Factors that Might Give Rise to Musculoskeletal Disorders when Mothers Lift Children in the Home

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Abstract

Objective. The objective of this research was to identify the risk factors for musculoskeletal disorders present when mothers lift normally developing children weighing between 20 and 31 lbs (9–14 kg) in the home. Method. Twenty five mothers aged 28–40 years completed Sanders and Morse’s (2005) self-report survey of pain and high-risk practices. In addition, the OMLITH, a structured checklist for observing mothers lifting children in the home, was developed. Criteria to rate variables relating to the load (child), environment, person (mother) and task as low, moderate or high risk were developed, on the basis of published manual handling assessments. The mothers were observed performing 87 lifts, and risk factors were rated. Results. The majority of participants reported low back pain (64%). They self-rated bending while carrying a child as most stressful, and various other tasks involving carrying; prolonged bending, squatting or stooping; and lifting a child as physically stressful. At least one risk factor related to the load was recorded in all 87 observations, with moderate to high risk most frequently related to the child’s weight (73.6%) or the mother’s grip on the child (93.1%). Common environmental factors presenting a moderate to high risk related to space constraints (59.7% of tasks) and equipment (58.6%). Factors related to the mothers’ strength and fitness (57.5% of tasks) commonly posed moderate to high risk, as did horizontal reach distances (82.8%), vertical lift distances (78.2%) and reaches above shoulder height or below mid thigh level (88.5%). Trunk rotation greater than 45° or combining rotation and side bending while lifting resulted in a moderate to high risk rating in 72.4% of tasks. The developmental age of the child interacted with weight to increase or decrease the requirement for lifting. Conclusion. Risk factors for musculoskeletal disorders are present to a significant degree, and further research in this area is warranted. Copyright © 2012 John Wiley & Sons, Ltd.

Keywords

ergonomics; lifting; mothers; observation; quantitative descriptive design; risk factors

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Introduction

Mothers routinely lift children in and out of car seats, tubs, cribs, strollers and highchairs. Some experience musculoskeletal disorders (MSDs) that affect their lower back, neck, shoulders, wrists and knees. Acknowledging a relationship between the lifting parents do and MSDs, one study surveyed parents of children under 4 years old to examine the frequency, type and severity of musculoskeletal symptoms, and the
contributory factors (Sanders & Morse, 2005). Among the 120 parents who participated, 66% reported musculoskeletal pain (low back pain, 48%; neck, upper back or shoulder pain, 44%; knee, finger, wrist or hip pain, 10%). Diagnoses of those who had visited a physician included low back strain, sciatica, shoulder tendinitis, knee pain, neck pain, wrist tendinitis, de Quervain’s tendonitis, carpal tunnel syndrome and hip tendinitis.

Although the researchers concluded that ‘a high number of parents, primarily mothers, appear to be at risk for developing some kind of musculoskeletal pain as a result of caring for children under 4 years of age’ (p. 292), the nature of the survey instrument did not allow them to identify the specific physical and psychological risk factors giving rise to MSDs. The current study built upon the work of Sanders and Morse by identifying the risk factors for mothers only, to eliminate the effect of gender differences, and because women are the primary caregivers and there is international recognition of the need for information on the occupational health of women (Kane, 1999).

Prevalence and significance of musculoskeletal disorders in mothers

The importance of addressing the prevalence of the MSDs mothers attribute to childcare tasks, in particular lifting, can be argued on several grounds: the function mothers perform in society, the proportion of the population who are mothers (56% of women in the United States) (US Census Bureau, 2005), the medical costs, and the social and personal costs associated with loss of productivity (Kane, 1999). Concern about the impact of MSDs on mothers has been expressed among health providers (American Academy of Orthopaedic Surgeons, 2005; Mayo Clinic, 2005; Methodist Rehabilitation Center, 2006) and physical therapists (APTA, 2006), and in parenting magazines and newsletters (Eller, 2001; Pathways Center, 2005). Nonetheless, only two studies addressing the association between mothering tasks and MSDs have been published (Griffin & Price, 2000; Sanders & Morse, 2005). However, the research into paid childcare workers supports the link between childcare tasks and MSDs (Childcare Employee Project, 1983; Brown & Gerberich, 1993; Gratz & Claffey, 1996).

Work-Related MSDs and risk factors associated with lifting

Work-related approaches used to establish causality between work-related exposures and MSDs are also applicable to mothers. The National Research Council document, Musculoskeletal disorders and the workplace (2001), informs that approach. It evaluated and collated theories of causation, prevalence data, and evidence relating to prevention and intervention. To describe the interplay of factors, a conceptual model identifying various pathways by which workplace and personal factors might lead to MSDs was developed (NRC, 2001). For this study, the National Research Council model was adapted to portray how four key groups of risk factors interact: those related to the task (lifting a child during a childcare activity), the primary external load (the child), the person (the mother) and occupational factors (such as the physical and social environment and additional external loads). See Figure 1.

Literature from occupational health and safety, ergonomics, biomechanics and occupational therapy provides some insights into these risk factors, as does the primary research in the paid childcare population (Brown & Gerberich, 1993; Grant et al., 1995; Kumagai et al., 1995; Gratz & Claffey, 1996; King et al., 1996; Shimaoka et al., 1998; Gratz, Claffey, King & Scheuer, 2002; Taloni et al., 2004; King et al., 2006). Examples of childcare tasks for which there is concern regarding the ergonomic strain include lifting a child onto or

![Figure 1 The adapted model of risk factors affecting mothers lifting children](image-url)
off a changing table, into or out of a crib with high sides or up from the floor; changing a child on the floor or in a crib or playpen; and pushing a child on a seated toy (Sanders & Morse, 2005). Specific factors associated with these tasks that increase risk are heavy or frequent lifting, awkward postures and tasks involving bending, twisting, stooping, or sitting or kneeling on the floor (Grant et al., 1995; King et al., 1996; Griffin & Price, 2000; Sanders & Morse, 2005).

Child-related factors that may influence risk include the developmental level, weight, body structure and behaviour (Grant et al., 1995; Kumagai et al., 1995, King et al., 1996; Shimaoka et al., 1998; Sanders & Morse, 2005), because they impact the frequency of lifting, the time the mother spends in non-neutral postures, and the ease of lifting and handling the child. Factors related to the mother that have been considered include height, shape, weight, physical capacity, biomechanics and physiology (Lindbeck & Kjellberg, 2000; Marras, 2000; Marras et al., 2000; NRC, 2001; Sanders & Morse, 2005). An association between pre-existing physical conditions and a higher risk for developing MSDs has been demonstrated (NRC, 2001). Pregnancy is also considered to alter manual handling capacity (Tapp, 2003).

All of the occupational (as opposed to individual) factors associated with WRMSDs (Bernard, 1997) are potentially present in mothers’ work. The workload intensity is largely determined by the needs of the child and not controlled by the mother (Griffin & Price, 2000; Tardy, 2000). Mothers may also experience work monotony and strain caused by the reduced job clarity associated with perceived expectations to fulfil multiple roles. Additional occupational factors include the extra loads mothers carry while carrying a child, such as childcare equipment, clothing, toys or furniture (Griffin & Price, 2000; Sanders, 2004; Sanders & Morse, 2005).

Relevant organizational factors include the space in which childcare tasks are performed, heights of work surfaces, safety of surfaces and childcare equipment (e.g. crib, changing tables, highchairs, car seats, mobility aids, strollers, indoor swings and child size furniture) (Griffin & Price, 2000; Sanders, 2004; Sanders & Morse, 2005). The degree to which risk factors can be modified will be affected by the norms, values, beliefs and attitudes within the home and in the wider community, economic factors, and the practical and social support that mothers receive (Francis-Connolly, 2000; Bell, 2004).

Therefore, the aim of this small-scale descriptive study was to investigate the physical demands of performing childcare occupations in a sample of healthy mothers aged between 28 and 40 years to confirm whether factors that might give rise to MSDs are present when mothers lift their children in the home environment.

**Method**

**Instrument development: survey**

To provide data comparable with Sanders and Morse’s (2005) original sample, their self-report Ergonomics of Caring for Children survey of participants’ demographic profile, height, weight, time use, pain and perceptions of high-risk practices was adopted. Part of this seven-page survey asked for physical stress ratings for 50 childcare activities. An example of the stress rating section of the survey is given in Figure 2. Adaptations made in consultation with Sanders comprised identifying children by weight rather than age and changing terminology to the New Zealand equivalent, for example crib to cot, tub to bath and diapers to nappies. Instructions to note bodily pain were simplified (McKay, 2008).

Because of the lack of previous research in this area, Sanders and Morse had developed their survey instrument from field observations of childcare tasks, focus-group feedback from parents of children 0 to <4 years of age, the literature and 20 pilot surveys. It was reviewed by seven experts (three occupational therapy professors specializing in ergonomics, orthopaedics or paediatrics; one social research scientist; an ergonomist and two experienced daycare providers). The survey was critiqued with regard to clarity, face validity and the degree to which the survey question answered the research questions. For the current study, the survey was primarily used to gather demographic and descriptive data and not used to make causal associations. Therefore, the development process of the original survey was deemed acceptable, and the benefits of building on the data collected by Sanders and Morse outweighed the disadvantages of a non-standardized tool, particularly as standardized tools do not exist for this specific area.

**Instrument development: structured observation checklist**

A structured checklist for observing mothers lifting children in the home (the OMLITH) was developed. It covered a broad range of factors covering aspects of
the load (weight, bulkiness, centre of gravity, hindrance to vision, and difficult to grip), environment (flooring, slopes or steps, atmospheric conditions, noise, lighting, space, and equipment), person (strength/fitness, special considerations, clothing, and fatigue) and task (horizontal reach, vertical lift, lift above shoulders or below mid thigh, carrying, twisting, mother’s movement, work pace, seated handling and squat/kneel/crouch). Fatigue was measured using a visual analogue scale developed for the study to indicate fatigue on the day compared with a usual day. The scale ranged from no tiredness at all to complete exhaustion, allowing inferences to be made about fatigue as a confounding factor.

Observation-based methods are commonly used in occupational settings where direct instrumentation is not easy to achieve. Such methods have the advantage of being low cost, easy to use, not interfering with the job process and having a relatively quick analysis time. However, the disadvantages are that they may lack precision or reliability if each observation factor does not have clearly outlined rating criteria and if too fine a measurement is expected; that is, reliability is higher when less fine distinction is required (Dartt, 2010). Reliability of the observations was addressed by developing clear criteria for rating each variable as low, moderate or high risk. The criteria were drawn from the New Zealand Manual Handling Hazard Control Record (OSH & ACC, 2001) and other widely used assessment tools: Manual Handling Assessment Chart (HSE, 2004), Manual Handling of Loads Assessment Checklist (HSE, 2004), Manual Tasks Risk Assessment (Burgess-Limerick et al., 2004), National Institute of Occupational Safety and Health equation (Neumann, 2006) and Rapid Entire Body Assessment Tool (Coyle, 2005). See Figure 3 for examples of the rating criteria.

The validity of the tools from which the rating criteria were derived has been discussed in the literature, and the identified limitations of observational tools were taken into account for the current tool. The internal validity (the ability of the tool to measure what was intended) of the OMLITH was addressed by deriving the assessment criteria from a standardized tool for which internal validity was established; however, the external validity of the tool (i.e. the tool’s ability to distinguish physical levels of posture associated with an increase in MSDs for a given area) would still be limited (Lowe, 2004). This limitation was acceptable to the researchers, as this study was not trying to establish a causal link between certain risk factors and MSD outcomes but only to establish whether risk factors are present.

The OMLITH was developed in consultation with an expert in ergonomics at Auckland University of Technology, Auckland, and trialled on a pilot group of five mothers (10 scenarios). Difficulties faced during the pilot study were familiarity with the tool rating criteria, ability to observe and rate risk factors without disturbing the activity and ability to be consistent with...
some risk factors as criteria delineations are not clear enough. These issues were addressed by further time spent learning the criteria, systems to check and cross check the rating of criteria between observations with the written tool, and modifying rating criteria to enhance the accuracy of the ratings. Research on other observation-based ergonomic tools has shown that high consistency can be attained when the researcher is well trained and the rating criteria are clear and specific (McAtamney & Corlett, 1993).

### Procedure

Approval from a university ethics committee was obtained, and a convenience sample was recruited via an advertisement distributed by contacts of the authors and by snowball recruitment. Inclusion criteria were women not receiving treatment from a health provider, aged from 20 to 40 years, and the primary caregiver of one or more normally developing, healthy children, weighing between 20 and 31 lbs (9–14 kg). Prospective participants contacted the first author to arrange for a 2-hour observation visit in their home. They were then sent consent and information forms and the survey to complete. During the observation visit, the survey was collected, height and weight measurements of the mother and children were taken, and several tasks the mother undertook that involved lifting children within the specified weight range were observed and rated.

### Data analysis

Survey data were coded, entered into Microsoft Excel®, and descriptive statistics generated. To determine which activities were most stressful, the raw scores were turned into stress ratios (stress rating given by mother for that activity divided by average stress rating for all activities for that mother), and a one-way ANOVA was performed using Minitab®. The transformed data met the normality assumption required to use ANOVA.

Observational checklist ratings of each risk factor (low, moderate and high) were collated across all the 87 lifts observed. Pie graphs were generated to demonstrate the frequency of each level of the risk factor (e.g. unstable centre of gravity of the load was present at a high level in 25.3% of all lifts).

### Survey results

#### Participant demographics

Twenty five mothers with one or two children weighing between 9 and 15 kg (n = 30; mean weight 26.15 lbs [11.86 kg]) completed the survey and were...
observed lifting in their home. Participants ranged from 28 to 40 years of age (mean 34.6). They were between 157 and 185 cm tall (5 ft 1½–6 ft ½ in.; mean 169 cm, 5 ft 5½ in.), and had a body mass index of between 19.2 and 33.6 (mean 24.2). Most were married (80%), and all reported that they always (48%) or frequently (52%) received help with childcare. About half were working either full (12%) or part time (40%) outside the home. Most used childcare facilities (80%). They reported a mean of 6.8 hours of sleep per night. Most exercised (88%), on average 2.9 hours per week, with most engaging in cardiovascular exercise (80%). Most also had a hobby (76%), most commonly reading, writing, arts and crafts, or cooking, pursued for 2.2 hours per week on average. All reported housework responsibilities.

Pain reports

Low back pain was reported by 64% of the mothers, followed by neck, shoulder and upper back pain (all at 32%), knees (20%), hips/thighs (16%), and ankles/feet or elbows (both 4%). The results show that mothers in this sample did differentiate to a statistically significant degree (p = 0.000) between activities when rating physical stress associated with the activity. The mothers typically rated ‘Bending while carrying a child’ almost twice as stressful as their average rating. Other tasks rated above the average stress rating were ‘Use of a backpack to carry infant/child’, ‘Use of a baby jogger’, ‘Carrying a child on your shoulders’, ‘Standing bent over to wash child in bath or sink’, ‘Lifting child into or out of cot’, ‘Prolonged squatting or stooping while playing with a child’ and ‘Placing a child in car seat or removing child from car seat’.

Results from the observations: incidence of risk factors

Eighty seven childcare tasks involving lifting were observed, with each mother performing two to five tasks (mean of 3.48). Half of the tasks were lifting a child in or out of a cot (18) or a car seat (12), or changing a diaper on the floor (12). The other half involved lifting a child into or out of a piece of equipment (e.g. bath, highchair, stroller or toy), or onto or off a surface (changing table, knee, couch, coffee table or hip). At least one risk factor related to the load was recorded in all 87 observations. Most significantly, there was a moderate to high risk related to the grip required to lift the child, the weight of the child or the child’s unstable centre of gravity in 93.1%, 73.6%, and 52.9% of the tasks, respectively. See Table 1.

The factors in the environment that presented a moderate to high risk were the equipment involved (58.6% of tasks), the space constraints during the task (59.7% of tasks), the surface the task was performed on (41.4% of tasks) and noise (24.4% of tasks). See Table 2.

The risk rating for strength and fitness corresponded to the rate of perceived exertion the mothers reported and was rated high enough in 57.5% of tasks to constitute a physiological workload that resulted in a moderate to high risk rating. Special considerations related to the individual were present in 85% of tasks observed, ranging from minor temporary illnesses or physical impairments to third trimester of pregnancy, or serious physical health problems. In 41.4% of the tasks, the mother reported fatigue of moderate to high levels or fatigue that was higher than average for her. See Table 3.

Horizontal reach distances that required combined reach and trunk flexion and constituted moderate to high risk occurred in 82.8% of tasks. Extended vertical lift distances or reaches above shoulder height or below mid thigh level caused a moderate to high risk rating in 78.2% and 88.5% of tasks, respectively. Rotating the trunk more than 45° or combining rotation and side bending while lifting resulted in a moderate to high risk rating in 72.4% of tasks. When observed, lifting while seated or while kneeling or squatting presented a mostly high level of risk. See Table 4.

<table>
<thead>
<tr>
<th>Load-related factor</th>
<th>High risk</th>
<th>Moderate risk</th>
<th>Low risk</th>
<th>No risk present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty gripping load</td>
<td>75.9% (66)</td>
<td>17.2% (15)</td>
<td>2.3% (2)</td>
<td>4.6% (4)</td>
</tr>
<tr>
<td>Weight of load</td>
<td>20.7% (18)</td>
<td>52.9% (46)</td>
<td>26.4% (23)</td>
<td>Risk factors present during all observed tasks</td>
</tr>
<tr>
<td>Unstable centre of gravity</td>
<td>25.3% (22)</td>
<td>27.6% (24)</td>
<td>44.8% (39)</td>
<td>2.3% (2)</td>
</tr>
<tr>
<td>Shape/size of load 'bulkiness'</td>
<td>4.6% (4)</td>
<td>34.5% (30)</td>
<td>47.1% (41)</td>
<td>13.8% (12)</td>
</tr>
</tbody>
</table>

Table 1. Percentage of tasks in which risk factors related to the load were present and level of risk rated (n = 87 observed tasks)
Discussion

This study identified the risk factors for MSDs present when a sample of healthy mothers aged between 28 and 40 years lifted their children while performing childcare tasks at home. It followed the approach used by ergonomists to study the physical demands experienced by paid childcare workers of using combined research methods (survey or interview and observation) (Grant et al., 1995; King et al., 1996) but used a structured observation process so that the presence of risks could be quantified and presented graphically.

The research sample was broadly similar to Sanders and Morse’s (2005) sample, in terms of age, incidence and location of pain, time use and sleep. Mothers in this study perceived certain childcare tasks to be physically stressful and were able to differentiate the level of physical stress associated with different tasks to a statistically significant degree. This finding supports Sanders and Morse’s finding that mothers are able to identify activities that might expose them to higher levels of risk for MSDs. The self-report survey had limitations, however, in not identifying a time frame for the onset of MSDs, not establishing a MSD history for the mother, not identifying co-existing health conditions (e.g. illness or pregnancy) and not seeking information about why some of the other risk factors were present.

Factors related to the load, environment, person and task that might give rise to MSDs were present during all 87 observed tasks. Gripping the child represented a high risk in three quarters of the observed lifts and a moderate risk in 17% of the remaining lifts. Rotation while lifting, horizontal reach involving flexion, lifting above shoulder height or below mid thighs, and the mother’s strength and fitness presented a high risk in between 47% and 30% of lifts observed. Vertical lifts, lifting above shoulder height or below mid thighs and the child’s weight represented a moderate lift in between 71% and 53% of observed lifts. Additionally, childcare equipment such as cots and highchairs and cramped work space presented moderate levels of risk in a further 47% to 40% of lifts.

The OMLITH performed well in providing a broad overview of risk factors and clear criteria for assigning a rating to each factor. With a larger sample, associations...
between different factors could be analysed. Two risk factors (atmospheric conditions and the mother’s clothing and footwear) were not associated with high risk in any of the observed lifts and might safely be omitted from future research. Three other factors (slopes and steps, lighting and the child hindering the mother’s vision) were present in less than 40% of observed lifts and associated with high risk in less than 7% of lifts and might also be omitted in future studies to reduce the complexity of data collection.

The main limitations of the OMLITH, as with other observation-based ergonomic exposure tools, are that it would need further extensive testing to establish intra-rater and inter-rater reliability in order to become standardized and that the ability of such tools to identify causative links is limited. With a single researcher, there is also a risk of rater bias. However, the data gained from such preliminary observational studies can be used to direct future research using direct measurement or to establish whether it is worthwhile undertaking further testing of the tool if resources allow. This study suggests that further testing of the OMLITH is warranted, as it was easy to use, the criteria were clearly defined in a way that made for increased consistency and the data gained was consistent with the ergonomic exposures identified in other childcare research and those reported in the survey.

Despite the frequency of high risk associated with gripping and lifting heavy, moving or distressed children, the mothers were not observed to and did not report limiting childcare tasks to reduce the risk. That is consistent with reports that mothers do not class their infants as ‘heavy’ and therefore do not modify their lifting technique, and that when mothers lift children, they prioritize the safety and comfort of the child (Griffin & Price, 2000).

The weight-related risk was notable for its relationship with the developmental stage of the child. The youngest child in the current study weighed 25.6 lbs (11.6 kg) at 5 months of age, and feeding, changing and playing with him, and putting him to sleep required frequent lifting. His needs were extremely different to the oldest child in the study who weighed 28.7 lbs (13 kg) at 3 years old and moved independently. Future injury prevention studies might focus on the developmental stage of the child in combination with the child’s weight, in order to generate more specific advice regarding how to cope with the challenges presented by the child at different stages. The weight-related risk also interacts with the behaviour and mood of the child. The cooperation between the child and the mother affects the safety of the lift in that cooperative behaviour from a child in a quiet alert state will reduce the risk associated with load stability. Hence, future studies could examine behaviour and cooperation of the child and its influence on risk.

Implications

In confirming that mothers can accurately identify childcare tasks associated with physical strain and in quantifying the risk factors for MSDs, the study provides useful information for physiotherapists working with mothers of young children who present with MSDs. Specifically, it suggests the need to inquire about childcare practices, particularly how children are gripped, and positioning in relation to the child and highchairs, changing tables, and cots to reduce rotation and horizontal reach while lifting. Strategies to reduce the frequency of lifts, such as encouraging independence in toddlers where appropriate and soliciting help by involving partners and family in childcare, are suggested, as ongoing childcare demands may compromise recovery and long-term outcomes. Recruiting the child’s cooperation is also suggested. An awareness of how the child’s mood state and resulting behaviour can influence risk during lifting might encourage mothers to persevere with behavioural modification strategies to help reduce their physical strain. Strengthening in preparation for childcare may also be indicated in women presenting with pre-existing MSDs, deconditioning associated with chronic illness or a sedentary lifestyle, and for women known to be expecting a child with disabilities. Consultation with a physician is indicated for women with existing health conditions and in relation to developing carpal tunnel syndrome during pregnancy.

In relation to future research, despite the limitations of its small sample size, the study supports the continued use of the Ergonomics of Caring for Children survey, with modifications to remove activities rated as minimally stressful and gather information about pre-existing conditions and the onset of MSDs. It also supports the use of the OMLITH, with the possible removal of less frequently observed risk factors. Additionally, qualitative data that might provide insights into the reasons risk factors for MSDs exist, and how the contributory factors interweave might inform the development of intervention strategies.
REFERENCES


