group 3: Massage and supplemental carrying Group 4: No treatment control group. Massage group 7 - 10 days postpartum parents taught massage plus they received a video tape showing the steps and printed instructions 2nd home visit parent was assessed by research assistant (RA) to check that massage covered 85% of infant's body and took 10-20 mins. to complete Supplemental carrying group Received carrier and instructions for use Carried infant in carrier for minimum of 3 hours not only in response to crying but in addition to time spent feeding and independent of whether the infant was awake or asleep. Supplemental carrying/massage Received instruction and equipment for both interventions above
Outcomes	1.Nursing Child Assessment Sleep Activity Record (NCASA) 2.Nursing Child Assessment Feeding (NCAFS) and teaching 3.Early infant temperament questionnaire (EITQ)

Elliott 2002 (*Continued*)

	4.State Trait Anxiety Inventory - STAI-T-anxiety scale 5.Parental sense of competence scale (PSOC) 6.Difficult life circumstances scale (DLC)
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Ferber 2002

Methods	Randomised controlled trial
Participants	21 dyads of mothers and full term infants
Interventions	Massage therapy was performed daily by the mother for 14 days. No treatment control group
Outcomes	1. Circadian rhythmicity; 2. Excretion of the main melatonin metabolite 6sulphatoxymelatonin
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Field 1996

Methods	Randomised controlled trial
Participants	40 full-term 1 - 3 month old infants
Interventions	Infants in the intervention group received massage by a researcher (complete face and body using mineral baby oil); the control group infants were rocked (by cradling in the arms of the researcher) 2 days a week over 6 weeks 15 mins
Outcomes	1.Sleep / wake behaviours 2.Salivary Cortisol. 3.Weight and formula intake. 4.Temperament ratings - using Colorado Child
Notes	

Field 1996 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Jump 1998

Methods	Randomised controlled trial
Participants	57 mother-infant dyads with babies under 9 months
Interventions	Mothers trained in the use of infant massage in groups delivered over 4 weeks plus information about infant development. Control group received information about infant development only. Intervention group learned techniques of infant massage as well as received information about infant development. Control group received information about infant development.
Outcomes	1. Attachment Q set scored as a continuous variable 2. Parenting stress Index PSI (Abidin 1986) - child and parent variables were analysed separately in their respective scales as well as combined into composite child and parent scores 3. Adult attachment style was measured using the relationship survey 4. Infant temperament was measured using the Infant Behaviour Questionnaire (IBQ) 5. Parental attitudes were measured using the parental attitudes toward child rearing (PACR)
Notes	

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Ke 2001

Methods	Randomised controlled trial
Participants	400 newborn infants
Interventions	Fifteen minutes of massage three times a day plus additional method of kneading the back. No treatment control group
Outcomes	Weight, length and health circumference. Additional measures included grasp of hands, stretch and crook of front arms etc
Notes	

Ke 2001 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Kim 2003

Methods	Randomised controlled trial
Participants	58 Korean orphaned infants
Interventions	In addition to receiving the routine orphanage care, infants in the experimental group received 15 min of auditory (female voice), tactile (massage), and visual (eye-to-eye contact) stimulation. Usual orphanage care control group
Outcomes	1. Weight 2. Head circumference 3. Length
Notes	Also presents results for six-month follow-up

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Koniak-Griffin 1988

Methods	Randomised controlled trial
Participants	81 primiparous mothers and newborn infants
Interventions	1. The unimodal stimulation group received infant massage once daily. 2.The multimodal stimulation group of infants were placed on a hammock with multisensory elements during expected sleep periods. A simulated heartbeat and mild vestibular stimulus were added continuously during the sleep period. 3. The combined stimulation group received both. 4. No treatment control group.
Outcomes	1. Bayley Scales of Infant Development (BSID) 2. Eyberg's Child Behavior Inventory 3. Nursing Child Assessment Teaching Scales (NCATS)
Notes	Also presents results for eight-month follow-up

Koniak-Griffin 1988 (*Continued*)

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Koniak-Griffin 1995

Methods	24-month follow-up of earlier 1988 study
Participants	49 of original 81 infants at follow-up
Interventions	As above
Outcomes	1. Bayley Scales of Infant Development (BSID) 2. Eyberg's Child Behavior Inventory 3. Nursing Child Assessment Teaching Scales (NCATS) 4. HOME Inventory
Notes	Follow-up study only

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Liu 2005

Methods	Randomised controlled trial
Participants	200 newborn infants
Interventions	15 minutes of massage twice daily over 42 days. No treatment control group
Outcomes	Weight, height, head circumference and length of sleep.
Notes	Paper not fully transcribed

Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Liu Chun 2005

Methods	Randomised controlled trial
Participants	80 newborn infants
Interventions	15 minutes of massage twice daily over 42 days. No treatment control group
Outcomes	Weight
Notes	Paper not fully transcribed

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Lu 2005

Methods	Randomised controlled trial
Participants	200 newborn infants
Interventions	15 minutes of massage twice daily over 3 months. No treatment control group
Outcomes	Weight, height, head circumference and bilirubin
Notes	Paper not fully transcribed

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Na 2005

Methods	Randomised controlled trial
Participants	80 newborn infants
Interventions	15 minutes of massage three times daily for 28 days. No treatment control group
Outcomes	Weight, height, head circumference
Notes	Paper not fully transcribed

Risk of bias

Na 2005 (*Continued*)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Onozawa 2001

Methods	Randomised controlled trial
Participants	34 primiparous depressed mothers and their infants aged 9 weeks
Interventions	Infant massage for I hour weekly over 5 weeks, plus support group for both intervention and control mothers
Outcomes	1. EPDS 2. Asessment of mother-infant interaction
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Shao 2005

Methods	Randomised controlled trial
Participants	210 newborn infants
Interventions	15 minutes of massage twice daily over 30 days. No treatment control group
Outcomes	Weight
Notes	Paper not fully transcribed

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Shi 2002

Methods	Randomised controlled trial	
Participants	80 newborn infants	
Interventions	15 minutes of massage twice daily over 28 days. No treatment control group	
Outcomes	Weight and height	
Notes	Paper not fully transcribed	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Sun 2004

Methods	Randomised controlled trial	
Participants	210 newborn infants	
Interventions	15 minutes of massage twice daily over 42 days. No treatment control group	
Outcomes	Weight, bilirubin and sleeping time	
Notes	Paper not fully transcribed	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Wang 1999

Methods	Randomised controlled trial
Participants	60 newborn infants
Interventions	15 minutes of massage three times daily over 42 days. No treatment control group
Outcomes	Weight
Notes	Paper not fully transcribed
Risk of bias	

Wang 1999 (*Continued*)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Xua 2004

Methods	Randomised controlled trial
Participants	124 newborn infants
Interventions	15 - 20 minutes of massage twice daily over three months. No treatment control group
Outcomes	Duration of sleep; frequency of night wakes and crying; length of crying; length of time for normal sleeping pattern
Notes	Paper not fully transcribed Also present results for six month follow-up

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Ye 2004

Methods	Randomised controlled trial
Participants	100 newborn infants
Interventions	10 - 15 minutes of massage twice daily over 42 days. No treatment control group
Outcomes	Weight
Notes	Paper not fully transcribed

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Zhai 2001

Methods	Randomised controlled trial	
Participants	100 newborn infants	
Interventions	15 minutes of massage three times daily over 30 days. No treatment control group	
Outcomes	Weight, height and head circumference	
Notes	Paper not fully transcribed	
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Clarke 2000	Trial was not randomised
Cullen 2000	Infants participating in the study were aged between 3 and 14 months (mean 7.1 SD= 3.4)- outside of the stated aged range for this review
Darmstadt 2002	Large survey
Fernandez 1998	Spanish study of paediatric massage - not randomised controlled trial
Field 2000b	Study intervention aimed at mothers rather than infants - consisted of free day care for the infants and a rehab program (social, educational, and vocational) plus several mood induction interventions for the mothers, including relaxation, massage therapy, and mother-infant interaction coaching
Field 2004	Study compared infants who either received light pressure or moderate pressure massage. There was no control group
Glover 2002	Repeat of findings for Onozawa 2001
Huhtala 2000	Study compared infant massage and crib vibrator interventions. There was no control group
Ineson 1995	This was a review article of literature, not a randomised controlled trial
Pardew 1996	This dissertion investigated the effects of infant massage on interactions between high risk infants and their care givers

(*Continued*)

Peláez-Nogueras 1996	Measured infant affect during the still face procedure only
Peláez-Nogueras 1997	This study was a test procedure for measuring eye contact when infants were touched or not touched
Peláez-Nogueras1997b	This study compares stroking with tickling and poking on infant eye contact
Scafidi 1996	Sample comprised HIV-exposed infants with a lower gestational age and birthweight than normal
Stack 1990	Measured tactile stimulation during the still face procedure only

DATA AND ANALYSES

Comparison 1. Infant massage versus control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Weight (gms)	4	264	Mean Difference (IV, Random, 95% CI)	-297.72 [-859.26, 263.81]
2 Length (cms)	2	183	Mean Difference (IV, Random, 95% CI)	-0.76 [-2.67, 1.15]
3 Head circumference (cms)	2	183	Mean Difference (IV, Random, 95% CI)	-0.87 [-2.62, 0.87]

Comparison 2. Infant massage versus control - Chinese studies

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Weight (gms)	10	1570	Mean Difference (IV, Random, 95% CI)	-378.12 [-511.02, -245.22]
1.1 Sub-category	10	1570	Mean Difference (IV, Random, 95% CI)	-378.12 [-511.02, -245.22]
2 Head Circumference (cms)	5	1040	Mean Difference (IV, Random, 95% CI)	-0.93 [-1.21, -0.64]
3 Length (cms)	6	1120	Mean Difference (IV, Random, 95% CI)	-1.48 [-1.70, -1.26]
4 Sleep (hrs)	3	534	Mean Difference (IV, Random, 95% CI)	-0.62 [-1.12, -0.12]
5 Bilirubin (mmol/l) (7 days PN)	2	410	Mean Difference (IV, Random, 95% CI)	-38.11 [-50.61, -25.61]

Comparison 3. Sensitivity analysis

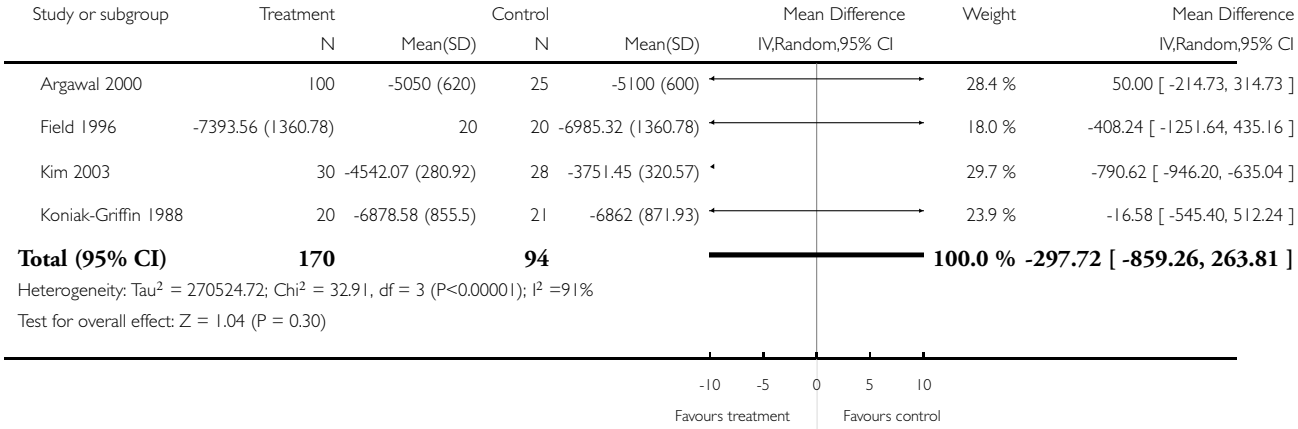
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Weight	3	206	Mean Difference (IV, Random, 95% CI)	4.12 [-223.91, 232.16]

Analysis 1.1. Comparison 1 Infant massage versus control, Outcome 1 Weight (gms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 1 Infant massage versus control

Outcome: 1 Weight (gms)

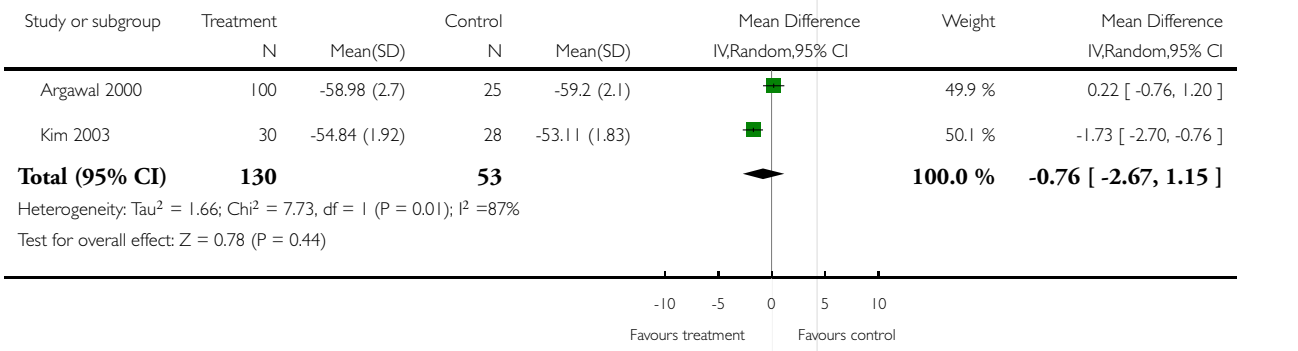


Analysis 1.2. Comparison 1 Infant massage versus control, Outcome 2 Length (cms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 1 Infant massage versus control

Outcome: 2 Length (cms)



Analysis 1.3. Comparison 1 Infant massage versus control, Outcome 3 Head circumference (cms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

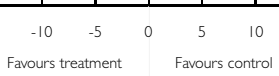
Comparison: 1 Infant massage versus control

Outcome: 3 Head circumference (cms)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Argawal 2000	100	-38.7 (1.3)	25	-38.7 (1)		50.9 %	0.0 [-0.47, 0.47]
Kim 2003	30	-37.36 (0.87)	28	-35.58 (1.57)		49.1 %	-1.78 [-2.44, -1.12]
Total (95% CI)	**130**		**53**			**100.0 %**	**-0.87 [-2.62, 0.87]**

Heterogeneity: $Tau^2 = 1.50$; $Chi^2 = 18.62$, df = 1 (P = 0.00002); $I^2 = 95\%$

Test for overall effect: Z = 0.98 (P = 0.33)



Analysis 2.1. Comparison 2 Infant massage versus control - Chinese studies, Outcome 1 Weight (gms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 2 Infant massage versus control - Chinese studies

Outcome: 1 Weight (gms)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Sub-category							
Duan 2002	80	-4761 (450)	80	-4216 (344)		10.5 %	-545.00 [-669.12, -420.88]
Ke 2001	200	-5226.55 (387.25)	200	-4674 (288.73)		11.2 %	-552.55 [-619.49, -485.61]
Liu 2005	100	-5198 (438)	100	-4932 (308)		10.7 %	-266.00 [-370.95, -161.05]
Liu Chun 2005	40	-5603.3 (219.7)	40	-5546 (180.3)		11.0 %	-57.30 [-145.38, 30.78]
Lu 2005	100	-5140 (630)	100	-4710 (500)		9.9 %	-430.00 [-587.64, -272.36]
Na 2005	40	-4619.5 (493.5)	40	-4318.9 (496.2)		8.8 %	-300.60 [-517.47, -83.73]
Shi 2002	40	-4844.55 (438.61)	40	-4253 (388.73)		9.5 %	-591.55 [-773.17, -409.93]
Sun 2004	105	-5689.9 (536)	105	-5263.2 (526.4)		10.2 %	-426.70 [-570.40, -283.00]
Wang 1999	30	-5578 (642)	30	-5154.2 (393.3)		7.8 %	-423.80 [-693.21, -154.39]

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Ye 2004	50	-5391 (345.63)	50	-5174 (297.14)		10.4 %	-217.00 [-343.34, -90.66]
Total (95% CI)	**785**		**785**			**100.0 %**	**-378.12 [-511.02, -245.22]**

Heterogeneity: Tau^2 = 39906.50; Chi^2 = 101.36, df = 9 (P<0.00001); I^2 =91%

Test for overall effect: Z = 5.58 (P < 0.00001)

Analysis 2.2. Comparison 2 Infant massage versus control - Chinese studies, Outcome 2 Head Circumference (cms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

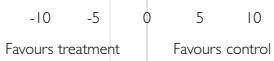
Comparison: 2 Infant massage versus control - Chinese studies

Outcome: 2 Head Circumference (cms)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Duan 2002	80	-38.3 (1.05)	80	-36.91 (1.73)		19.3 %	-1.39 [-1.83, -0.95]
Ke 2001	200	-38.12 (1.05)	200	-37.54 (1.73)		26.7 %	-0.58 [-0.86, -0.30]
Liu 2005	100	-39.21 (1.27)	100	-38.33 (1.51)		21.7 %	-0.88 [-1.27, -0.49]
Lu 2005	100	-36.3 (1.1)	100	-35.4 (1.2)		24.9 %	-0.90 [-1.22, -0.58]
Na 2005	40	-41.2 (2.25)	40	-40 (1.99)		7.4 %	-1.20 [-2.13, -0.27]
Total (95% CI)	**520**		**520**			**100.0 %**	**-0.93 [-1.21, -0.64]**

Heterogeneity: Tau^2 = 0.06; Chi^2 = 9.90, df = 4 (P = 0.04); I^2 =60%

Test for overall effect: Z = 6.37 (P < 0.00001)



Analysis 2.3. Comparison 2 Infant massage versus control - Chinese studies, Outcome 3 Length (cms).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 2 Infant massage versus control - Chinese studies

Outcome: 3 Length (cms)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Duan 2002	80	-56.16 (1.36)	80	-54.22 (1.3)		17.3 %	-1.94 [-2.35, -1.53]
Ke 2001	200	-56.84 (1.36)	200	-55.44 (1.3)		27.2 %	-1.40 [-1.66, -1.14]
Liu 2005	100	-57.5 (1.45)	100	-55.91 (1.49)		17.6 %	-1.59 [-2.00, -1.18]
Lu 2005	100	-53.9 (1)	100	-52.7 (1.3)		22.7 %	-1.20 [-1.52, -0.88]
Na 2005	40	-58 (2.34)	40	-56.6 (2.18)		4.4 %	-1.40 [-2.39, -0.41]
Shi 2002	40	-56.84 (1.36)	40	-55.44 (1.3)		10.8 %	-1.40 [-1.98, -0.82]
Total (95% CI)	**560**		**560**			**100.0 %**	**-1.48 [-1.70, -1.26]**

Heterogeneity: Tau² = 0.03; Chi² = 8.37, df = 5 (P = 0.14); I² =40%

Test for overall effect: Z = 13.18 (P < 0.00001)

Analysis 2.4. Comparison 2 Infant massage versus control - Chinese studies, Outcome 4 Sleep (hrs).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 2 Infant massage versus control - Chinese studies

Outcome: 4 Sleep (hrs)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Liu 2005	100	-21 (0.8)	100	-20.2 (0.6)		40.3 %	-0.80 [-1.00, -0.60]
Sun 2004	105	-20 (1)	105	-19.8 (0.9)		38.6 %	-0.20 [-0.46, 0.06]
Xua 2004	61	-17.97 (2.1)	63	-16.92 (2.33)		21.0 %	-1.05 [-1.83, -0.27]
Total (95% CI)	**266**		**268**			**100.0 %**	**-0.62 [-1.12, -0.12]**

Heterogeneity: Tau² = 0.15; Chi² = 14.56, df = 2 (P = 0.00069); I² =86%

Test for overall effect: Z = 2.43 (P = 0.015)

Analysis 2.5. Comparison 2 Infant massage versus control - Chinese studies, Outcome 5 Bilirubin (mmol/l) (7 days PN).

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 2 Infant massage versus control - Chinese studies

Outcome: 5 Bilirubin (mmol/l) (7 days PN)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Lu 2005	100	142.7 (38.8)	100	186.3 (34.9)		57.4 %	-43.60 [-53.83, -33.37]
Sun 2004	105	147.1 (54.7)	105	177.8 (49.6)		42.6 %	-30.70 [-44.82, -16.58]
Total (95% CI)	**205**		**205**			**100.0 %**	**-38.11 [-50.61, -25.61]**

Heterogeneity: Tau² = 43.62; Chi² = 2.10, df = 1 (P = 0.15); I² =52%

Test for overall effect: Z = 5.97 (P < 0.00001)

Analysis 3.1. Comparison 3 Sensitivity analysis, Outcome 1 Weight.

Review: Massage intervention for promoting mental and physical health in infants aged under six months

Comparison: 3 Sensitivity analysis

Outcome: 1 Weight

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Argawal 2000	100	-5050 (622)	25	-5100 (600)		74.1 %	50.00 [-214.91, 314.91]
Field 1996	-7393.56 (1360.78)	20	20	-6985.32 (1360.78)		7.3 %	-408.24 [-1251.64, 435.16]
Koniak-Griffin 1988	20	-6878.58 (855.5)	21	-6862 (871.93)		18.6 %	-16.58 [-545.40, 512.24]
Total (95% CI)	**140**		**66**			**100.0 %**	**4.12 [-223.91, 232.16]**

Heterogeneity: Tau² = 0.0; Chi² = 1.04, df = 2 (P = 0.59); I² =0.0%

Test for overall effect: Z = 0.04 (P = 0.97)

WHAT'S NEW

Last assessed as up-to-date: 10 August 2005.

Date	Event	Description
13 November 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 2004

Review first published: Issue 4, 2006

Date	Event	Description
1 April 2008	Amended	Minor error about dropout in Onozawa 2001 corrected.
10 November 2006	Amended	Minor changes have been made in November 2006 (to be published Issue 1, 2007)
9 August 2006	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

This review was written by Angela Underdown, Jane Barlow, and Sarah Stewart-Brown. Vincent Cheung identified, translated, and data extracted the Chinese papers.

Angela Underdown and Jane Barlow will share responsibility for updating the systematic review as new material becomes available.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- University of Warwick, UK.

External sources

- No sources of support supplied

INDEX TERMS

Medical Subject Headings (MeSH)

*Child Development; *Massage; *Therapeutic Touch; Infant, Newborn; Physical Stimulation; Randomized Controlled Trials as Topic

MeSH check words

Humans; Infant