

THE ASSOCIATION OF INFANT CARRIAGE ALTERED POSTURE AND MUSCULOSKELETAL PAIN: A NARRATIVE REVIEW

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ABSTRACT

Infant carriage in rural Africa is a daily activity for the 'impoverished' residents. The empirical evidence on the effect of infant carriage on caregivers' health and well-being is limited. This literature review presents the effect of infant carriage on musculoskeletal pain. An electronic literature surveillance was conducted using the Preferred Reporting Items for Systematic Reviews and NCBI, PubMed, Bookshelf, and Google Scholar (2013-2023). Key descriptors were chosen as "infant carriage, musculoskeletal pain, injury". The merit of the papers was assessed using a modified Downs and Black Appraisal Scale. Scientific papers (n=2033) were initially identified and reduced to seven (7) empirical studies. A total of 843 participants were described across the seven empirical investigations. Their mean age was 29.27 ±4.06 years, body mass (65.51±4.97 kg), height (1.62±0.08 m) and infant mass (12.81±3.99 kg). Four studies reported that infant carrying is associated with altered posture, which produces musculoskeletal pain. Six studies reported an association between infant carriage and musculoskeletal pain in caregivers. The literature confirms that infant-carrying methods alter caregivers' posture, with front infant carriage producing excessive lumbar lordosis and thoracic kyphosis, thereby coercing the caregiver to adopt a kypholordotic posture. To maintain an upright posture, the caregiver had to hyperextend the lumbar vertebrae, adopting an excessive lordotic posture. The caregiver adopted a kypholordotic posture to ensure that her body and the infant's centre of mass remained within the caregiver's base of support. The literature surveillance further identified an association between infant carriage and a high occurrence of musculoskeletal pain. The vulnerable anatomical sites include the lower back, upper back, and shoulders. This article describes how infant carriages alter sagittal plane posture. Further, the narrative indicates the link between altered posture and the incidence of musculoskeletal pain when carrying an infant. This evidence can be used to create awareness among rural female African caregivers and develop strategies to prevent deviated postures when carrying an infant, thereby alleviating musculoskeletal pain.

Keywords: Infant carriage method, posture, musculoskeletal pain

INTRODUCTION

Human infant carrying is an essential task because infants depend on their mothers and/or caregivers for nutrition, protection, and mobility. Infant carrying, also known as baby wearing, is a crucial part of the child-rearing process (Schön and Silven, 2007). Baby wearing is known as the fourth trimester, and/or the Exterogestation period (Ojukwu, Anyanwu, Anekwu, Chukwu and Fab-Agbo, 2017). Generally, infants are carried until weaned, which coincides with the time when the infant is capable of walking independently, or when the infant's biological mother has another baby (Wall-

Scheffler, Shalska-Izdebska, Rachwal and Truscynska, 2007). Ojukwu, Fab-Agbo, Ikele, Onuchukw and Anekwuet (2017) reported the following benefits of infant carriage: improved infant learning, immunity, general health, and sleep patterns.

In rural indigenous communities, manual domestic labour is a daily occurrence due to limited financial resources (Ojukwu et al., 2017; Van Eeden, Ellapen and Paul, 2023a). Many nursing mothers resume paid employment, leaving their infants in the care of surrogate caregivers (older siblings and grandmothers) (Van Eeden et al., 2023a). Those unfortunate mothers who do not have this social infrastructure carry their infants on their backs while resuming these responsibilities.

Infants are usually carried in close body contact with their caregiver, with a wrap, sling, or flexible pouch (Van Eeden et al., 2023a). Singh has identified cross-cultural distinctions among infant-carrying methods (ICM) (Singh, 2009). McMann has identified three distinct methods of carrying infants: front, back, and side on the caregiver's hip (McMann, 2008). The back and front ICMs are achieved using a large, solitary piece of cloth, such as a shawl, which envelops the infant against the caregiver's torso, with the ends tied around the shoulder or torso (Singh, 2009). Rural African mothers and/or caregivers traditionally carry their infants in a cotton cloth called a kanga (in Benin) or a capulana (in Mozambique) (Wax, 2004). The side ICM involves placing the infant on the caregiver's hip, with their arm and/or a shawl providing support and stability (Deloache and Gottlieb, 2001).

Infant carriage biomechanically imposes trunk loading, which invariably places physical stress on the caregiver, increasing energy cost and risk of musculoskeletal injury. The literature indicates that ICMs incur high caregiver energy expenditure (Altmann and Samuels, 2001; Kramer, 1998). The additional mass of the infant on the caregiver's trunk creates an external load that increases their energy expenditure (Wall-Scheffler et al., 2007; Watson, Payne, Chamberlain, Jones and Sellers, 2008). However, there is a paucity of empirical evidence explaining the pathomechanics of altered posture associated with ICMs. There are postulations that ICMs change the caregiver's posture, but a pathomechanical explanation is needed. This narrative review aims to summarise the empirical literature investigating the effects of ICMs on the caregiver's posture, the association with musculoskeletal pain, and the pathomechanical explanation for this association. This evidence will then be synthesised through Mill's canon for epidemiological trustworthiness.

METHODS

Protocol

The authors conducted an electronic narrative literature review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Search strategy and literature sources

The authors conducted an electronic search of peer-reviewed empirical articles across the following databases: NCBI, PubMed, Bookshelf, and Google Scholar, from 2013 to 2023 (Figure 1). The chief keywords in the literature search were infant carriage, and subsequent descriptors were musculoskeletal pain and injury. The literature surveillance criteria were applied in three distinct phases: title review, abstract review, and full-text review. The papers were vetted by the authors (TJE and BKG).

Eligibility criteria

Participants were empirical articles relating to the effect of infant carriage on the caregiver's posture and musculoskeletal health. The articles were chosen based on the keywords. The articles (participants) were screened according to the exclusion criteria as stipulated below. Pertinent themes that emerged included: a deviated posture due to infant carriage and an association between musculoskeletal pain and infant carriage. The identified themes evolved into the following research questions:

- What series of kinematic events produced in postural change?
- What is the association between musculoskeletal pain and infant carriage?
- What is the strength of the clinical evidence supporting the ill effects of infant loading that produces deviated posture among caregivers?

Exclusion criteria

The exclusion criteria covered the following aspects:

- Empirical investigations and review papers before the time frame of 2013.
- Studies relating infant carriage investigations not focusing on postural deviations.
- Studies relating to infant carriage investigations not focusing on musculoskeletal health.
- EMG studies.
- Duplicate papers.
- Non-English papers.

The above exclusion criteria and review process are outlined in Figure 1 below.

PRISMA Flow Diagram

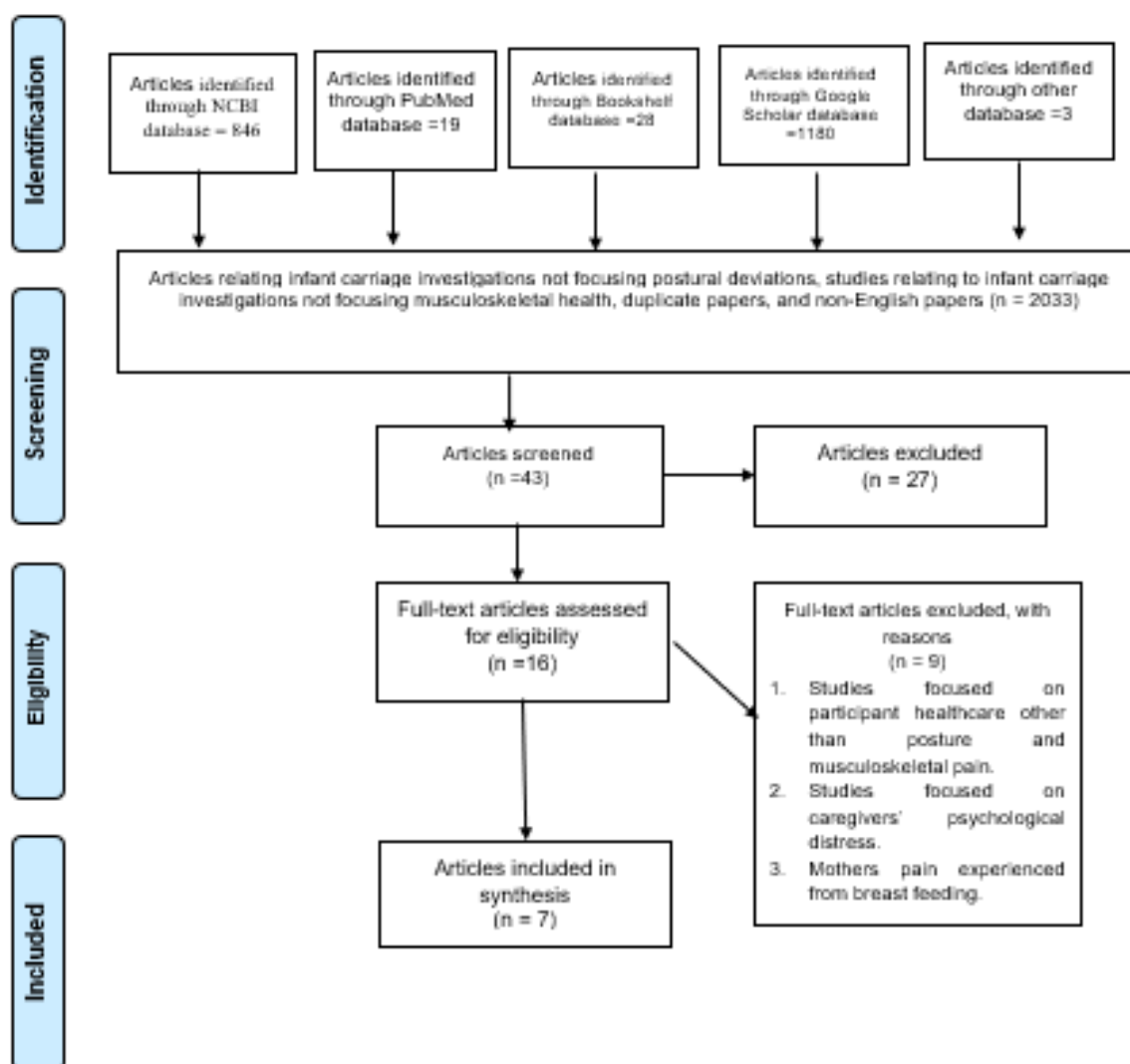


Figure 1: The review process applied to papers

Appraisal of Papers

The literature was assessed for the appropriateness of the title and subsequent compliance with the eligibility criteria. The value of individual papers was assessed employing a modified Downs and Black Appraisal Scale, which scrutinised the merit of the papers (Table 1) (Downs and Black, 1998). The modified Downs and Black Appraisal Scale was employed because all the questions on the primary checklist were relevant to this study, as stated by Grober, Tremblay, Mober and Gorber (2007). This application was employed to prevent any author/s prejudice. The modified checklist comprises 13 questions, each worth up to 13 points. A score of either 0 (no) or 1 (yes) was given for each answer. The questions adopted from the modified Downs and Black Appraisal Scale were 1, 2, 3, 4, 6, 10, 11, 12, 13, 14, 18, 20, and 27. These questions are classified into four sections that evaluate the overall merit of individual papers (Table 2). The classification considered the reporting quality (n= 6 questions), external validity (n= 3 questions), internal validity (n= 3 questions), and power to detect

significance (n= 1 question) of each publication (Downs and Black, 1998). Both authors were able to query the scoring of each record and would then discuss the scores, adopting the jointly accepted score if necessary. The cumulative score of individual papers was subsequently converted into a percentage, thereby appraising the overall merit of the individual records (Downs and Black, 1998). The overall value of the empirical papers was further categorised into the following scale: < 50% (weak), 50-69% (fair), 70-79% (good) and <80% (very good) (Downs and Black, 1998). The mean rating of the selected papers was 86.80% (very good). Table 2 is the mean appraisal of selected papers by TJE and BKG.

Table 1: The questions modified Downs and Black Appraisal Scale (Downs and Black, 1998)

Question	Yes (Score =1)	No (score =2)
REPORTING		
1. Is the hypothesis/aim/objective clearly described?		
2. Are the main outcomes to be measured clearly described in the Introduction or Methods sections?		
3. Are the characteristics of the patients included in the study clearly described?		
4. Are the interventions of interest clearly described?		
6. Are the main findings of the study clearly described?		
10. Have the actual probability values been reported for the main outcomes, except where the probability value is less than 0.001?		
EXTERNAL VALIDITY		
11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?		
12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?		
13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority receive?		
INTERNAL VALIDITY BIAS		
14. Was an attempt made to blind study subjects to the intervention they received?		
18. Were the statistical tests used to assess the main outcomes appropriate?		
20. Were the main outcome measures used accurately? (validity and reliability)		
POWER OF SIGNIFICANCE		
27. Did the study have sufficient power to detect a clinically important effect, where the probability value for a difference being less than 5%		

Table 2: Mean appraisal of empirical papers pertaining to infant carriage among caregivers associated with postural changes and musculoskeletal pain during the period of 2009-2019 (n=6)

Authors	Modified Downs and Black Appraisal Scale					
	Reporting (n=6)	External Validity (n=3)	Internal Validity (n=3)	Power (n=1)	Total (n=13)	Grading %= $x/13 \times 100$
Havens, Severin, Bumpass and Mannen (2020)	6	2	2	1	11	84.61
Holtermann, Fjeldstad, Greby Schmidt, Svendsen, Nørregaard Rasmussen (2020)	5	2	2	1	10	76.92
Ojukwu et al (2017)	6	2	2	1	11	84.61
Ojukwu et al (2017)	6	2	2	1	11	84.61
Schmid, Stauffer, Jäger, List and Lorenzett (2019)	6	2	3	1	12	92.30
Van Eeden et al. (2023a)	6	2	3	1	12	92.30
Van Eeden et al. (2023b)	6	2	3	1	12	92.30

RESULTS

A total of 843 participants were documented across the six empirical investigations, with a mean age of 29.27 ± 4.06 years, body mass of 65.51 ± 4.97 kg (only four studies provided data), height of 1.62 ± 0.08 m (only four studies provided data), infant mass of 12.81 ± 3.99 kg (only two studies provided data) and the mean infant mass relative to the caregiver's body mass of 18.37% (only two studies provided data). The seven studies comprised two randomised control trials, two pseudo-randomised control trials, and three comparative trials without controls (Table 3). Van Eeden et al (2023a) fall into the categories of randomised controlled trial, comparative trial with control, and pre-test/post-test comparison (Table 3) (Van Eeden et al., 2023a). All the empirical investigations (n=6) explored the effects of infant carriage, three included interventions (Table 4) (Van Eeden et al., 2023a; Havens et al., 2020; Schmid et al., 2019). The other four investigations reported on the incidence of infant carriage-associated musculoskeletal pain (Table 4) (Ojukwu et al., 2017; Holtermann et al., 2020; Ojukwu et al., 2017; Schmid et al., 2019). There were four investigations completed in the African continent (57.14%) and two in Europe (28.57%), and a solitary investigation in the United States of America (14.28%) ($p=0.0002$). Country stratification identified two empirical investigations were completed in South Africa and Nigeria (28.57%), one study in the United States of America (14.28%), Germany (14.28%) and Denmark (14.28%) ($p=0.001$) (Table 4).

Table 3: Evaluation of the grading of empirical papers (n=7)

Level	Type of record	No.	Authors
Level 1	Systematic reviews and clinical commentaries	0	Nil
Level II-1	Randomised control trials	2	Van Eeden et al. (2023a); Van Eeden et al. (2023b)
Level III-1	Pseudo-randomised controlled trial	2	Ojukwu et al. (2017)
Level III-2	Comparative study with concurrent controls	1	Van Eeden et al. (2023a)
Level III-3	Comparative study without concurrent controls	3	Havens et al. (2020), Holtermann et al. (2020); Schmid et al. (2019)
Level IV	Case series/studies with either post-test or pre-test/post-test outcomes	1	Van Eeden et al. (2023a)

Data synthesis

The study's findings were categorised into aims, methods, and findings. In the method sub-category, the data presented included the research design, the demographic characteristics of the sample, and the data collection protocol. Findings include participant age, body mass, stature, body mass index, posture findings and incidence of musculoskeletal pain (Table 3).

Table 4: Chronological cataloguing of empirical papers (n=7) relevant to the effect of infant carriage on caregivers' posture and musculoskeletal health (2013-2023)

Authors/countries	Aim	Method	Findings
Havens et al. (2020) United States of America	To determine the kinematics while carrying infants and attempting to lift objects.	In this biomechanics investigation, 10 healthy females performed walking and an object lifting task under three conditions: (1) holding nothing (unloaded), (2) carrying an infant mannequin in-arms, and (3) an infant mannequin in a baby carrier.	Participants' mean age (27.4 ± 4.1 years), body mass (62.6 ± 12.2 kg) and height were 1.7 ± 0.1 m. When carrying and/or wearing an infant, it induces a mechanical constraint which adversely affects the incumbent's kinematics, causing pain and dysfunction to the caregiver/porter.
Holtermann et al. (2020) Denmark	To determine the physical demands of infant caregivers	Data gathering involved completing an electronic questionnaire, performing kinanthropometry measurements, assessing physical activity using accelerometer measurements, and analysing posture using Acti4 on 199 participants.	Participants' average age was 37 years, body mass index of 25.3 kg/m^2 , systolic blood pressure (118.1 systolic mmHg) and diastolic blood pressure (78.9 diastolic mmHg). On average, participants worked 34.9 hours weekly. The principal activities of the working hours included: standing (22.8%), moving (13.0%), walking (14.6%), running (0.1%), and climbing stairs (0.7%). One hundred and seventy-five participants adopted knee-straining postures, kneeling (2.5%) and squatting (1.6%). Child caring does produce musculoskeletal pain.
Ojukwu et al. (2017) Nigeria	To understand the musculoskeletal pain associated with different ICMs.	Participants completed a self-report questionnaire with three sections. Section A focused on socio-demographic characteristics, Section B focused on infant and maternal characteristics, and Section C probed the incidence of musculoskeletal-associated infant carriage.	Participant numbered 227, with an average of 25.5 ± 6.81 years. The most vulnerable anatomical sites of musculoskeletal pain were the lower back (82.8%) and the upper back (74.9%). Back and ICM were associated with upper and lower back pain. Participants generally preferred the back ICM (60.4%), while front ICM was adopted by 21.9% and side (17.7%).

Authors/countries	Aim	Method	Findings
Ojukwu et al (2017)	To determine the musculoskeletal risk factors associated with infant carriage among Nigerian mothers	A convenience sample of 192 Nigerian mothers, aged 18 to 35 years, whose infants completed a pre-tested self-administered questionnaire. The questionnaire probed maternal demographics, postpartum characteristics and history of infant carrying related to lower back pain.	Predisposing factors of lower back pain associated with infant carriage among mothers included maternal age over 35 years, nursing an infant whose body mass exceeds 10kg and caesarean birth
Schmid et al. (2019) Germany	To determine what are the effects of different sling-based infant carrying techniques on trunk mechanics.	Through Vicon motion analyses of the pelvis and spinal kinematics of 15 healthy young women during upright standing and level walking without wearing a load and wearing a 6 kg mannequin with a sling in front and on the sides.	When participants carried the mannequin, they adopted a hyper-extended lumbar vertebral lordosis and excessive kyphosis. Participants' mean age, body mass and stature were 27.0±8.0 years, 60.0±9.0kg, and 1.68±0.07m, respectively.
Van Eeden et al. (2023a) South Africa	To determine whether the caregivers' posture changed when carrying their infants on their backs compared to standing without infants.	South African mothers and caregivers (n=100), whose age ranged between 18 and 40, willingly participated in a pre-test/post-test crossover observational randomised control investigation. The experimental group (n=50) stood carrying their infants on their backs in a loaded state. The control group (n=50) was evaluated without carrying their infants (unloaded). The control group crossed over to the experimental group, and vice versa. Participants' standing	Participants' mean age, standing height, body mass, and infant mass were 29.36±7.68 years, 1.558±0.051 m, 69.72±18.92 kg, and 12.81±3.99 kg, respectively. Infant carriage significantly diminished caregivers' standing vertex (1.558±0.051 vs 1.555±0.052 m) and anterior iliac crest (0.943±0.045 vs 0.924±0.058 m) heights as compared with the unloaded state (p<0.001). Participants' CHA (14.69±7.83 vs 16.20±6.41°), and SPA (15.08±6.30vs 29.36±7.68°) were enlarged during infant carriage (p<0.01).

Authors/countries	Aim	Method	Findings
		vertex, and anterior iliac crest heights, standing pelvic angle (SPA), and craniohorizontal angle (CHA), were assessed.	
Van Eeden et al. (2023b) South Africa	To ascertain whether the back infant carriage is associated with musculoskeletal pain.	South African mothers and caregivers (n=100) freely participated in the study. All participants completed an infant carriage health-related questionnaire, which included the incidence of infant carriage-associated musculoskeletal pain, anatomical site, and type of pain. Participants' body mass, standing height and infant mass were recorded.	Participants' mean age, standing height, body mass, and infant mass were 29.36±7.68 years, 1.558±0.051 m, 69.72±18.92 kg, and 12.81±3.99 kg, respectively. Most participants (89%) predominantly complained of neuro-musculoskeletal pain in their lower back, upper back, shoulders, and neck associated with infant carriage (p<0.0001). A predisposing risk of infant carriage associated neuro-musculoskeletal pain was carrying heavy infants (12.97±3.99 kg) (effect size p=0.6).

DISCUSSION

The discussion presents these themes: the effect of ICM on the caregiver's posture, the association between musculoskeletal pain and infant carriage, and the strength of the evidence supporting the impact of ICMs on altered posture and musculoskeletal pain.

The effects of ICM on the caregiver's posture

The literature confirms that ICMs alter caregivers' posture, with front infant carriage producing excessive lumbar lordosis and thoracic kyphosis, coercing caregivers to adopt a kypholordotic posture (Ojukwu et al., 2017; Van Eeden et al., 2023a; Havens et al., 2020; Schmid et al., 2019). Havens et al. and Schmid et al (2019). postulated that when participants carried an infant in front, their thoracic vertebrae anteriorly flexed, their scapulae were protracted, and their shoulders were rounded, simulating a kyphotic posture (Havens et al., 2020; Schmid et al., 2019). To maintain an upright posture, the caregiver had to hyper-extend the lumbar vertebrae, adopting an excessive lordotic posture. The caregiver adopted a kypholordotic posture to ensure that the caregiver's body and the infant's centre of mass remained within the caregiver's base of support.

Van Eeden et al. (2023a) confirmed that the back infant carriage does produce anterior pelvic rotation and cervical lordosis. The cervical lordosis was associated with craniohorizontal angle (CHA) enlargement, while simultaneously diminishing the craniovertebral angle (CVA). The diminished CVA decreased, suggesting anterior translation of the cervical vertebrae on the thoracic vertebrae (Lau, Chiu and Lam, 2009). Van Eeden et al. (2023a) extrapolate the pathomechanical rationale for the altered posture from Ellapen, Hammill, Paul and Swanepoel's (2021) biomechanical explanation of posterior school backpack loading (Van Eeden et al., 2023a; Ellapen et al., 2021). Ellapen et al suggested that when an individual carries a backpack, their CVA decreases to maintain the equilibrium of the natural anterior-posterior vertebral curves (Ellapen et al., 2021). The typical architecture of the human anterior-posterior vertebral curves comprises negligible but tolerable cervical lordosis, thoracic kyphosis, and lumbar lordosis, which enable the vertebral column to maintain an upright posture (Mansfield and Neumann, 2014). When the posterior external load (backpack or infant) surpasses the individual's muscle strength and endurance of the sacrospinalis muscles, an anterior pelvic tilt in the medial-lateral axis occurs (Kistner, Fiebert and Roach, 2012). Voll and Klimt contended that individuals should not carry posterior external loads beyond 10% of their body mass (Voll and Klimt, 1977). The simultaneous increase in CHA enabled the individual to maintain an upright cervical posture, counteracting the increased forward CVA translation (Hammill et al., 2017). Van Eeden et al. (2023a) identified an increased standing pelvic angle during back infant carriage, consistent with earlier findings (Van Eeden et al., 2023a; Voll and Klimt, 1977; Hammill et al., 2017). Abrahams, Ellapen, Van Heerden and Vanker (2011) report that individuals adopt an excessive lumbar lordotic posture when carrying backpacks exceeding 10% of their relative body mass, findings that are consistent with this study (Abrahams et al., 2011; Walikca-Cuprys, Shalska-Izdebska, Rachwal and Trusczyńska, 2015).

The association of musculoskeletal pain and infant carriage

The literature confirmed that ICMs are associated with a high occurrence of musculoskeletal pain (Ojukwu et al., 2017; Van Eeden et al., 2023b). The vulnerable

anatomical sites include the lower back, upper back, and shoulders (Ojukwu et al., 2017; Van Eeden et al., 2023a). Ojukwu et al. (2017) and Van Eeden et al (2023a) concurred that those infants beyond 10% of the caregiver's relative body mass and weighing greater than 10kg predispose caregivers to the incidence of musculoskeletal pain (Ojukwu et al., 2017; Van Eeden et al., 2023b). Ojukwu et al. (2017) also identified other predisposing factors of musculoskeletal pain, including maternal age older than 35 years and previous caesarean birth (Ojukwu et al., 2017). Van Eeden et al (2023a) also identified that caregivers with a body mass index greater than 27.58 kg/m² are predisposed to musculoskeletal pain (Van Eeden et al., 2023b). The literature has also recommended that ergonomists, health scientists, physiotherapists, and biokineticists strategise to develop an ergonomic product that enables nursing staff to carry infants without sustaining musculoskeletal pain (Ojukwu et al., 2017; Van Eeden et al., 2023b).

The strength of evidence supporting the impact of ICMs associated with altered posture and musculoskeletal pain

It is common practice to apply Mill's Canons to establish the strength of the empirical evidence supporting causal conclusions (Dishman, Heath and Lee, 2013). As such, the authors adopted Mill's Canons to determine the vigour of synthesised evidence, concluding the causal inference that ICMs produce posture alterations among caregivers, leading to associated musculoskeletal pain:

- i. Temporal sequence denotes the order of the intervention exposure, which must herald the change of the pathological condition (ICM associated with musculoskeletal pain) within an appropriate period to establish a credible conclusion. Four studies reported that infant carrying is associated with altered posture, which produces musculoskeletal pain (Ojukwu et al., 2017; Van Eeden et al., 2023a; Ojukwu et al., 2017; Van Eeden et al., 2023b). Five studies indicated that infant carriage alters the caregiver's posture. (Ojukwu et al., 2017; Van Eeden et al., 2023a; Havens et al., 2020; Ojukwu et al., 2017; Van Eeden et al., 2023b). Six studies reported an association between infant carriage and musculoskeletal pain in caregivers (Ojukwu et al., 2017; Van Eeden et al., 2023a; Havens et al., 2020; Schmid et al., 2019; Ojukwu et al., 2017; Van Eeden et al., 2023b).
- ii. Strength of association refers to the clinical importance between the disease (altered posture) and the intervention (ICMs). Four studies reported that infant carrying is associated with altered posture, which produces musculoskeletal pain (Ojukwu et al., 2017; Havens et al., 2020; Ojukwu et al., 2017; Van Eeden et al., 2023b).
- iii. Consistency of results refers to the reliable observation of the relationship between the consequence of the intervention (ICMs) and the pathology (musculoskeletal pain). Four studies reported that infant carrying is associated with altered posture, which produces musculoskeletal pain (Ojukwu et al., 2017; Havens et al., 2020; Ojukwu et al., 2017; Van Eeden et al., 2023b).
- iv. Biological plausibility refers to the scientific explanation of the observed result of the intervention (ICMs) regarding pathology (musculoskeletal pain). Six studies reported an association between infant carriage and musculoskeletal pain in caregivers (Ojukwu et al., 2017; Van Eeden et al., 2023a; Havens et al., 2020; Holtermann et al., 2020; Ojukwu et al., 2017; Van Eeden et al., 2023b).

- v. Dose response refers to the volume of intervention required to produce a specific outcome on the disease. Ojukwu et al (2017) and Van Eeden et al (2023b) reported that carrying infants greater than 10kg and/or 10% of the caregiver's body mass is associated with musculoskeletal pain (Ojukwu et al., 2017; Van Eeden et al., 2023b).

CONCLUSION

This narrative overview has found that ICMs do produce altered posture, which is associated with musculoskeletal pain. Additional predisposing risk factors to musculoskeletal pain include mothers older than 35 years who are having babies, caesarean birth, infants heavier than 10kg and/or 10% or more than the caregiver's body, and high body mass (> 27 kg/m²). The vulnerable anatomical sites of musculoskeletal pain were the lower back and upper back. It is recommended that these findings be communicated to the rural female caregivers who carry their infants as well as to biokineticists and physiotherapists. The biokineticists and physiotherapists should draft exercise, stretching, and strengthening programmes to symmetrically stretch and strengthen the respective muscles. The improved symmetrical alignment of vertebral muscles will prevent the altered posture and musculoskeletal pain.

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